Wayne State University
IBio RadioChemistry Facility
WSU Project Number 211-277899
Prevailing Wage Work

FOR:
Board of Governors
Wayne State University
Detroit, Michigan

Owner's Agent:
Valerie Kreher, Senior Buyer
WSU – Procurement & Strategic Sourcing
5700 Cass, Suite 4200
Detroit, Michigan 48202
313-577-3720 / 313-577-3747 fax
rfpteam2@wayne.edu and copy
leiann.day@wayne.edu

Owner's Representative:
Jason R. Davis, Project Manager
Facilities Planning & Management
Design & Construction Services
5454 Cass
Wayne State University
Detroit, Michigan 48202

Consultant:
Harley Ellis Devereaux
26913 Northwestern Hwy, Suite 200
Southfield, MI 48033

June 16, 2016
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INFORMATION FOR BIDDERS

OWNER: Board of Governors
Wayne State University

PROJECT: IBio RadioChemistry Facility
Project No. 211-277899

LOCATION: Wayne State University
IBio Building, 6135 Woodward Ave
Detroit, Michigan 48202

OWNER’S AGENT: Valerie Kreher, Senior Buyer
WSU – Procurement & Strategic Sourcing
5700 Cass, Suite 4200
Detroit, Michigan 48202
313-577-3720 / 313-577-3747 fax
rfpteam2@wayne.edu & copy leiann.day@wayne.edu

OWNER’S REPRESENTATIVE: Jason R. Davis, Project Manager
Facilities Planning & Management
Design & Construction Services
Wayne State University
5454 Cass Avenue
Detroit, Michigan 48202

Architect: Harley Ellis Devereaux
26913 Northwestern Hwy, Suite 200
Southfield, MI 48033

SPECIAL NOTE: Right to reject any and all proposals, either in whole or in part and to waive any irregularities therein is reserved by the Owner.

BIDS ADVERTISED: June 16, 2016

BIDDING: Bidding documents may be obtained by vendors from the University Purchasing Web Site at http://www.forms.procurement.wayne.edu/Adv_bid/Adv_bid.html beginning June 16, 2016. When visiting the Web Site, click on the "Construction" link in green. Copies of the RFP will not be available at the pre-proposal meeting.

MANDATORY Pre-Bid Conference: 2:00 P.M., local time, June 23, 2016 to be held at Wayne State University – 6135 Woodward Avenue, 1010 (Multi/Seminar Room), Detroit, MI, 48202. Late Arrivals may not be permitted to submit bids.

OPTIONAL Second Walk Through: (if needed) To be determined at the conclusion of the pre-bid conference, by those in attendance.

DUE DATE FOR QUESTIONS: Due Date for questions shall be June 30, 2016 at 12:00 Noon. All questions must be reduced to writing and emailed to the attention of Valerie Kreher, Senior Buyer at rfpteam2@wayne.edu, copy to Leiann Day, Procurement Analyst at leiann.day@wayne.edu.

Bids Due: Sealed proposals for lump-sum General Contract will be received at the office of the Procurement & Strategic Sourcing located at 5700 Cass Avenue, Suite 4200, Detroit, MI 48202 on July 6, 2016, until 2:00 p.m. (local time).

No public bid opening will be held.

Bid Qualification Meeting: Bidders must be available for bid prequalification meeting as soon as the day following the bid opening. The lowest qualified bidder will be contacted and requested to meet with Facilities Planning &
Management at their office located at 5454 Cass Avenue, Detroit, MI 48202. During the prequalification, the Vendor must provide a Project Schedule and a Schedule of Values, including a list of Contractor’s suppliers, subcontractors and other qualifications.

An unsigned contract will be given to the successful Contractor at the conclusion of the Pre Award meeting, if all aspects of the bid are in order. The Contractor has 5 business days to return the contract to the Project Manager for University counter signature. The contractor must also submit a Performance Bond as outlined above and a Certificate of Insurance in the same 5 business day period. In the event the Contractor fails to return the documents in this 5 day period, the University reserves the right to award the contract to the next most responsive bidder.

All available information pertaining to this project will be posted to the Purchasing web site at http://www.forms.procurement.wayne.edu/Adv_bid/Adv_bid.html. Information that is not posted to the website is not available/not known.
INSTRUCTIONS TO BIDDERS

OWNER: Board of Governors
Wayne State University

PROJECT: IBio RadioChemistry Facility
Project No. 211-277899

LOCATION: Wayne State University
IBio Building, 6135 Woodward Ave,
Detroit, Michigan 48202

OWNER’S AGENT: Valerie Kreher, Senior Buyer
WSU – Procurement & Strategic Sourcing
5700 Cass, Suite 4200
Detroit, Michigan 48202
313-577-3720 / 313-577-3747 fax
rfpteam2@wayne.edu & copy leiann.day@wayne.edu

1. PROPOSALS
   A. The Purchasing Agent will receive sealed Proposals for the work as herein set forth at the place and
      until the time as stated in the "Information for Bidders", a copy of which is bound herewith in theses
      specifications. **No public bid opening will be held.**

   B. Proposals shall be for a lump-sum General Contract for the entire work of the Project as
      provided in the Form of Proposal.

   C. Proposals shall be submitted in duplicate on forms furnished with the Bidding documents. The forms
      must be fully filled out in ink or typewritten with the signature in longhand, and the completed forms
      shall be without alterations, interlineations, or erasures. Forms shall contain no recapitulations of the
      work to be done. Each proposal shall be delivered in an opaque sealed envelope, marked
      "PROPOSAL" AND SHALL BEAR THE NAME OF THE PROJECT AND THE NAME OF THE
      BIDDER. Proposals submitted by telephone or telegraph will not be accepted. Modifications by
      telephone or telegraph to previously submitted proposals will not be accepted.

   D. (revised 5-29-2009) All base bids must be conforming to the detailed specifications and drawings
      provided by the University, including any Addenda issued. Voluntary Alternates will only be
      considered if the Contractor has also submitted a conforming base bid. Any stipulation of voluntary
      alternates or qualifications contrary to the Contract requirements made by the Bidder in or
      accompanying his proposal as a condition for the acceptance of the Contract will not be considered in
      the award of the Contract and will cause the rejection of the entire Proposal.

   E. The competency and responsibility of Bidders will be considered in making the award. The
      Owner does not obligate himself to accept the lowest or any other bids. The Owner reserves
      the right to reject any and all bids and to waive any informalities in the Proposals.

2. PROPOSAL GUARANTEE (revised 3-22-2012)
   A. A certified check or bank draft payable to the Owner, or satisfactory Bid Bond executed by the Bidder
      and Surety Company, in an amount equal to not less than five percent (5%) of the maximum proposal
      amount shall be submitted with each Proposal, which amount may be forfeited to the Board of
      Governors, Wayne State University, if the successful Bidder refuses to enter into a Contract within
      ninety (90) days from receipt of Proposals.

   B. Bond must be issued by a Surety Company with an "A rating as denoted in the AM Best Key Rating
      Guide"
C. The bid deposit of all bidders except the lowest three will be returned within three (3) days after the bids are opened. After the formal Contract and bonds are approved, the bid deposit will be returned to the lowest three bidders, except when forfeited.

D. Bid bonds shall be accompanied by a Power of Attorney authorizing the signer of the bond to do so on behalf of the Surety Company.

E. Withdrawal of Proposals is prohibited for a period of ninety (90) days after the actual date of opening thereof.

3. CONTRACT SECURITY (revised 3-22-2012)

A. The successful Bidder will be required to furnish a Performance Bond and Labor and Material Payment bond in an amount equal to 100% of the contract award amount, and include such cost in the Proposal, complying with the laws of the State of Michigan. The graduated formula no longer applies.

B. Performance Bond and Labor and Material Payment Bond shall be from a surety company acceptable to the Owner and made payable as follows:

   (1) A bond for 100% of the contract award amount to the Board of Governors of Wayne State University, and guaranteeing the payment of all subcontractors and all indebtedness incurred for labor, materials, or any cause whatsoever on account of the Contractor in accordance with the laws of the State of Michigan relating to such bonds.

   (2) A bond for 100% of the contract award amount to the Board of Governors of Wayne State University to guarantee and insure the completion of work according to the Contract.

C. The only acceptable Performance Bond shall be the AIA A312 – 2010.

D. Bond must be issued by a Surety Company with an “A rating as denoted in the AM Best Key Rating Guide”.

4. BOND CLARIFICATION

For bids below $50,000.00,

A. Bid bond will not be required.
B. Performance Bond will not be required.

5. INSPECTION

A. Before submitting his Proposal, each Bidder shall be held to have visited the site of the proposed work and to have familiarized himself as to all existing conditions affecting the execution of the work in accordance with the Contract Documents. No allowance or extra consideration on behalf of the Contractor will subsequently be made by reason of his failure to observe the Conditions or on behalf of any subcontractor for the same reason.

6. EXPLANATION TO BIDDERS AND ADDENDA

A. Neither the Owner nor Representative nor Purchasing Agent will give verbal answers to any inquiries regarding the meaning of drawings and specifications, and any verbal statement regarding same by any person, previous to the award, shall be unauthoritative.

B. Any explanation desired by Bidders must be requested of the Purchasing Agent in writing, and if explanation is necessary, a reply will be made in the form of an Addendum, a copy of which will be forwarded to each Bidder registered on the Bidders' List maintained by Procurement & Strategic Sourcing.
C. All addenda issued to Bidders prior to date of receipt of Proposals shall become a part of these Specifications, and all proposals are to include the work therein described.

7. **INTERPRETATION OF CONTRACT DOCUMENTS**

A. If any person contemplating submitting a bid for the proposed Contract is in doubt as to the true meaning of any part of the drawings, specifications, or other Contract Documents, he may submit to the Purchasing Agent, a written request for an interpretation thereof. The person submitting the request will be responsible for its prompt delivery. Any interpretation of the Contract Documents will be made by an addendum duly issued. A copy of such addendum will be mailed and delivered to each registered Bidder. Each proposal submitted shall list all addenda, by numbers, which have been received prior to the time scheduled for receipt of proposal.

8. **SUBSTITUTION OF MATERIALS AND EQUIPMENT**

A. Whenever a material, article or piece of equipment is identified on the Drawings or in the Specifications by reference to manufacturers' or vendors' names, trade names, catalog numbers, or the like, it is so identified for the purpose of establishing a standard, and any material, article, or piece of equipment of other manufacturers or vendors which will perform adequately the duties imposed by the general design will be considered equally acceptable provided that the material, article, or piece of equipment so proposed is, in the opinion of the Architect, of equal substance, appearance and function. It shall not be purchased or installed by the Contractor without the Architect's written approval.

9. **TAXES**

A. The Bidder shall include in his lump sum proposal and make payment of all Federal, State, County and Municipal taxes, including Michigan State Sales and Use Taxes, now in force or which may be enacted during the progress and completion of the work covered.

10. **REQUIREMENTS FOR SIGNING PROPOSALS AND CONTRACTS**

A. The following requirements must be observed in the signing of proposals that are submitted:

   (1) Proposals that are not signed by individuals making them shall have attached thereto a Power of Attorney, evidencing the authority to sign the Proposal in the name of the person for whom it is signed.

   (2) Proposals that are signed for partnerships shall be signed by all of the partners or by an Attorney-in-Fact. If signed by an Attorney-in-Fact, there must be attached to the Proposal a Power of Attorney evidencing authority to sign the Proposal, executed by the partners.

   (3) Proposals that are signed for a corporation shall have the correct corporate name thereof and the signature of the President or other authorized officer of the corporation, manually written in the line of the Form of Proposal following the words "signed by". If such a proposal is signed by an official other than the President of the Corporation, a certified copy of resolution of the Board of Directors, evidencing the authority of such official to sign the bid, shall be attached to it. Such proposal shall also bear the attesting signature of the Secretary of the Corporation and the impression of the corporate seal.

11. **QUALIFICATIONS OF BIDDERS**

A. The Owner may request each of the three (3) low bidders to submit information necessary to satisfy the Owner that the Bidder is adequately prepared to fulfill the Contract. Such information may include past performance records, list of available personnel, plant and equipment, description of work that will be done simultaneously with the Owner's Project, financial statement, or any other pertinent information. This information and such other information as may be requested will be used in determining whether a Bidder is qualified to perform the work required and is responsible and reliable.
12. **SPECIAL REQUIREMENTS**

A. The attention of all Bidders is called to the General Conditions, Supplementary General Conditions, and Special Conditions, of which all are a part of the Specifications covering all work, including Subcontracts, materials, etc. Special attention is called to those portions dealing with Labor Standards, including wages, fringe benefits, Equal Employment Opportunities, and Liquidated Damages.

B. Prior to award of the project, the apparent low bidder will be required to produce a schedule of values which will include the proposed subcontractors for each division of work and whether the subcontractor is signatory or non-signatory. A contract will not be issued to the apparent low bidder until this document is provided. A contractor will have one week to produce this document. If the required document is not received within this time, the bidder will be disqualified.


A. The Proposal shall be deemed as having been accepted when a copy of the Contract (fully executed by both the vendor and the appropriate signatory authority for the University), with any/all Alternates, Addenda, and Pre-Contract Bulletins, as issued by the office or agent of the Owner has been duly received by the Contractor. After signing the Contracts, the Contractor shall then return all copies, plus any required bonds and certificates of insurance, to the office of the Owner's Representative, at 5454 Cass, Wayne State University, Detroit, MI 48202. Construction will begin when the fully-executed contract has been returned to the Contractor.

14. **TIME OF STARTING AND COMPLETION**

A. It is understood that the work is to be carried through to substantial completion with the utmost speed consistent with good workmanship and to meet the established start and completion dates.

B. The Contractor shall begin work under the Contract without delay, upon receipt of a fully-executed contract from the Owner, and shall substantially complete the project ready for unobstructed occupancy and use of the Owner for the purposes intended within the completion time stated in the Contract.

C. The Contractor shall, immediately upon receipt of fully-executed contract, schedule his work and expedite deliveries of materials and performance of the subcontractors to maintain the necessary pace for start and completion on the aforementioned dates.

15. **CONTRACTOR’S PERFORMANCE EVALUATION (2-2015)**

In an effort to provide continuous process improvement regarding the construction of various university projects, Wayne State University is embarking upon a process of evaluating the contractor’s overall performance following the completion of work. At the conclusion of the construction project a subjective evaluation of the Contractor’s performance will be prepared by the Project Manager and the supervising Director of Construction. The evaluation instrument that will be used in this process is shown in Section 00440-01 - Contractor's Performance Evaluation.

16. **BIDDING DOCUMENTS**

A. Bid specifications are not available at the University, but are available beginning June 16, 2016 through Wayne State University Procurement & Strategic Sourcing’s Website for Advertised Bids: http://www.forms.procurement.wayne.edu/Adv_bid/Adv_bid.html. The plans for this project can be viewed in advance and/or printed from the above website. Copies of the RFP will not be available at the pre-proposal meeting.

B. **DOCUMENTS ON FILE (revised 12-2007)**

(1) Wayne State University Procurement & Strategic Sourcing’s Website.
All available information pertaining to this project will be posted to the Purchasing web site at http://www.forms.procurement.wayne.edu/Adv_bid/Adv_bid.html. Information that is not posted to the website is not available/not known.

(2) Notification of this Bid Opportunity has been sent to DUNN BLUE (for purchase of Bid Documents only), DODGE REPORTS, REED CONSTRUCTION, CONSTRUCTION NEWS and the CONSTRUCTION ASSOCIATION OF MICHIGAN (CAM).

(3) Please note: Effective December 1, 2007, bid notices will be sent only to those Vendors registered to receive them via our Bid Opportunities list serve. To register, to http://www.forms.procurement.wayne.edu/Adv_bid/Adv_bid.html, and click on the “Join our Listserve” link at the top of the page.

15. **Smoke and Tobacco-Free Policies (9-2015)**

On August 19, 2015, Wayne State joined hundreds of colleges and universities across the country that have adopted smoke- and tobacco-free policies for indoor and outdoor spaces. Contractors are responsible to ensure that all employees and all subcontractors’ employees are in compliance anytime they are on WSU’s main, medical, or extension center campuses. The complete policy can be found at http://wayne.edu/smoke-free/policy/.
NOTICE OF MANDATORY PRE-BID CONFERENCE

PROJECT: IBio RadioChemistry Facility

PROJECT NOS.: WSU PROJECT NO. 211-277899

It is MANDATORY that each Contractor proposing to bid on this work must attend a pre-bid conference at the following location:

Wayne State University
6135 Woodward Avenue, 1010 (Multi/Seminar Room)
Detroit MI 48202

2:00 P.M., local time, June 23, 2016

The purpose of this conference is to clarify the procedures, scope of work, and to identify any omissions and/or inconsistencies that may impede preparation and submission of representative competitive bids.

In the event that less than 4 individual contractor firms attend the pre-bid conference, the University reserves the right, at its sole discretion, to either reschedule the pre-bid conference or proceed and offer a second pre-bid conference date. (Attendance at only one pre-bid conference will be required).

An attendance list shall be prepared and minutes of the conference shall be furnished to all those attending.

Any clarifications or corrections that cannot be made at the conference will be by Addendum.

For your convenience a map of the University and appropriate parking lots can be downloaded and printed from: http://campusmap.wayne.edu. Guest parking in any of the University student and guest lots is $7.00. A detailed list of Cash & Coin operated lots can be viewed at http://purchasing.wayne.edu/cash_and_credit_card_lots.php. Cash lots dispense change in quarters. Due to time constraints, Vendors are encouraged to avoid parking at meters on the street (especially blue "handicapped" meters).

All available information pertaining to this project will be posted to the Purchasing web site at http://www.forms.procurement.wayne.edu/Adv_bid/Adv_bid.html. Information that is not posted to the website is not available/not known.
AGENDA

I. Welcome and Introductions
A. Wayne State University Representatives
B. Vendor Representatives
C. Sign in Sheet - be sure to include your fax number and email address (LEGIBLY) on the sign in sheet.

II. Brief Overview of Wayne State University
A. Purpose and Intent of RFP.
B. Detailed review of the RFP and the requirements for a qualified response.
C. Review of all pertinent dates and forms that are REQUIRED for a qualified response.

III. Vendor Questions/Concerns/Issues
A. Questions that can be answered directly by the appropriate person in this meeting will be answered and both question and answer will be recorded in the minutes of the meeting.
B. Questions that need to be researched will be answered and a nature of clarification will be emailed to the appropriate ListServ. See http://www.forms.purchasing.wayne.edu/Adv_bid/Adv_Bid_Listserve.html for a list of ListServ Bid Lists.
C. Minutes will be emailed to all participants of the meeting within a reasonable amount of time. (be sure to include your email address/addresses on the sign in sheet)
D. Questions and concerns that come up after this meeting are to be addressed to Valerie Kreher, Procurement & Strategic Sourcing. Discussion with other University members is seriously discouraged and could lead to disqualification from further consideration. All questions and answers will be recorded and emailed to all participants of the RFP.
E. Due date for questions is June 30, 2016, 12:00 noon.

IV. Minimum Participation
A. Pre-registration for the Pre-Bid meeting is required. In the event that we do not have four (4) or more eligible bidders pre-registered, the University reserves the right to postpone the Pre-bid meeting with up to 4 business hour notice.
B. If less than 4 individual contractor firms attend the mandatory pre-bid meeting, the University reserves the right, at its sole discretion, to either reschedule the pre-bid conference or proceed and offer a second pre-bid conference date. (Attendance at only one pre-bid conference will be required).
C. On the day of the bid opening, if less than 3 sealed bids are received, the University reserves the right, at its sole discretion, to rebid the project in an effort to obtain greater competition. If the specifications are unchanged during the rebid effort, any contractor who submitted a bid will be given the option of keeping its bid on file for opening after the second bid effort, or of having the bids returned to them unopened.

V. Proposal Due Date - July 6, 2016, 2:00 p.m.

VI. Final Comments

VII. Adjourn
VENDOR NAME

GENERAL CONTRACT - PROPOSAL FORM (revised 1 - 2011)

Please Note – Vendors must Pre-qualify themselves when responding to this bid opportunity. Our Prequalification questions can be found on page 4 of this section.

OWNER:         Board of Governors
                Wayne State University

PROJECT:       IBio RadioChemistry Facility

PROJECT NO.:   WSU PROJECT NO. 211-277899

PROJECT TYPE:  General Construction Work

PURCHASING AGENT: Valerie Kreher, Senior Buyer
                WSU – Procurement & Strategic Sourcing
                5700 Cass, Suite 4200
                Detroit, Michigan 48202
                313-577-3720/313-577-3747 fax
                rfpteam2@wayne.edu & copy leiann.day@wayne.edu

OWNER’S REPRESENTATIVE: Jason R. Davis, Project Manager
                        Design & Construction Services
                        Facilities Planning & Management
                        Wayne State University
                        5454 Cass Avenue
                        Detroit, Michigan 48202

TO:            Board of Governors
                Wayne State University
                Detroit, Michigan

BASE PROPOSAL: The undersigned agrees to enter into an Agreement to complete the entire work of the IBio RadioChemistry Facility project (WSU Project No. 211-277899) in accordance with the Bidding Documents for the following amounts:

                                                           $  Dollars

LAWN REPLACEMENT: The undersigned agrees that, in the event of existing lawn or landscaping damage, due to the Contractor’s work, that has not been properly addressed and repaired to the satisfaction of the University, the University may repair/replace the lawn and/or landscaping, and that the expense will be at a unit cost of $10.00 per square yard for lawn, and landscaping at a rate of 1.5 times the cost of said repairs, the full cost of which shall be reimbursed by the contractor.

CONTRACT CHANGE ORDERS: (revised 4-01-2011)

The undersigned agrees to the following pricing formula and rates for changes in the contract work:

1. For subcontract work, Contractor's markup for handling, overhead, profit and bonding on subcontractors sell price, shall not exceed 5%.
1.1. For subcontract work that is provided on a time and material basis, the subcontractor shall be permitted a single markup for handling, overhead, profit and bonding of 5%. When a markup is identified in the subcontractor’s hourly labor rate, additional markup on labor is not permitted.

1.1.1 For changes that are based upon a lump sum value, subcontractor shall provide all labor and material back-ups to ensure that duplicative charges are avoided and authorized mark-ups for OH&P can be confirmed.

2. For work by his own organization, Contractor's markup for job* and general overhead, profit and bonding shall not exceed 5% of the net labor** and material costs.

Within 14 days of the project’s contract execution Contractor shall provide to the Owner; Subcontractor’s hourly labor rate breakdown details. This requirement shall extend to the lowest level of subcontractor participation.

* Job and general overhead includes supervision and executive expenses; use charges on small tools, scaffolding, blocking, shores, appliances, etc., and other miscellaneous job expenses.

** Net labor cost is the sum of the base wages, fringe benefits established by governing trade organizations, applicable payroll taxes, and increased expense for contractor's liability insurance (Workman's Compensation, P.L. and P.D.).

TIME OF COMPLETION:

(revised 4-01-2011)
The Contract is expected to be fully executed on or about 25 calendar days after successful bidder qualification and recommendation of award. The undersigned agrees to start construction immediately after receipt of a fully executed contract, and to complete the work as follows:

Substantial Completion will be completed no later than October 31, 2016.

LIQUIDATED DAMAGES:

It is understood and agreed that, if project is not completed within the time specified in the contract plus any extension of time allowed pursuant thereto, the actual damages sustained by the Owner because of any such delay, will be uncertain and difficult to ascertain, and it is agreed that the reasonable foreseeable value of the use of said project by Owner would be the sum of $100.00, One hundred dollars per day, and therefore the contractor shall pay as liquidated damages to the Owner the sum of $100.00, One hundred dollars per day for each day's delay in substantially completing said project beyond the time specified in the Contract and any extensions of time allowed thereunder.

TAXES:

The undersigned acknowledges that prices stated above include all applicable taxes of whatever character or description. Michigan State Sales Tax is applicable to the work. Bidder understands that the Owner reserves the right to reject any or all bids and to waive informalities or irregularities therein.

ADDENDA:

The undersigned affirms that the cost of all work covered by the following Addenda are included in the lump sum price of this proposal.

Addendum No. Date Addendum No. Date
Addendum No. Date Addendum No. Date
Addendum No. Date Addendum No. Date
Addendum No. Date Addendum No. Date
Addendum No. Date Addendum No. Date

CONTRACTOR'S PREQUALIFICATION STATEMENT & QUESTIONNAIRE:
Our Minimum Requirements for Construction Bids are:

WSU considers this project: General Construction Work.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Small Project bid less than $50,000</th>
<th>Medium Project bid between $50,001 and $250,000</th>
<th>Large Project bid between $250,001 and $2 million</th>
<th>Very Large Project bid greater than $2 million</th>
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</thead>
<tbody>
<tr>
<td>EMR Rating (Experience Modification Rating)</td>
<td>1.0 or Less</td>
<td>1.0 or Less</td>
<td>1.0 or Less</td>
<td>1.0 or Less</td>
</tr>
<tr>
<td>Bondable Vendor</td>
<td>N.A.</td>
<td>Required</td>
<td>Required</td>
<td>Required</td>
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<tr>
<td>Length of Time in Construction Business</td>
<td>2 Years</td>
<td>3 Years</td>
<td>5 Years</td>
<td>5 Years</td>
</tr>
<tr>
<td>Demonstrated Experience in Projects Similar in Scope and Price in the last 3 years</td>
<td>1 or more</td>
<td>1 or more</td>
<td>2 or more</td>
<td>3 or more</td>
</tr>
<tr>
<td>Unsuccessful Projects on Campus in last 3 years</td>
<td>None Allowed</td>
<td>None Allowed</td>
<td>None Allowed</td>
<td>None Allowed</td>
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<tr>
<td>Failure to comply with Prevailing Wage and/or Project Labor requirements</td>
<td>None Allowed</td>
<td>None Allowed</td>
<td>None Allowed</td>
<td>None Allowed</td>
</tr>
<tr>
<td>Withdrawn University Bid (with or without Bond forfeiture) within the last 3 years **</td>
<td>1 or less</td>
<td>1 or less</td>
<td>1 or less</td>
<td>1 or less</td>
</tr>
<tr>
<td>Company currently not in Chapter 11 of the US Bankruptcy Code</td>
<td>1 Year</td>
<td>2 Years</td>
<td>3 Years</td>
<td>3 Years</td>
</tr>
</tbody>
</table>

** Withdrawal of a bid is subject to the University suspension policy, for a period up to one year.

Contractors must complete the following information to determine their eligibility to participate in this bid. This information is required with your Bid to the University.

Failure to complete this form in its entirety will result in your bid being disqualified.

Check one of the following on the makeup of your company:

- Corporation
- Individual
- Partnership
- Joint Venture
- Other (Explain below):

______________________________

Diversity Classification: Please indicate the appropriate diversity classification for your company. The University recognizes the following groups as diverse or disadvantaged:

- Majority Owned
- Minority Business Enterprises (MBE)
- Women Business Enterprises (WBE)
• Disabled Veteran Enterprises (DVBE) ___________
• Disabled Person Enterprises (DBE) ___________
• Veteran Owned Businesses (VBE) ___________
• Small Businesses per the US Small Business Administration (SBE) ___________
• Other (Please Explain): ___________

1. How many years has your organization been in business as a contractor? ___________
2. How many years has your organization been in business under its present business name? ___________
3. List states in which your organization is legally qualified to do business. ___________

4. Provide the Name and Address of your Liability Insurance Carrier. ___________

5. What is your current EMR Rating?
The minimum requirement is an EMR Rating of 1.0 or less for all projects. Bidders with a rating higher than 1.0 understand that their bid may be disqualified, at the sole discretion of the University.

6. What percentage of work performed on projects are by company employees; excluding any hired subcontracting and outsourced relationships, for the bid submitted? _______ %
7. What percentage of work performed on your companies behalf are by subcontracted business relationships; disallowing 1099 contracting work forces, for the bid submitted? _______ %
8. Have you ever failed to complete any work awarded to you? If so, attach a separate sheet of explanation. Include the name of the Project, the customer, the dates of the work, and the amount of the contract?

9. Have you withdrawn a bid after a University bid opening and/or refused to enter into a contract with the University upon notification of award within the last 3 years? If so, state the Project Name and Number, and the date of bid submission below.

10. Has any officer or partner of your organization ever been an officer or partner of another organization that failed to complete a construction contract? If so, attach a separate sheet of explanation.

11. List the construction experience of the principals and superintendents of your company.

Name: ___________________________ Title: ___________________________

_________________________________________________________________________________

Name: ___________________________ Title: ___________________________

_________________________________________________________________________________

Name: ___________________________ Title: ___________________________

_________________________________________________________________________________

Name: ___________________________ Title: ___________________________

_________________________________________________________________________________

FORM OF PROPOSAL FOR THE GENERAL CONTRACT
12. List the construction Projects, and approximate dates, when you performed work similar in Scope to this project.

Project: ___________________________ Owner: ___________________________  
Contract Amount: ___________________________ Date Completed: ___________________________

Project: ___________________________ Owner: ___________________________  
Contract Amount: ___________________________ Date Completed: ___________________________

Project: ___________________________ Owner: ___________________________  
Contract Amount: ___________________________ Date Completed: ___________________________

13. List the construction Projects, and approximate dates, when you performed work similar in Dollar Amount to this project.

Project: ___________________________ Owner: ___________________________  
Contract Amount: ___________________________ Date Completed: ___________________________

Project: ___________________________ Owner: ___________________________  
Contract Amount: ___________________________ Date Completed: ___________________________

Project: ___________________________ Owner: ___________________________  
Contract Amount: ___________________________ Date Completed: ___________________________

14. Is your Company “bondable”?  Yes  No 

15. What is your present bonding capacity?  $ ___________________________

16. Who is your bonding agent?

NAME:                   ___________________________

ADDRESS:                ___________________________

PHONE:                  (_______) ____________________

CONTACT:                ___________________________

17. Does your company agree to provide financial reports to the University upon request? Failure to agree may result in disqualification of your bid. Yes  No

18. Does your company agree that all of the Terms and Conditions of this RFP and Vendor’s Response Proposal become part of any ensuing agreement? Yes  No

19. Does your company agree to execute a contract containing the clauses shown in Section 00500 “Agreement Between Contractor and Owner for Construction”?  Yes  No

If “No”, clearly note any exceptions to any information contained in the contract documents and include with your proposal.

20. Did your company quote based upon Prevailing Wage Rates?  Yes  No

21. Does your company agree to comply with the University Smoke and Tobacco Free Policies?  Yes  No
Note: Contractors submitting proposals for this project may, at the discretion of the University, be required to submit references including contact information to be used to assist in the post bid evaluation process for the subject project.

ACKNOWLEDGEMENT OF MINIMUM QUALIFICATIONS:

The undersigned has read and understands the minimum qualifications for University construction projects, and has completed the Prequalification section completely and accurately. The undersigned understands that a contractor, who fails to meet the minimum qualifications in the category identified for this project, will be disqualified from consideration for the project.

ACCEPTANCE OF PROPOSAL:

The undersigned agrees to execute a Contract, being the Wayne State University standard form titled "Agreement Between Contractor and Owner for Construction" (see section 00500 of the bid documents), provided that we are notified of the acceptance of our Proposal within sixty (60) days of the date set for the opening thereof.

The undersigned below understands that the bid will be disqualified if the Prequalification information above is not completed in its entirety.

NAME OF COMPANY: __________________________________________

OFFICE ADDRESS: __________________________________________

PHONE NUMBER: ____________________ DATE________________

FAX NUMBER: __________________________________________

SIGNED BY: __________________________________________

________________________________________________________ Signature

________________________________________________________ (Please print or type name here)

TITLE __________________________________________

EMAIL ADDRESS: ________________________________ @______________
PREVAILING WAGE RATE SCHEDULE (revised 4-05-2010)

A. See also Page 00100-4 Section 12.B

B. Wayne State University requires all project contractors, including subcontractors, who provide labor on University projects to compensate at a rate no less than prevailing wage rates.

C. The rates of wages and fringe benefits to be paid to each class of laborers and mechanics by each VENDOR and subcontractor(s) (if any) shall be not less than the wage and fringe benefit rates prevailing in Wayne County, Michigan, as determined by the United States Secretary of Labor. Individually contracted labor commonly referred to as "1099 Workers" and subcontractors using 1099 workers are not acceptable for work related to this project.

D. To maintain compliance with State of Michigan Ordinances, Certified Payroll must be provided for each of the contractor’s or subcontractor’s payroll periods for work performed on this project. Certified Payroll should accompany all Pay Applications. Failure to provide certified payroll will constitute breach of contract, and pay applications will be returned unpaid, and remain so until satisfactory supporting documents are provided.

A Prevailing Wage Rate Schedule has been issued from the State of Michigan that is enclosed in this section. Additional information can be found on the University Procurement & Strategic Sourcing’s web site at the following URL address:

http://purchasing.wayne.edu/vendors/wage-rates.php

If you have any questions, or require rates for additional classifications, please contact:

Michigan Department of Consumer & Industry Services,
Bureau of Safety and Regulation, Wage and Hour Division,
7150 Harris Drive,
P.O. Box 30476,
Lansing, Michigan 48909-7976

http://www.michigan.gov/dleg/0,1607,7-154-27673_27706---,00.html

E. Wayne State University’s Prevailing Wage Requirements:

When compensation will be paid under prevailing wage requirements, the University shall require the following:

A. The contractor shall obtain and keep posted on the work site, in a conspicuous place, a copy of all current prevailing wage and fringe benefit rates.

B. The contractor shall obtain and keep an accurate record showing the name and occupation of and the actual wages and benefits paid to each laborer and mechanic employed in connection with this contract.

C. The contractor shall submit a completed certified payroll document [U.S. Department of Labor Form WH 347] verifying and confirming the prevailing wage and benefits rates for all employees and subcontractors for each payroll period for work performed on this project. The contractor shall include copies of pay stubs for all employee or contract labor payments related to Wayne State University work. The certified payroll form can be downloaded from the Department of Labor website at http://www.dol.gov/whd/forms/w347.pdf.

D. A properly executed sworn statement is required from all tiers of contractors, sub-contractors and suppliers which provide services or product of $1,000.00 or greater. Sworn statements must accompany applications for payment. All listed parties on a sworn statement and as a subcontractor must submit Partial or Full Conditional Waivers for the amounts invoiced on the payment application. A copy of the acceptable WSU Sworn Statement and Waiver will be provided to the awarded contractor.
E. Apprentices for a skilled trade must provide proof of participation in a Certified Apprenticeship Program and the level of hours completed in the program.

F. Daily project sign-in sheets and field reports for the project must be turned in weekly.

Note: Contractor invoices WILL NOT be processed until all listed certified payroll documents are received.

G. If the VENDOR or subcontractor fails to pay the prevailing rates of wages and fringe benefits and does not cure such failure within 10 days after notice to do so by the UNIVERSITY, the UNIVERSITY shall have the right, at its option, to do any or all of the following:

1. Withhold all or any portion of payments due the VENDOR as may be considered necessary by the UNIVERSITY to pay laborers and mechanics the difference between the rates of wages and fringe benefits required by this contract and the actual wages and fringe benefits paid.

2. Terminate this contract and proceed to complete the contract by separate agreement with another vendor or otherwise, in which case the VENDOR and its sureties shall be liable to the UNIVERSITY for any excess costs incurred by the UNIVERSITY.

3. Propose to the Director of Purchasing that the Vendor be considered for Debarment in accordance with the University’s Debarment Policy, found on our website at http://purchasing.wayne.edu/docs/appm28.pdf

Terms identical or substantially similar to this section of this RFP shall be included in any contract or subcontract pertaining to this project.

H. The current applicable prevailing wage rates as identified by the State of Michigan Department of Consumer & Industry Services, Bureau of Safety and Regulation, Wage and Hour Division are attached. Refer to item C above if additional information is required.

I. Prior to award of the project, the apparent low bidder will be required to produce a schedule of values which will include the proposed subcontractors for each division of work and whether the subcontractor is signatory or non-signatory. A letter of intent or contract will not be issued to the apparent low bidder until this document is provided. The apparent low bidder will have one week to produce this document. If the required document is not received within this time, the bidder will be disqualified, and the next low bidder will be required to provide this schedule of values.

APPENDIX A FOR THE
STATE PREVAILING WAGE SCHEDULE FOR THIS PROJECT

See web site:
http://www.forms.procurement.wayne.edu/Adv_bid/Adv_bid.html
APPENDIX A FOR THE
STATE PREVAILING WAGE SCHEDULE FOR THIS PROJECT

See web site:

http://www.forms.procurement.wayne.edu/Adv_bid/Adv_bid.html
Key Performance Indicator Tracking
Sworn Statement Requirements

The University tracks its level of spend along a number of socio-economic categories. This includes its spend with Diverse organizations, its spend with Detroit based organizations, and its spend with Michigan based organizations. To assist with this, the University has the following requirements for submission of your bid and for Pay Applications submitted by the successful contractor.

Submission of Bid

1. **Diverse or disadvantaged prime contractor:** Please specify in your bid whether ownership of your company is a certified diverse or disadvantaged business, according to the categories listed previously in section 00300. In accordance with guidelines from the MMSDC and GL-WBC, the University considers a business to be diverse when it is at least 51% owned, operated, and controlled by one or more members of a diverse classification. Section 00300 has a place for this information on page 00300-3.

2. **Detroit based and Michigan Based contractor:** It is presumed that the contractor is headquartered at the location we submit our Purchase Orders to, and that it should be the same address as listed in Section 00300 at the signature line. If a supplier is headquartered elsewhere, please make note of this information, so we do not inaccurately include or exclude spend.

Pay Applications and Sworn Statements

1. **Applicability:** The University requires Sworn Statements with Pay Applications for all construction projects that use
   - Subcontractors greater than $1,000.00
   - Significant suppliers (those with a purchase value of $1,000 or more).

2. **Sworn Statements:** The Supplier must submit applicable monthly sworn statements to the Project Manager and the Buyer of Record, in the format shown on page 2 of Section 00420. Sworn Statements are “always required” for this project, and are to be submitted to (Project Manager), the project manager, and to Valerie Kreher, Senior Buyer

3. **Inclusion:** Sworn Statements are to detail the inclusion of recognized diverse and disadvantaged groups in the following 2 categories; Subcontracts or Suppliers. The University recognizes the following groups as diverse or disadvantaged:
   - Minority Business Enterprises (MBE)
   - Women Business Enterprises (WBE)
   - Disabled Veteran Enterprises (DVBE)
   - Disabled Person Enterprises (DBE)
   - Veteran Owned Businesses (VBE)
   - Small Businesses per the US Small Business Administration (SBE)

4. A complete set of the University's Supplier Diversity Program, which includes complete definitions of each of the above, can be downloaded from our web site at http://policies.wayne.edu/administrative/04-02-supplier-diversity.php.
STATE OF MICHIGAN |
COUNTY OF _____________________ |

} §

being duly sworn, deposes and says that (s)he makes the Sworn Statement on behalf of ________________, who is the Contractor for an improvement to the following described real property situated in _________ County, Michigan, and described as follows:

That the following is a statement of each subcontractor and supplier and laborer, for which laborer the payment of wages or fringe benefits and withholdings is due but unpaid, with whom _____________________________ has subcontracted for performance under the contract with the Owner or lessee thereof, and that the amounts due to the persons as of the date thereof are correctly and fully set forth opposite their names, as follows. (Subcontracts or suppliers of values of less than $1,000 are omitted.)

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<tr>
<th>NO.</th>
<th>SUBCONTRACTOR (Name, Address, Telephone Number)</th>
<th>SUPPLIER OR LABORER</th>
<th>Type of Entity *</th>
<th>Type of Entity</th>
<th>TOTAL CONTRACT PRICE</th>
<th>CONTRACT CHANGE</th>
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TOTALS

* Type of Entity: MBE=Minority Business Enterprises; WBE=Women Business Enterprises; DVE=Disabled Veteran Enterprises; DBE=Disabled Person Enterprises; VBE=Veteran Owned Businesses; SBE=Small Businesses per the US Small Business Administration

Please attach additional sheets if the number of items exceeds the page limit.
That ___________________________________________ has not procured material from, or subcontracted with, any person other than those set forth above and owes no money for the improvement.

Deponent further says that ___________________________________________ makes the foregoing statement as a representative of ____________________________________________, for the purpose of representing to the owner or lessee of the above-described premises and his or her agents that the above-described property is free from claims of construction liens, or the possibility of construction liens, except as specifically set forth above and except for claims of construction liens by laborers which may be provided pursuant to section 109 of the construction lien act, Act No. 497 of the Public Acts of 1980, as amended, being section 570.1109 of the Michigan Compiled Laws.

WARNING TO DEPONENT: A PERSON, WHO WITH INTENT TO DEFRAUD, GIVES A FALSE STATEMENT IS SUBJECT TO CRIMINAL PENALTIES AS PROVIDED IN SECTION 110 OF THE CONSTRUCTION LIEN, ACT, ACT NO. 497 OF THE PUBLIC ACTS OF 1980, AS AMENDED, BEING SECTION 570.2220 IF THE MICHIGAN COMPILED LAWS.

________________________________________________________________________

Deponent Signature

WARNING TO OWNER: AN OWNER OR LESSEE OF THE ABOVE-DESCRIBED PROPERTY MAY NOT RELY ON THIS SWORN STATEMENT TO AVOID THE CLAIM OF A SUBCONTRACTOR, SUPPLIER, OR LABORER WHO HAS PROVIDED A NOTICE OF FURNISHING OR A LABORER WHO MAY PROVIDE A NOTICE OF FURNISHING PURSUANT TO SECTION 109 OF THE CONSTRUCTION LIEN ACT TO THE DESIGNEE IS NOT NAMED OR HAS DIED.

ON RECEIPT OF THIS SWORN STATEMENT, THE OWNER OF LESSEE, OR THE OWNER'S OR LESSEE'S DESIGNEE, MUST GIVE NOTICE OF ITS RECEIPT, EITHER IN WRITING, BY TELEPHONE, OR PERSONALLY, TO EACH SUBCONTRACTOR, SUPPLIER AND LABORER WHO HAS PROVIDED A NOTICE OF FURNISHING UNDER SECTION 109 OR, IF A NOTICE OF FURNISHING IS EXCUSED UNDER SECTION 108 OR 108A, TO EACH SUBCONTRACTOR, SUPPLIER OR LABORER WHO HAS PROVIDED A NOTICE OF FURNISHING OR WHO IS NAMED IN THE SWORN STATEMENT MAKES A REQUEST, THE OWNER, LESSEE, OR DESIGNEE SHALL PROVIDE THE REQUESTER A COPY OF THE SWORN STATEMENT WITHIN 10 BUSINESS DAYS AFTER RECEIVING THE REQUEST.

WARNING TO DEPONENT: A PERSON, WHO WITH INTENT TO DEFRAUD, GIVES A FALSE STATEMENT IS SUBJECT TO CRIMINAL PENALTIES AS PROVIDED IN SECTION 110 OF THE CONSTRUCTION LIEN, ACT, ACT NO. 497 OF THE PUBLIC ACTS OF 1980, AS AMENDED, BEING SECTION 570.2220 IF THE MICHIGAN COMPILED LAWS.

Subscribed and sworn to before me this _______ day of ________________

Notary Public _______________________________________________________

________________________ County, Michigan - My commission expires: ___________________________________
PAYMENT PACKAGE DOCUMENT REQUIREMENTS

Review and comply with Section 410 of Bid Front End Documents.
Review and comply with Article 15 of the Supplemental General Conditions.

PAYMENT APPLICATION - AIA document G702 & G703 (or equivalent) – Checklist:
- Correct Project Name – Found on your contract.
- Correct Project Number – Found on your contract.
- Purchase Order Number – Required prior to beginning work.
- Correct Application Number.
- Correct Period Reporting Dates – Applications support docs must be sequential and within application range.
- Approved & Executed Change Orders Listed. (Cannot invoice for unapproved Change Orders)
- Schedule of Values percentages and amounts match the approved Pencil Copy Review – Signed by the Architect, Contractor, and University Project Manager.
- Correct Dates – Back dating not accepted.
- Signed and Notarized.

SWORN STATEMENT – Checklist:
- List all contractors, sub-contractors, suppliers… ≥ $1000.00
- A sworn statement is required from every Sub Contractor on the job with a material purchase or sub-contract of $1,000 or more. (All tiers.)
- Purchase Order Number
- Dates – Back dating not accepted.
- Signed and Notarized.

CERTIFIED PAYROLL - Dept. of Labor Form WH-347 – Checklist: (Union and Non-Union)
- For every contractor & sub-contractors work, for each week within the application reporting period.
- Correct Project Number
- List ALL workers on-site.
- Make sure their addresses are listed.
- Social Security Numbers MUST be blackened out or listed in XXX-XX-1234 format.
- Work classifications based on the job specific Prevailing Wage Schedule descriptions. If you require rates for additional classifications, contact the Michigan Department of Consumer & Industry Services.
  http://www.cis.state.mi.us/bwuc/bsr/wh/revised_rates/whc_tbl.htm
- For any workers paid at the Apprenticeship rates - proof of enrolled program and current completion required.
- Rate of Pay verified against the Prevailing Wage Schedule with an hourly cost breakdown of fringes paid.
- Authorized signatures on affidavit.
- Dates – must represent the weeks within the application period.

APPLICATION PACKAGE SUPPORTING DOCUMENTATION –
- Copies of Pay Stubs for each Certified Payroll period reported may be required– (Social Security Numbers MUST be blackened out or listed in XXX-XX-1234 format. Pay stubs need to reflect claimed participation of fringes like Medical, Dental, Retirement or 1099 classification.)
- Proof of Ownership for any ‘Owner Operator’ contractors not wishing to claim their time on prevailing wage. – (Must list their hours and dates worked on the WH-347 Form and enter EXEMPT on the income
brackets.) The Owner must provide copies of “DBA” registration form confirming status as exempt from prevailing wage requirements.

- **Proof of Stored Materials** – Bill of Lading, Delivery Receipts, Pictures, Certificate of Insurance or endorsement pate specifically insuring stored material at location, and pictures with materials clearly separated and labeled for WSU. The University reserves the right to on site verification of stored materials.

- **Partial Conditional Waivers** – The contractor shall provide covering the entire amount of the application. For non-bonded projects all sub-contractors must provide for all applications which they have a draw.

- **Partial Unconditional Waivers** – Must release amount paid for work and be delivered starting with application #2 and in no case after payment application #3, through all sequential applications for contractors, sub-contractors, and suppliers listed on the Sworn Statements.

- **Full Unconditional Waivers** – Must be delivered with final payment application, releasing all contractors, sub-contractors, suppliers listed on the sworn statements and any legitimate notice of furnishings reconciled.

**FINAL PAYMENT APPLICATION – Checklist:**

- Clear and concise As-Built drawings.
- Operation and Maintenance Manuals
- Process and training directions (if applicable).
- Warranty of work in accordance with project documents.
- Submittals log and samples installed on the job.
- Certificate of Substantial Completion
- Full Unconditional Waiver

The Project Manager may provide additional requirements as may apply to individual jobs

Revised 7-23-2015
Contractor Performance Evaluation

In an effort to provide continuous process improvement regarding the construction of various university projects, Wayne State University is embarking upon a process of evaluating the contractor’s overall performance following the completion of work. At the conclusion of the construction project a subjective evaluation of the Contractor’s performance will be prepared by the Project Manager and the supervising Director of Construction. The evaluation instrument that will be used in this process is presented below:
**Contractor Evaluation Sheet**

Contractor Name: ___________________________ Project Name: ___________________________
Contractor's PM: ___________________________ PM Name: ___________________________
Superintendent: _____________________________ Project Number: _______________
Designer: _____________________________

**EVALUATION SCORING:**
1 = Unacceptable, 2 = Less than Satisfactory, 3 = Satisfactory or Neutral, 4 = Good, 5 = Excellent

Note: Comments are REQUIRED if any score is less than 3. Write comments on the back of the evaluation.

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<th>Field Management</th>
<th>Score</th>
<th>Weight</th>
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<td>1) Work Planning / Schedule:</td>
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<td>2) Compliance with Construction Documents:</td>
<td>1 2 3 4 5</td>
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<tr>
<td>3) Safety Plan &amp; Compliance:</td>
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<td>4) Compliance with WSU procedures:</td>
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<td>5) Effectiveness of Project Supervision:</td>
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<td>6) Project Cleanliness:</td>
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<td>7) Punch List Performance:</td>
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<td>8) Contractor Coordination with WSU Vendors:</td>
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<td>9) Construction Quality:</td>
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<td>14) Compliance with Contract Requirements:</td>
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<td>15) Submittal/RFI Process:</td>
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<td>16) Close-out - Accuracy of Documents</td>
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<td>18) Applications for Payment</td>
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<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>21) Would you work with this Contractor again?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22) Would you work with this team again?</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

One year follow up

| | 1 2 3 4 5 |
|-------------------------------|-----|-----|-----|-----|-----|
| 23) Warranty Support: | | | | | |

Evaluator

<table>
<thead>
<tr>
<th>Signature</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Title:

Name:

Please Print

Rev. 2-17-2015 RGP

CONTRACTOR’S EVALUATION
We are providing the evaluation instrument at this time to allow the bidder’s to review and understand the criterion that the University’s project management team will use to evaluate the successful bidder’s performance at the conclusion of the project. It is the intent of the university to utilize the results of this evaluation to determine if it will continue to conduct business with the Contractor in future bidding opportunities.

The scoring range is between 100 to 500 points, with 100 being low and 500 being high. Each question has an associated ‘weight’ factor, and the higher the weight; the greater the importance of satisfactory performance on the final score. At the conclusion of the project, and after the Project Manager and the supervising Director has prepared their independent evaluation, the University’s project representative will meet with the Contractor to review the results. Acceptable contractor performance is essential to avoid having the University decline future work with the Contractor. An appeals process is available for Contractor disagreement with evaluation scores.

Contractors engaged in work are encouraged to maintain an open and regular dialog with the Design and Construction Department over the course of the construction project to ensure that the final evaluation is an accurate representation of the Contractor’s performance.
AGREEMENT BETWEEN THE UNIVERSITY AND CONTRACTOR
FOR CONSTRUCTION SERVICES

Executed as of the _____ day of ____________, 2015 by and between:

The Board of Governors, Wayne State University
Detroit, Michigan 48202
(The University)

and

CONTRACTOR’S_NAME
CONTRACTOR’S_ADDRESS

regarding

PROJECT_NAME
PROJECT_LOCATION
CONTRACT_NUMBER
In consideration of the mutual covenants and conditions contained herein, the Parties agree as follows:

**Article 1 - Scope of Work**

1.1 This Agreement provides for "(Enter a one or two-sentence description of the project)". The documents listed in Article 4 fully define the scope of work.

1.2 The Contractor shall furnish all the labor, materials, equipment, services, and supervision to perform all the work shown on the drawings and specifications listed in Article 18, including any addenda issued during the bid phase, and approved change orders issued during the construction phase.

1.3 The Contractor shall notify the University in writing within five (5) calendar days when the Contractor discovers any condition that will affect the contract amount or the completion date.

**Article 2 - Time of Completion**

2.1 The work to be performed under this Agreement shall commence upon the Contractor's receipt of a fully-executed Agreement, and substantial completion shall be achieved by Month Day Year.

**Article 3 - The Contract Sum**

3.1 The University shall pay the Contractor a "lump sum/not-to-exceed (pick one)" amount of $$$$$$$ ("Amount in words 00" /100 dollars) for the performance of all work associated with the Contractor's Base Bid "and Alternates (List)".

3.2 The University may, at its sole discretion, during the life of the contract, award the following alternates at the amounts indicated:

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate</td>
<td>□</td>
</tr>
<tr>
<td>Alternate</td>
<td>□</td>
</tr>
<tr>
<td>Alternate</td>
<td>□</td>
</tr>
</tbody>
</table>

"(If section 3.2 is not used, delete all text and enter Deleted"

3.3 In the event additional work becomes necessary, the following unit prices will apply:

"(If section 3.3 is not used, delete all text and enter Deleted"

<table>
<thead>
<tr>
<th>Work Item</th>
<th>Unit Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
</tr>
</tbody>
</table>

**Article 4 - The Contract Documents**

4.1 The Contract Documents shall consist of this Agreement, the drawings and specifications as listed in Article 18, the General Conditions of the Contract for Construction as defined by AIA Document A201 1970 Edition, except as otherwise provided herein, and Wayne State University's Supplementary General Conditions 1997 Edition.

4.2 For any inconsistencies found among or between these Contract Documents, the language contained in this Agreement shall prevail over all other documents and the Supplementary
General Conditions shall prevail over the General Conditions. In the event of a conflict between the Drawings and Specifications, the requirement for the higher quantity and/or higher quality shall prevail.

**Article 5 – Examination of Premises**

5.1 The Contractor acknowledges that the University provided the opportunity for a thorough examination of the project site and its surroundings and that the Contractor knows of no conditions preventing accomplishment of the full scope of work within the time and for the amount specified in this Agreement.

5.2 The University will deny all claims for additional time and/or cost for conditions that could have been reasonably discovered during such an examination.

**Article 6 - The Architect/Engineer**

6.1 The Architect/Engineer for this project is:

"(List the Architect and Engineer separately if appropriate)"

**Article 7 - Additional Work**

7.1 The University reserves the right to let other Agreements in connection with this work. The Contractor will afford other Contractors or the University's own workforce reasonable opportunity for the delivery and storage of their material and for the performance of their work and shall properly connect and coordinate its work with theirs.

7.2 If any part of the Contractor's work depends for proper execution or results upon the work of another Contractor or the University's own workforce, the Contractor shall inspect and promptly report to the University's Project Manager any defects in such work that render it unsuitable for such proper execution and results. The Contractor's failure to so inspect and report shall constitute an acceptance of the work of others as fit and proper for reception of the Contractor's work and as a waiver of any claim or defense against the University or other contractor which relies in whole or in part upon the contention that such work was unsuitable for proper execution and resolution.

**Article 8 – Dispute Resolution**

8.1 Jurisdiction over all claims, disputes, and other matters in question arising out of or relating to this contract or the breach thereof, shall rest in the Court of Claims of the State of Michigan. No provision of this agreement may be construed as Wayne State University's consent to submit any claim, dispute or other matter in question for dispute resolution pursuant to any arbitration or mediation process, whether or not provisions for dispute resolution are included in a document
which has been incorporated by reference into this agreement. Specifically, all references to Arbitration contained in the General Conditions are superceded by this Article.

8.2 In any claim or dispute by the Contractor against the University, which cannot be resolved by negotiation, the Contractor shall submit the dispute in writing for an administrative decision by the University’s Vice President for Finance and Administration, within 30 days of the end of negotiations. Any decision of the Vice President shall be made within 45 days of receipt from the Contractor and is final unless it is challenged by the Contractor by filing a lawsuit in the Court of Claims of the State of Michigan within one year of the issuance of the decision. The Contractor agrees that appeal to the Vice President is a condition precedent to filing suit in the Michigan Court of Claims.

8.3 For purposes of this section, the “end of negotiations” shall be deemed to have occurred when:

8.3.1 Either party informs the other that pursuant to this section, negotiations are at an impasse; or

8.3.2 The Contractor submits the dispute in writing to the Vice President.

8.4 Unless otherwise agreed by the University in writing, and notwithstanding any other rights or obligations of either of the parties under any Contract Documents or Agreement, the Contractor shall continue with the performance of its services and duties during the pendency of any negotiations or proceedings to resolve any claim or dispute, and the University shall continue to make payments in accordance with the Contract Documents; however, the University shall not be required or obligated to make payments on or against any such claims or disputes during the pendency of any proceeding to resolve such claims or disputes.

Article 9 - Termination for Convenience

9.1 Upon thirty days written notice to the Contractor, the University may, without cause and without prejudice to any other right or remedy of the University, elect to terminate the contract. In such case, the Contractor shall only be paid (without duplication of any items), using a Close out Change Order, for the following:

9.1.1 For completed and acceptable work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;

9.1.2 For expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted work, including fair and reasonable sums for overhead and profit on such expenses.

9.2 The Contractor shall not be paid on account of loss of anticipated profits or revenue, delay or disruption, or other economic loss arising out of or resulting from such termination. For purposes of this section, “fair and reasonable sums for overhead and profit” shall be determined by reference to Michigan law, without reference to principles used for such determinations in arbitration.
Article 10 - Progress Payments

10.1 On or before the 20th day of each month, the Contractor shall submit a written application for payment, using form AIA G702, to the Architect/Engineer and the University's Project Manager for review. The Architect/Engineer shall have ten (10) calendar days to accept or reject the Contractor's application for payment. Acceptable applications for payment shall then be submitted to the University for Payment of authorized amount(s) within thirty (30) calendar days of receipt by the University's Project Manager.

10.2 The application for payment shall contain a full schedule of values organized and sorted by subcontractor, by Construction Specifications Institute standard work categories, or in another format acceptable to the University.

10.3 Monthly progress payments shall show the percentage of work installed as of the date of the application, less amount previously installed and the amount due for the application period. The Contractor shall deduct a 10% retainage from the balance due for each progress payment and indicate the net amount due on each application.

10.4 When 50% of the work associated with this Agreement is installed, the Contractor shall not deduct additional retainage from the balance due from the University. When substantial completion is achieved and acknowledged by the Architect/Engineer, the Contractor and the University in writing, the University shall remit to the Contractor all but 2% of the retainage. The remaining 2% shall be retained by the University until the final payment is authorized and remitted to the Contractor.

Article 11 - Acceptance and Final Payments

11.1 Final payment shall be due thirty (30) days after the completion of the work, including all punch list items, provided the work is fully completed and the Agreement fully performed.

11.2 Upon receipt of written notice that the work is ready for final inspection and acceptance, the Architect/Engineer shall promptly inspect the work. When the Architect/Engineer concludes that the work is acceptable and the Agreement to be fully performed, the Architect/Engineer shall promptly issue a final certificate with an original signature, stating that the work provided is complete and acceptable and that the entire remaining balance found to be due the Contractor shall be remitted by the University once the final application for payment is received.

11.3 If, after the work has been substantially completed, full completion thereof is materially delayed through no fault of the Contractor, and the Architect/Engineer so certifies, the University shall, upon certificate of the Architect/Engineer, and without terminating the Contract, make payments of the balance due for that portion of the work fully completed and accepted. Such payments shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of claims.

Article 12 - Non-Discrimination

12.1 The Contractor agrees that it will not discriminate against any employee or applicant for employment, to be employed in the performance of this Agreement, 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, sex, age, national origin, or ancestry. Breach of this covenant may be regarded as material breach of this Agreement.
12.2 The Contractor further agrees that it will, in all subcontracts relating to the performance of the work under this Agreement, provide in its subcontracts that the subcontractor will not discriminate against any employee or applicant for employment, to be employed in the performance of such contract, with respect to hire, tenure, terms, conditions or privileges of employment, or any matter directly or indirectly related to employment because of race, sex, age, color, religion, national origin or ancestry. Breach of this covenant may also be regarded as a material breach of this Agreement.

**Article 13 – Laborers and Mechanics**

13.1 All laborers and mechanics must be covered by Worker’s Compensation and Employer’s Liability Insurance as required by Federal and Michigan law. The Contractor shall also require all of its Subcontractors to maintain this insurance coverage.

13.2 The Contractor acknowledges and shall abide by the University’s prohibition on use of 1099 independent contractors and owner / operator business entities. The Contractor shall ensure that all classifications of laborers and construction mechanics performing Work on the Project job site are employees of the Contractor or any Trade Contractor for any tier thereof, and that each worker is covered by workers compensation insurance.

**Article 14 - Prevailing Wages**

14.1 The Contractor and each subcontractor shall pay to each class of mechanics and laborers not less than the wage and fringe benefit rates prevailing in the Detroit Metropolitan Area, as determined by the Michigan Department of Licensing and Regulatory Affairs, Department of Wage and Hour. The Contractor shall post on site, in a conspicuous place, a copy of all applicable wage and benefit rates, and shall provide the University with a copy of the applicable wage and benefit rates.

14.2 The Contractor and each subcontractor shall keep an accurate record showing the name and occupation of and the actual benefits and wages paid to each laborer and mechanic employed in connection with this contract. The Contractor and each subcontractor shall make certified payroll records available to the University’s representatives upon request.

14.3 If a Contractor or subcontractor fails to pay the prevailing rates of wages and fringe benefits and does not cure such failure within ten (10) days after notice to do so by the University, the University shall have the right, at its option, to do any or all of the following:

14.3.1 Withhold all or any portion of payments due the Contractor as may be considered necessary by the University to pay laborers and mechanics the difference between the rates of wages and fringe benefits required by this Agreement and the actual wage and fringe benefits paid.

14.3.2 Terminate part or all of this Agreement or any subagreement and proceed to complete the Agreement or subagreement by separate agreement with another Contractor or otherwise, in which case the Contractor and its sureties shall be liable to the University for any excess costs incurred by the University.

14.4 The Contractor shall include terms identical or substantially similar to this section in any Agreement or subagreement pertaining to the project.

**Article 15 - Save Harmless**
15.1 The Contractor shall indemnify, defend and hold harmless the University, its agents and employees from any and all loss, damage, claims, and causes of action whatsoever, including all costs, expenses and attorneys’ fees arising out of Contractor’s performance of obligations under the terms and conditions of this agreement. Such responsibility shall not be construed as liability for damage caused by or resulting from the negligence of the University, its agents other than the Contractor, or its employees.

**Article 16 - Liquidated Damages**

16.1 It is understood and agreed that, if the project is not completed within the time specified in the Agreement plus any extension of time allowed pursuant thereto, the actual damages sustained by the University because of any such delay will be uncertain and difficult to ascertain, and it is agreed that the reasonable foreseeable value of the use of said project by the University would be the sum of $$$$$$$ ("Amount in words 00" /100 dollars) per day. Therefore, the Contractor shall pay as liquidated damages to the University the sum of $$$$$$$ ("Amount in words 00" /100 dollars) per day for each day’s delay in substantially completing said project beyond the time specified in this Agreement and any extensions of time allowed thereunder.

"ENTER N/A FOR ABOVE AMOUNT IF NO LIQUIDATED DAMAGES"

**Article 17 - Interpretation**

17.1 This Agreement shall be interpreted and construed according to the laws of the State of Michigan.

17.2 If one part of this Agreement is found to be void by legal or legislative action, the remainder of the contract remains in full effect.

**Article 18 - Drawings and Specifications**

18.1 The Technical Specifications and the Project Manual dated SPECIFY DATES, and the following List of Drawings represents the scope of work as defined in the Contract Documents from Article 4.

<table>
<thead>
<tr>
<th>Drawing No.</th>
<th>Description</th>
<th>Dated</th>
</tr>
</thead>
</table>

AGREEMENT BETWEEN CONTRACTOR AND OWNER FOR CONSTRUCTION
IN WITNESS WHEREOF the parties to these presents have hereunto set their hands as of the day and year first written above.

Signed, sealed and delivered
In the presence of:

CONTRACTOR’S NAME GOES HERE

By ________________________________
Signature

Please print name here

Date signed

Title

Witness

THE BOARD OF GOVERNORS of WAYNE STATE UNIVERSITY

By

William R. Decatur, Vice President for Finance and Business Operations

Date signed

Form Contract Approved by OGC 06/13 - LG
Rev. 5-6.30.2014 formatting only RGP
Rev.6-1-15-2015 date changes only SS
Rev.7-7-1-2015 formatting, signatory only RGP

Sample
FORM OF GUARANTEE

PROJECT:   IBio RadioChemistry Facility

OWNER:   BOARD OF GOVERNORS, WAYNE STATE UNIVERSITY

CONTRACTOR:  

DATE:  

Know all men by these presents that, in consideration of my (our) having been awarded the Contract or Subcontract for complete furnishing and installation of:

IBio RadioChemistry Facility (211-277899)

For:  Board of Governors, Wayne State University

In conformity with drawings and specifications prepared by Architect or Engineer, Harley Ellis Devereaux, and known as the buildings indicated above, I (we) do hereby agree that, should I (we) be notified that the said work has proved faulty, etc., that I (we) will return to the buildings within three (3) working days of the receipt of such notice, and will furnish the necessary labor and material to repair such work to the satisfaction of the Owner and without cost to the Owner.

The Agreement shall remain in full force and effect for a one year period (DATE TBD)

WITNESS:

signed: ____________________________________
Subcontractor

by: _______________________________________

address: __________________________________

city/state/zip: ____________________________

signed: _________________________________
General Contractor

by: ______________________________________

(THIS FORM TO BE FILED IN DUPLICATE.)
GENERAL CONDITIONS (Revised 10-2009)

A. Although AIA Document A201 - Twelfth Edition (April 1970) - "General Conditions of the Contract for Construction" is not bound herein, it forms a part of these construction documents.

B. A reference copy of AIA Document A201 - Twelfth Edition (April 1970) - "General Conditions of the Contract for Construction" is on file at the following location:

Wayne State University
Finance & Facilities Management
Procurement & Strategic Sourcing
Academic / Administrative Services Building
5700 Cass Avenue
Detroit Michigan 48202
SUPPLEMENTARY GENERAL CONDITIONS

OF

THE CONTRACT FOR CONSTRUCTION

Facilities Planning & Management - Design & Construction Services
Wayne State University
WSU SUPPLEMENTARY GENERAL CONDITIONS
OF THE
CONTRACT FOR CONSTRUCTION

NOTE: The following items related to A.I.A. General Conditions, A.I.A. Document A-201 - Twelfth Edition (April 1970), by specific number being amended to. These items, as amendments, shall have precedence over the article being amended.

ARTICLE 1 - CONTRACT DOCUMENTS

1.1 DEFINITIONS

1.1.5 The Agreement

The Agreement executed by the Contractor and the Owner.

1.2 EXECUTION, CORRELATION, INTENT, AND INTERPRETATIONS

1.2.6 "General Conditions and "Supplementary General Conditions" apply with equal force to all Contractors, Subcontractors work, and extra work required under this Contract.

1.2.7 Precedence of Drawings and Specifications.

The Agreement has precedence over WSU Supplementary General Conditions.

WSU Supplementary General Conditions have precedence over A.I.A. A-201 General Conditions of the Contract.

Specifications have precedence over drawings. Full-size drawings have precedence over scale drawings. Large-scale plans and details have precedence over small-scale plans and details. Figured dimensions have precedence over plans and elevations.

ARTICLE 2 - ARCHITECT

2.1 DEFINITION

2.1.1.1 The term Architect or Architect/Engineer as used in these specifications refers to Facilities Planning and Management - Design Services, and/or Consulting Architect/Engineer.

2.2 ADMINISTRATION OF THE CONTRACT

2.2.16 The Architect will assign Field Representatives to make periodic visits to the project for the purpose of assisting the Architect in carrying out his field responsibilities at the site. The duties, responsibilities and limitations of authority of any such Field Representative shall be as follows:

a. Explain Contract Documents: Assist the Contractor via the Contractor's Superintendent to understand the intent of the Contract Documents.

b. Observations: Conduct on-site observations and spot checks of the work in progress as a basis for determining conformance of the work, material, and equipment with the Contract Documents.

c. Additional Information: Obtain from the Architect, additional details or information, if and when required, at the job site for proper execution of the work.

d. Modifications: Consider and evaluate suggestions or modifications that may be submitted by the Contractor and report them with recommendations to the Architect for final decision.

e. Construction Schedule and Completion: Be alert to the completion, and report same to the Architect. When the construction work has been completed in accordance with the Contract Documents, advise the Architect that the work is ready for general inspection and acceptance.
f. Job Conferences: Attend and report to the Architect on all required conferences held at the job site.

g. Observe Tests: See that tests which are required by the Contract Documents are actually conducted; observe, record and report to the Architect all details relative to the test procedures; and advise the architect's office in advance of the schedules of tests.

h. Inspection by Others: If inspectors, representing local, state or federal agencies having jurisdiction over the project, visit the job site, accompany such inspectors during their trips through the project, record the outcome of these inspections, and report same to the Architect's office.

i. Shop Drawings: Do not permit the installation of any materials and equipment for which shop drawings are required unless such drawings have been duly approved and issued by the Architect.

j. Contractor's Requisitions for Payment: Review and make recommendations to the Architect for disposition.

k. List of Items for Correction: After substantial completion, make a list of items for correction before final inspection and check each item as it is corrected.

l. Owner's Occupancy of the Building: If the Owner occupies (to any degree) the building prior to actual completion of the work by the Contractor, be especially alert to possibilities of claims for damage to completed work prior to the acceptance of the building.

m. Owner Existing Operation: In the case of additions to or Demolitions of an existing facility, which must be maintained as an operational unit, be alert to conditions on the job site which may have an effect on the Owner's existing operation.

n. Limitations of Authority: Do not become involved in any of the following areas of responsibility unless specific exceptions are established by written instructions issued by the Architect.

   aa. Do not authorize deviations from the Contract Documents.

   bb. Avoid conducting any test personally.

   cc. Do not enter into the area of responsibility of the Contractor's field superintendent.

   dd. Do not expedite job for Contractor unless so instructed by the Architect.

   ee. Do not advise on or issue directions relative to any aspect of the building technique or sequence unless a specific technique or sequence is called for in the Specifications or by written instructions from the Architect.

   ff. Do not approve shop drawings or samples.

   gg. Do not authorize or advise the Owner to occupy the Project, in whole or in part, prior to the final acceptance of the building.

   hh. Do not issue a Certificate for Payment.

ARTICLE 3 - OWNER

3.5 OWNER'S RIGHT TO DO WORK

3.5.1 The Owner may exercise his right, which is hereby acknowledged by the Contractor, to let independent of the Contract for the work herein specified, any other work on the premises even if of like character and trades, and the Owner shall not be liable for any damage, loss or expense incurred by the Contractor through the fault of any other Contractor so employed by the Owner. The Contractor acknowledges the necessity of work by others, to be performed at approximately the same time as the work hereunder, and agrees to perform his work in full cooperation with the work of such other trades and/or Contractors, partially
or entirely completed, by such other trades and/or Contractors, or by the Owner, when, in the opinion of the Architect, such access or use is necessary for the performance and completion of any portion or all of the work of others or of any work on the site.

3.6 OWNER'S ACCESS AND PARTIAL OCCUPANCY

3.6.1 The Owner shall have access to the work at all times, and at his election, may from time to time (prior to the stipulated contract completion date) occupy any of the units or parts of the project as the work in connection therewith is complete to such a degree as will, in the opinion of the Owner, permit their temporary or permanent use. The Owner will, prior to any such partial occupancy, give notice to the Contractor thereof and such occupancy shall be upon the following terms:

a. Such occupancy shall not constitute an acceptance of work not performed in accordance with the Contract nor shall such occupancy relieve the Contractor of liability to perform any work by the Contractor by not complete at the time of occupancy.

b. Except as otherwise provided by an agreement at the time of such partial occupancy, the Contractor shall be relieved of all maintenance costs on units or parts so occupied.

c. The Contractor shall not be responsible for wear and tear or damage resulting from partial occupancy.

d. The Owner shall assume risk of loss with respect to any unit or part so occupied.

e. The Contractor shall, if required by the Owner, furnish heat, light, water, or other such services to the units or parts occupied and the Owner shall make proper remuneration therefore to the Contractor.

3.6.2 The Contractor agrees that the Owner shall have the right, after seven (7) days' written notice to the Contractor, to place and install as much equipment and machinery during the progress of the work as is possible before the completion of the various parts of the work; and further agrees that such placing and installation of equipment shall not in any way evidence the completion of the work or any portion thereof, nor signify the Owner's acceptance of the work or any portion thereof. Should the Owner place or install such equipment and machinery with his own forces he shall be responsible for any damage to work of the Contractor caused by the Owner's work or workmen. Should the Owner have such placement or installation performed by another Contractor, then the Owner shall require said Contractor to be responsible for all such damage caused by his work, his workers, or his subcontractors.

ARTICLE 4 - CONTRACTOR

4.4 LABOR AND MATERIALS

4.4.3 All materials shall be so delivered, stored and handled to prevent the inclusion of foreign materials and the damage of materials by water or breakage. Packaged materials shall be delivered and stored in original packages until ready for use. Packages or materials showing evidence of water or other damage shall be rejected. All materials shall be of the respective qualities specified herein.

4.4.4 The Contractor shall be responsible for the proper care and protection of all his materials, equipment, etc., delivered at the site. Building materials, equipment, etc., may be stored on the premises subject to the approval of the Architect.

4.4.5 To insure timely availability of critical materials in case of national emergency, the Contractor may order his subcontractors to proceed with fabrication of the same earlier than required by normal sequence of construction. In the event storage facilities are not available on the site or at the source of fabrication, the Owner will endeavor to provide such storage space as may be available to care for same. Where this is necessary, the Contractor shall be paid for all stored material on the Owner's property or on the properties approved by the Owner upon approval of certified invoices. It shall be the Contractor's obligation to pay for all handling costs and damage to this material. The Contractor shall protect this property against damage.

4.6 TAXES
The Bidder shall include in his proposal and make payment of all Federal, State, County and Municipal taxes including Michigan State Sales and Use Taxes, now in force or which may be enacted during the progress and completion of the work covered.

PERMITS, FEES AND NOTICES

The Contractor shall pay highway or DPW fees for damages to sidewalks, streets, or other public property or to any public utilities.

Permits and licenses of a temporary nature necessary for the execution of the work shall be secured and paid for by the Contractor.

Except for the General Building Permit (which is not required), the Contractor shall secure and pay for all other required permits, including the following:

- Electrical - State of Michigan
- Plumbing - State of Michigan
- Mechanical - State of Michigan
- Elevator - City of Detroit

The Contractor shall secure certificates of inspection and of occupancy that may be required by authorities having jurisdiction over the work. These certificates shall be delivered to the Architect upon completion of the work.

SUPERINTENDENT

The Contractor shall give sufficient supervision to the work, using his best skill and attention. He shall carefully study and compare all drawings, specifications, and other instructions, and shall at once report to the Architect any error, inconsistency, or omission which he may discover, but he shall not be held responsible for their existence or discovery.

The Contractor's superintendent shall periodically inspect the entire project to make certain that all of the stipulations of all of the articles of the General Conditions are being observed.

DRAWINGS AND SPECIFICATIONS AT THE SITE

Refer to Paragraph 4.12.1, of A.I.A. General Conditions of the Contract for Construction. Modify the last sentence of this paragraph to read:

"The Drawings, marked to record all changes made during construction, shall be incorporated in the Contractor's 'Informational Package'."

As a basic and interim step for the fulfillment of the "Informational Package", accurate records of all non-structural underground and concealed work shall be kept, including, but not limited to, all piping, conduit, equipment, and drainage and tunnel work. In addition, such records shall be available for review during various steps of the project.

SHOP DRAWINGS AND SAMPLES

Immediately before and as a condition of substantial completion, the Contractor shall provide the Owner an "Informational Package" and instructional sessions on the operation, maintenance, and service of the facility. The "Informational Package" shall include:

1. One (1) set of transparency (sepia) of the approved shop drawings and descriptive material submitted during construction. Any shop documents unobtainable in sepia shall
be supplied in three (3) sets.

2. One (1) set of transparency (sepia) of constructional shop drawings with all installation revisions incorporated to reflect the as-built condition. Examples of constructional shop drawings are dimensioned conduit, piping and ductwork layout drawings.

3. Three (3) sets of instructional manuals on the installation, operation, maintenance and service of equipment and systems, including parts lists.

Examples of Specific Information Required:

1. **Electrical**
   a. Conduit layout of light, power, and special systems, indicating dimensionally the locations and size of runs; circuit grouping and conductor size and number in conduit runs.
   b. System description and elementary diagrams, connection and interconnection diagrams, and device internal diagrams.

2. **Mechanical**
   a. Piping and ductwork layout indicating dimensionally the location and size of the runs.
   b. Description and diagrams of control systems.

Following the submittal of the "Informational Package", the Contractor shall schedule and provide, at the Owner's convenience, instructional sessions for Owner's personnel to acquaint them with the operation, maintenance, and service of the system.

3. **Elevators**
   a. Elementary diagrams and description of sequence of operation of the system control components, connection and interconnection diagrams, and device internal diagrams.

**ARTICLE 5 - SUBCONTRACTORS**

5.2 **AWARD OF SUBCONTRACTS AND OTHER CONTRACTS FOR PORTIONS OF THE WORK**

5.2.3 Delete Article 5.2.3 in its entirety.

5.2.4 Delete Article 5.2.4 in its entirety.

**ARTICLE 7 - MISCELLANEOUS PROVISIONS (Revised 6-13-2011)**

7.5 **PERFORMANCE BOND AND LABOR AND MATERIAL PAYMENT BOND**

7.5.1 The successful Bidder will be required to furnish a Performance Bond and Labor and Material Payment bond in an amount equal to 100% of the contract award amount, and include such cost in the Proposal, complying with the laws of the State of Michigan. The graduated formula no longer applies.

A. Performance Bond and Labor and Material Payment Bond shall be from a surety company acceptable to the Owner and made payable as follows:

(1) A Labor and Material Payment bond for 100% of the contract award amount to the Board of Governors of Wayne State University, and guaranteeing the payment of all subcontractors and all indebtedness incurred for labor, materials, or any cause whatsoever on account of the Contractor in accordance with the laws of the State of Michigan relating to such bonds.

(2) A Performance bond for 100% of the contract award amount to the Board of Governors of Wayne State University to guarantee and insure the completion of work according to the Contract.
B. The only acceptable Performance Bond shall be the AIA A312 – 2010.

C. The Contractor shall include with his bid evidence of his ability to obtain a Performance Bond in the amount of 100% of the bid amount, and in accordance with the terms and conditions outlined in this section. Such evidence shall be project specific and shall be submitted on a form provided by the Surety or Agent thereof.

7.7 ROYALTIES AND PATENTS

7.7.1 Indemnification and Hold Harmless (Revised 2-2015).

To the fullest extent permitted by law, the Contractor shall hold harmless, defend, and indemnify the Board of Governors of Wayne State University, the University, the Architect and Architect’s Consultants, and officers, employees, representatives and agents of each of them, from and against any and all claims or losses arising out of or alleged to be resulting from, or relating to (1) the failure of the Contractor to perform its obligations under the Contract or the performance of its obligation in a willful or negligent manner; (2) the inaccuracy of any representation or warranty by the Contractor given in accordance with or contained in the Contract Documents; and (3) any claim of damage or loss by any subcontractor, or supplier, or laborer against the University, the Architect or the Architect’s consultants arising out of any alleged act or omission of the Contractor or any other subcontractor, or anyone directly or indirectly employed by the Contractor or any subcontractor.

The Contractor shall also be liable for and hereby agrees to pay, reimburse, fully indemnify and hold the University, the Architect and Architect’s Consultants, harmless from and against all costs and expenses of every nature (including attorney fees and expenses incident thereto) incurred by the University in collecting the amounts due from the Contractor, or otherwise enforcing its rights, under the indemnification described in this Article.

7.9 INTEREST

7.9.1 Delete Article 7.9 in its entirety.

ARTICLE 8 - TIME

8.1 DEFINITIONS

8.1.3 The Date of Substantial Completion of the Work is the Date certified by the Architect when construction of the entire work is sufficiently complete, in accordance with the Contract Documents, so the Owner may occupy the Work for the use for which it is intended. It is the beginning date for the guarantees on all the Project Work.

8.3.5 LIQUIDATED DAMAGES

It is understood that if said Contract is not completed within the time specified in the Contract plus any extension of time thereto, the Contractor shall pay Liquidated Damages to the Owner as set forth in Article 11 of the Agreement between Contractor and Owner for Construction.

ARTICLE 9 - PAYMENT AND COMPLETION

9.3 PROGRESS PAYMENTS

9.3.1 On or before the 20th day of each month, the Contractor shall submit to the Architect on the Owner's Standard Form, a written application for payment showing the proportionate value of the work installed to date from which shall be deducted, a reserve of 10% and all previous payments, and the balance of the amount as approved by the Architect shall be due and payable to the Contractor on or about the 15th day of the succeeding month.

9.3.2.2 No payments will be made because of materials or equipment stored off the site, except as provided for in Subparagraph 4.4.5 of the Supplementary General Conditions or other special cases the Owner may approve.
9.6 FAILURE OF PAYMENT

9.6.1 Delete Article 9.6 in its entirety.

ARTICLE 11 - INSURANCE (Revised 2-06-2015)

11.1 CONTRACTOR'S LIABILITY INSURANCE

11.1.2 The insurance required by Subparagraph 11.1.1 shall be written for not less than any limits of liability specified herein, or required by law, whichever is greater, and shall include contractual liability insurance as applicable to the Contractor's obligations under Paragraph 4.18.

During the life of the Contract, the Contractor shall maintain the following types of insurance:

A. General Requirements

<table>
<thead>
<tr>
<th>Type of Insurance</th>
<th>Minimum Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial General Liability (CGL)</td>
<td>$1,000,000 combined single limit per occurrence</td>
</tr>
<tr>
<td>Contractor shall maintain commercial general liability (CGL)</td>
<td>$2,000,000 aggregate</td>
</tr>
<tr>
<td>CGL insurance shall be written on Insurance Services form CG 00 01 (or substitute form providing equivalent coverage) and shall cover liability arising from premises, operation, independent contractors, products-completed operation, and personal injury, contractual liability broad form property damage liability, products and completed operations coverage and X,C,U (explosion, collapse, underground) hazards.</td>
<td>Umbrella Liability per occurrence and in the annual aggregate of $5,000,000.</td>
</tr>
<tr>
<td>Commercial Automobile Liability (CSL)</td>
<td>$1,000,000 combined single limit</td>
</tr>
<tr>
<td>(including hired and non-owned vehicles)</td>
<td></td>
</tr>
<tr>
<td>Workers' Compensation</td>
<td>Statutory-Michigan $500,000</td>
</tr>
<tr>
<td>(Employers' Liability)</td>
<td></td>
</tr>
<tr>
<td>Professional Liability insurance</td>
<td>$500,000 Per Occurrence and in the Aggregate annually</td>
</tr>
<tr>
<td>This limit shall be dedicated to the risks of Professional Liability and it shall not be combined with limits of any other coverages such as Environmental/Pollution General Liability, or Umbrella Liability unless otherwise approved by the Owner. Coverage shall be for the benefit of the Contracting or Design- Build entity, its principles, Employees, affiliates, agents, and partners-whether joint or several. It is presumed that this insurance will be Claims Made, and therefore must have a Retro-active date prior to the performance of any work for the Owner, whether or not such work is under contract or purchase order. This insurance will be placed with an insurer licensed to do business in the State of Michigan and rated no less than A X; by AM Best</td>
<td></td>
</tr>
</tbody>
</table>

B. Maximum Acceptable Deductibles

<table>
<thead>
<tr>
<th>Type of Insurance</th>
<th>Maximum Deductible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive General Liability</td>
<td>$5,000</td>
</tr>
<tr>
<td>Fire Legal Liability</td>
<td>$5,000</td>
</tr>
</tbody>
</table>
Comprehensive Automobile Liability -0-
Workers' Compensation -0-
Property - All Risk $ 500

11.1.3 The Board of Governors, Wayne State University, shall be named as an additional insured but only with respect to accidents arising out of the performance of said contract. The contractor shall prepare a certificate of insurance which shall name the “Office of Risk Management; 5700 Cass Avenue” as the Wayne State University certificate holder.

11.1.3.1 The Contractor shall require each of his Subcontractors to procure and to maintain during the life of his subcontract, Subcontractors’ Comprehensive General Liability, Automobile Liability and Property Damage Liability Insurance of the type and in the same amounts as specified in the Subparagraph, or 2) insure the activity of his subcontractors in his own policy.

11.2 OWNER'S LIABILITY INSURANCE

Delete Article 11.2 in its entirety.

11.3 PROPERTY INSURANCE

Delete Article 11.3 in its entirety and replace with the following:

11.3.1 The Contractor shall purchase and maintain property insurance upon the entire work at the site to the full insurable value thereof. This insurance shall include the interests of the Owner, the Contractor, Subcontractors, and sub-subcontractors in the work and shall insure against the perils of Fire, Extended Coverage, Vandalism, and Malicious Mischief.

11.3.2 The Owner and Contractor waive all rights against each other for damages caused by fires or other perils to the extent covered by insurance provided under Subparagraph 11.3.1. The Contractor shall require similar waivers by Subcontractors and sub-subcontractors in accordance with Clause 5.3.1.5.

11.3.3 Insurance must be issued by an insurance company with an “A rating as denoted in the AM Best Key Rating Guide”.

ARTICLE 12 - CHANGES IN THE WORK

12.1 CHANGE ORDERS

12.1.8 Percentage markups in pricing under Subparagraphs 12.1.3.1, 12.1.3.3, and 1.2.4 shall be as limited in the Contract Documents. Unit price of Subparagraph 12.1.3.2 shall represent total unit cost to the Owner and shall include the Contractor's markup for overhead and profit.

ARTICLE 14 - TERMINATION OF THE CONTRACT

14.1 TERMINATION BY THE CONTRACTOR

14.1.1 If the work is stopped for a period of thirty days under any order of any court or other public authority having jurisdiction, or as a result of any act of government, such as a declaration of a national emergency making materials unavailable, through no act or fault of the contractor or a subcontractor or their agents or employees or other persons performing any of the Work under a contract with the contractor, then the contractor may, upon seven days' written notice to the Owner and the Architect, terminate the contract and recover from the Owner payment for all Work executed and for any proven loss sustained upon any materials, equipment, tools, construction equipment, and machinery, including reasonable profit and damages.

ARTICLE 15 - ADDITIONAL CONDITIONS

15.1 SUBSTITUTION OF MATERIALS AND EQUIPMENT

15.1.1 Whenever a material, article, or piece of equipment is identified on the Drawings or in the Specifications by reference to manufacturers' or vendors' names, trade names, catalog numbers, or the like, it is so identified for the purpose of establishing a standard, and any material, article, or piece of equipment of other
manufacturers or vendors, which will perform adequately the duties imposed by the general design will be considered equally acceptable provided the material, article, or piece of equipment so proposed is, in the opinion of the Architect, of equal substance, appearance, and function. It shall not be purchased or installed by the Contractor without the Architect’s written approval.

15.2 NON-DISCRIMINATION PROVISION AND WAGE AND HOUR ACT

15.2.1 During the performance of this contract, the Contractor agrees as follows:

15.2.1.1 The Contractor shall not discriminate against any employee or applicant for employment because of sex, race, creed, color, age, or national origin. The Contractor will take affirmative action to insure that applicants are employed, and that employees are treated during employment without regard to their sex, race, age, creed, color, or national origin.

15.2.1.2 Such action shall include but not be limited to, the following: employment; upgrading; demotion; or transfer; recruitment or recruitment advertising; layoff or terminations; rates of pay or other forms of compensation; and selection for training, including apprenticeship. The Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided setting forth the provisions of this non-discrimination clause.

15.2.1.3 The Contractor will, in all solicitations, or advertisements for employees, placed by or on behalf of the contractor, state that all qualified applicants will receive consideration for employment without regard to sex, race, creed, color, age or national origin.

15.2.1.4 The Contractor will send to each labor union or representative of workers with which he has a collective bargaining agreement or other contract or understanding, a notice advising the labor union or worker's representative of the Contractor's commitments under Section 202 of Executive Order No. 11246 of October 27, 1965, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

15.2.1.5 The Contractor will comply with all provisions of the Executive Order No. 11246 of October 27, 1965, and of the rules, regulations and relevant orders of the Secretary of Labor or other government agency authority having jurisdiction.

15.2.1.6 The Contractor will furnish all information and reports required by Executive Order No. 11246 of October 27, 1965, and by the rules, regulations, and orders of the Secretary of Labor or other government agency authority having jurisdiction, and will permit access to his books, records, and accounts by the administrative agency and the Secretary of Labor for the purposes of investigation to ascertain compliance with such rules, regulations and orders.

15.2.1.7 In the event of the Contractor's noncompliance with the non-discrimination clauses of this contract, or with any of the said rules, regulations, or orders, this Contract may be canceled, terminated or suspended in whole or in part, and the Contractor may be declared ineligible for further University contracts or federally-assisted contracts in accordance with procedure authorized in Executive Order No. 11246 of October 27, 1965, or by rule, regulation, or order of the Secretary of Labor or other government agency authority having jurisdiction.

15.2.1.8 The Contractor will include in the provisions of Subparagraph 15.2.1.1 through 15.2.1.8 in every subcontract or purchase order unless exempted by rules, regulations or orders of the President's Committee on Equal Employment Opportunity issued pursuant to Section 204 of Executive Order No. 11246 of September 14, 1965, so that provisions will be binding upon each subcontractor or vendor. The Contractor will take such action with respect to any subcontract or purchase order as the administering agency may direct as a means of enforcing such provisions including sanctions for noncompliance: Provided, however, that in the event the Contractor becomes involved as a result of such direction by the administering agency, the Contractor may request the United States to enter into such litigation to protect the interest of the United States.

15.3 COMPLIANCE WITH COPELAND ANTI-KICKBACK ACT AND REGULATIONS

15.3.1 The Contractor shall comply with the Copeland Anti-Kickback Act and Regulations of the Secretary of Labor
Preceding text is assumed to be included here.

15.4 PREVAILING WAGES

15.4.1 Contractors and subcontractors shall pay all mechanics and laborers, including apprentices and trainees, no less than the wage and fringe benefit rates prevailing in the locality in which the work is performed. Wage and fringe benefit rates are determined by the Federal Government Department of Labor.

15.4.2 Classifications not provided in the schedule shall be determined prior to the award of the contract and shall be no less than the wage and fringe benefit rates determined by the Federal Department of Labor.

15.4.3 Contractors and subcontractors shall adhere to the ratios of apprentices to journey workers as determined by the Federal Department of Labor.

15.4.4 Contractors and subcontractors shall keep a copy of the prescribed wage and benefit rates posted at the construction site in a conspicuous place.

15.4.5 Contractors and subcontractors shall keep an accurate record of the name, occupation, and the actual benefits paid to each mechanic or laborer for the contract. This record shall be made available for reasonable inspection by the Federal Department of Labor and the Owner.
The Technical Specifications dated June 16, 2016 and the following List of Drawings represent the scope of work as defined in the Contract Documents from Article 4.

**DRAWINGS**

<table>
<thead>
<tr>
<th>Drawing No.:</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AG-01</td>
<td>Title Sheet / Drawing List</td>
</tr>
<tr>
<td>AG-11</td>
<td>Abbreviations</td>
</tr>
<tr>
<td>AG-21</td>
<td>Code Summary / General Notes</td>
</tr>
<tr>
<td>AG-31</td>
<td>Material Designations / ADA Elevations</td>
</tr>
<tr>
<td>AP-01</td>
<td>Radio Chem Lab Plans and Schedules</td>
</tr>
<tr>
<td>A5-81</td>
<td>Lab Elevations &amp; Details</td>
</tr>
<tr>
<td>A5-82</td>
<td>Shielding and Slab Details</td>
</tr>
<tr>
<td>MH-01</td>
<td>Partial Basement HVAC Plans</td>
</tr>
<tr>
<td>MP-01</td>
<td>Partial Basement Piping Plans</td>
</tr>
<tr>
<td>M7-01</td>
<td>Mechanical Schedules and Details</td>
</tr>
<tr>
<td>M8-01</td>
<td>Control Diagrams</td>
</tr>
<tr>
<td>EG-01</td>
<td>Electrical Symbol List, General Notes &amp; Abbreviations</td>
</tr>
<tr>
<td>EQD-0Bf</td>
<td>Basement Floor Electrical Equip. Demo Plan – Area F</td>
</tr>
<tr>
<td>EQ-0Bf</td>
<td>Basement Floor Electrical Equipment Plan – Area F</td>
</tr>
<tr>
<td>EL-00E</td>
<td>Basement Lighting Plan – East</td>
</tr>
<tr>
<td>EM-00E</td>
<td>Basement Misc. Systems Plan – East</td>
</tr>
<tr>
<td>E6-01</td>
<td>Panel Schedules and Details</td>
</tr>
</tbody>
</table>
GENERAL REQUIREMENTS

GENERAL

A. CONTRACTOR'S RESPONSIBILITY

It is not the responsibility of the Architect/Engineer or Owner's Representative to notify the Contractor or subcontractors when to commence, to cease, or to resume work; nor in any way to superintend so as to relieve the Contractor of responsibility or of any consequences of neglect or carelessness by him or his subordinates. All material and labor shall be furnished at times best suited for all Contractors and subcontractors concerned, so that the combined work of all shall be properly and fully completed on the date fixed by the Contract.

The Contractor shall be responsible for all items contained in both the specifications and on the drawings for all trades. He shall be responsible for the proper division of labor according to current labor union agreements regardless of the division of responsibility implied in the contract documents.

B. CODES AND STANDARDS

Reference to standard specifications for workmanship, apparatus, equipment and materials shall conform to the requirements of latest specifications of the organization referenced, i.e., American Society for Testing Materials (ASTM), Underwriters Laboratories, Inc. (UL), American National Standards Institute, Inc. (ANSI), and others so listed in the Technical Specifications.

C. PERMITS, FEES AND NOTICES

See Supplementary General Conditions.

D. MEASUREMENTS

Before proceeding with each Work Item, Contractor shall locate, mark and measure any quantity or each item and report quantities to Engineer. If measured quantities exceed Engineer’s estimate, Contractor shall obtain written authorization to proceed from Owner before executing Work required for that Work Item.

Measurement of quantities for individual Work Items will be performed by Contractor and reviewed by Engineer. Coordinate measurements with inspection as required in Section “Coordination.”

Cost of Work included in Work Item for quantities as indicated in Contract Documents shall be included in Base Bid.

1. Additions to or deductions from lump sum price for quantities of each Work Item added to or deducted from Work respectively shall be at unit prices indicated in Bid Form and shall constitute payment or deductions in full for all material, equipment, labor, supervision and incidentals necessary to complete Work.

E. CONTRACTOR'S MEASUREMENTS

Before ordering material, preparing Shop Drawings, or doing any work, each Contractor shall verify, at the building, all dimensions which may affect his work. He assumes full responsibility for the accuracy of his figures. No allowance for additional compensation will be considered for minor discrepancies between dimensions on the drawings and actual field dimensions.

F. CONTINUITY OF SERVICE (Revised 3-26-2012)

Continuity of all existing services in the building shall be maintained throughout the construction period. Where it is necessary to tie into the existing electrical service, water or waste systems, it shall be done as directed by the Architect/Engineer. This Contract shall also provide temporary lines or bypasses that may be required to maintain continuous service in the building. All utility shutdowns must be approved by the Owners Representative / Project Manager, not less than 7 business days prior to the event, so that proper notification can be posted.
G. SUBMITTALS

All submittals (except Shop Drawings) and samples required by the Specifications shall be submitted in triplicate unless otherwise specified for a particular item under an individual Specification Section.

Each sample shall be clearly identified on a tag attached, showing the name of the Project Consultant, the project number and title, the names of the Contractor, manufacturer (and supplier if same is not the manufacturer), the brand name or number identification, pattern, color, or finish designation and the location in the work.

Each submittal shall be covered by a transmittal letter, properly identified with the project title and number and a brief description of the item being submitted.

Contractor shall be responsible for all costs of packing, shipping and incidental expenses connected with delivery of the samples to the Project Consultant or other designated address.

If the initial sample is not approved, prepare and submit additional sets until approval is obtained.

Materials supplied or installed which do not conform to the appearance, quality, profile, texture or other determinant of the approval samples will be rejected, and shall be replaced with satisfactory materials at the Contractor's expense.

H. GENERAL/STANDARD ELECTRONIC EQUIPMENT AND INFRASTRUCTURE REQUIREMENTS (Revised 11-2008)

1. Compliance with WSU Standards for Communications Infrastructure
   
   A. All applicable work, products, materials and methods shall comply with the latest version of the “WSU Standards for Communications Infrastructure” except as where noted.
   
   B. This document is available at the following website/URL: http://networks.wayne.edu/WSU-Communications-Standards.pdf

2. Automation System Program Code
   
   A. All automation system uncompiled and compiled program codes, source codes, custom modules, graphical user interface screen shots and any other automation system programming data and material (Program Code) shall be provided to the UNIVERSITY in hard copy and on CD Rom in an unencrypted format acceptable to the UNIVERSITY.
   
   B. Copyright for the Program Code shall be assigned to the UNIVERSITY for purposes of system maintenance.

PROTECTION OF OCCUPANCY (Revised 3-2006)

A. FIRE PRECAUTIONS

Take necessary actions to eliminate possible fire hazards and to prevent damage to construction work, building materials, equipment, temporary field offices, storage sheds, and other property.

During the construction, provide the type and quantity of fire extinguishers and fire hose to meet safety and fire prevention practices by National Fire Protection Association (NFPA) Codes and Standards (available at http://www.nfpa.org/)

In the event that construction includes "hot work", the contractor shall provide the Owner's Representative with a copy of their hot work policy, procedures, or permit program. No hot work activity (temporary maintenance, renovation, or construction by operation of a gas or electrically powered equipment which produces flames, sparks or heat that is sufficient to start a fire or ignite combustible materials) shall be performed until such documents are provided. During such operations, all highly combustible or flammable materials shall be removed from the immediate working area, and if removal is impossible, same shall be protected with flame retardant shield.
Not more than one-half day's supply of flammable liquids such as gasoline, spray paint and paint solvent shall be brought into the building at any one time. Flammable liquids having a flash point of 100 degrees F. or below which must be brought into the building shall be confined in an Underwriters Laboratories (UL) labeled safety cans. The bulk supply of flammables shall be stored at least 75 feet from the building and other combustible materials. Spigots on drums containing flammable liquids are prohibited on the project site. Drums shall be equipped with approved vented pumps, and be grounded and bonded.

Only a reasonable working supply of combustible building materials shall be located inside the building.

All oil-soaked rags, papers, and other similar combustible materials shall be removed from the building at the close of each day's work, or more often if necessary, and placed in metal containers, with self-closing lids.

Materials and equipment stored in cardboard cartons, wood crates or other combustible containers shall be stored in an orderly manner and accessibly located, fire-fighting equipment of approved types shall be placed in the immediate vicinity of any materials or equipment stored in this type of crate or carton.

No gasoline, benzene, or like flammable materials shall be poured into sewers, manholes, or traps.

All rubbish shall be removed from the site and legally disposed of. Burning of rubbish, waste materials or trash on the site shall not be permitted.

The contractor shall be responsible for the conduct of employees relative to smoking and all smoking shall be in the area designated by the Architect/Engineer.

B. GENERAL SAFETY AND BUILDING PRECAUTIONS

Provide and maintain in good repair barricades, railings, etc., as required by law for the protection of the Public. All exposed material shall be smoothly dressed.

At dangerous points throughout the work environment provide and maintain colored lights or flags in addition to above guardrails.

Isolate Owner's occupied areas from areas where demolition and alteration work will be done, with temporary, dustproof, weatherproof, and fireproof enclosures as conditions may require and as directed by the Architect/Engineer.

Cover and protect furniture, equipment and fixtures to remain from soiling, dust, dirt, or damage when demolition work is performed in rooms or areas from which such items have not been removed.

Protect openings made in the existing roofs, floors, and other construction with weatherproof coverings, barricades, and temporary fire rated partitions to prevent accidents.

Repair any damage done to existing work caused by the construction and removal of temporary partitions, coverings, and barricades.

The Contractor will be held responsible for all breakage or other damage to glass up to the time the work is completed.

Provide protection for existing buildings, interior and exterior, finishes, walls, drives, landscaping, lawns (see below), etc. All damages shall be restored to match existing conditions to the satisfaction of the Architect/Engineer.

The Contractor and Owner will define the anticipated area of lawn damage at the project Pre-Construction Meeting. Whether the lawn is sparse or fully developed, any lawn damaged due to the Contractor's work will be replaced with sod by the University. The University's unit cost of $10.00 per square yard and landscaping at a rate of 1.5 times the cost of the sod repairs, the full cost of which will be assessed against the Contractor. At the completion of the project, a deductive Change Order reflecting this cost will be issued.

The Contractor is to include an allowance in his bid for this corrective work.

C. INTERFERENCE WITH OWNER'S OPERATIONS
The Owner will be utilizing the Building Facilities to carry on his normal business operation during construction. The Contractor shall schedule performance of the work necessary to complete the project in such a way as to interfere as little as possible with the operation during construction. The Contractor shall schedule performance of the work necessary to complete the project in such a way as to interfere as little as possible with the operation of the Owner.

Work which will interfere with the Owner's occupancy, including interruptions to the Owner's mechanical and electrical services, and essentially noisy operations (such as jackhammering) shall be scheduled in advance. The schedule of alterations shall be approved by the Architect/Engineer and the work shall be done in accordance with the approved schedule.

It is understood that the work is to be carried through to completion with the utmost speed consistent with good workmanship and to meet the construction schedule.

The Contractor shall begin work under the Contract without delay upon receipt of the fully-executed contract and shall substantially complete the project ready for unobstructed occupancy and use of the Owner for the purposes intended within the completion time stated in the contract.

The Contractor shall, immediately upon award of contract, schedule his work and expedite deliveries of materials and performance of subcontractors to maintain the necessary pace to meet the construction schedule.

**CONTRACTOR'S REPRESENTATION AND COORDINATION**

**A. FIELD SUPERINTENDENT**

Contractor shall assign a full time project manager/superintendent for the duration of the project. This person shall be experienced and qualified in all phases of the work and shall be present at the site during Contractor's working hours. The project manager shall have Contractor's full authority to represent Contractor in all routine operations including payment, changes to the work, and scheduling. Contractor shall not re-assign this individual without prior written permission of the Owner.

**B. MEETINGS**

When directed by the Architect/Engineer, meetings shall be held for the purpose of coordinating and expediting the work. The invited contractors or subcontractors will be required to have qualified representatives at these meetings, empowered to act in their behalf.

**C. COORDINATION**

The Contractor shall also provide a staff adequate to coordinate and expedite the work properly and shall at all times maintain competent supervision of its own work and that of its subcontractors to insure compliance with contract requirements.

The Contractor shall be solely responsible for all construction means, methods, techniques, sequences, and procedures and for coordinating all portions of the work under the Contractor.

**D. CONSTRUCTION SCHEDULE**

The Construction Schedule shall be prepared after the award of contract. Soon after, a pre-construction meeting is held with the Owner and the Architect/Engineer to determine the areas to which the Contractor will be allowed access at any one time.

The Contractor is alerted to the fact that areas in which he will be working will be occupied by students and employees of the University as well as the general public. The Contractor's access, to and from the project site, will be confined to limited areas so as not to unduly disrupt the normal activities of the University.

**TEMPORARY FACILITIES**

**A. GENERAL**
The following temporary facilities descriptions represent standard conditions. Verify accuracy with Architect/Engineer at time of bids.

B. CONTRACTOR'S OFFICE

Provide field offices as required. Locate temporary field offices on site where directed by Architect/Engineer.

Appearance and location of field offices shall be approved by the Architect/Engineer.

Provide for all other administrative facilities and storage off the Owner's property.

C. STORAGE OF MATERIALS

All materials shall be stored in areas designated by the Architect/Engineer. All stored materials shall be arranged for the minimum disruption to occupants and to allow full access to and throughout the building. Materials stored outdoors shall be neat and orderly and covered to prevent damage or vandalism.

D. PARKING

1. GENERAL

University parking regulations will be strictly enforced.

Maintain Owner's parking areas free of dirt and debris resulting from operations under the contract.

2. STANDING AND UNLOADING/LOADING VEHICLES

All Contractors are to call Wayne State University Public Safety at 577-2222, and give at least 24 hours advance notice that they have vehicles that must be at the job site.

Vehicles will be permitted at the project site only as long as the vehicles are needed for loading/unloading, and must be immediately moved upon completion.

All unauthorized and/or unattended standing vehicles will be subject to ticketing and removal by University Police. Towed vehicles may be reclaimed by calling 577-2222, and paying any assessed charges.

3. COMPLIMENTARY PARKING

There is no complimentary parking for Contractor's employee vehicles.

4. WAYNE STATE UNIVERSITY PUBLIC/STUDENT PARKING AREAS

Public Parking, on a first-come first-served basis is available. Contact the office of the One Card System, at 313.577.9513 for information on availability of parking on a contractual basis.

E. TOILET FACILITIES

The Owner's designated existing toilet facilities may be used by workers on the project. Contractor shall maintain such facilities in a neat and sanitary condition.

F. TELEPHONE USE

If required, the Contractor shall provide and pay for a temporary telephone within the building for his use and that of his subcontractors.

No use of the Owner's telephone (except pay telephones) will be permitted.

G. ACCESS DEVICES
The Contractor shall furnish and maintain temporary hoists, ladders, railings, scaffolds, runways, and the like as required for safe, normal access to the permanent construction until the permanent facilities are complete. Each trade shall furnish such additional means of access as may be required for the progress and completion of the work. Such temporary access devices shall meet all applicable local, state, and federal codes and regulations.

H. HEAT AND VENTILATION

Provide cold weather protection and temporary heat and ventilation as required during construction to protect the work from freezing and frost damage.

Provide adequate ventilation as required to maintain reasonable interior building air conditions and temperatures, to prevent accumulation of excess moisture, and to remove construction fumes.

Tarpaulins and other materials used for temporary enclosures. Coverings and protection shall be flameproofed.

I. WATER SERVICE

Sources of water are available at the site. The Owner will pay for reasonable amounts of water used for construction purposes.

The Contractor shall provide, at the earliest possible date, temporary connections to the water supply sources and maintain adequate distribution for all construction requirements. The Contractor shall protect sources against damage.

Methods of conveying this water shall be approved by the Architect/Engineer and shall not interfere with the Owner's operations.

J. ELECTRICAL SERVICES

All charges for reasonable amounts of electrical power energy used for temporary lighting and power required for this work will be paid by the Owner.

The Contractor shall provide and maintain any temporary electrical lighting and power required for this work. At the completion of the work, all such temporary electrical facilities shall be removed and disposed of by the Contractor.

Temporary lighting and power shall comply with the regulations and requirements of the National Electrical Code

INSPECTIONS AND TESTS

The Architect/Engineer shall at all times have access to the work wherever it is in preparation or in progress and the Contractor shall provide proper facilities for such access and for observation.

No failure of the Architect/Engineer, during the progress of the work, to discover or reject materials or work not in accordance with the Contract Specifications and Drawings shall be deemed an acceptance thereof nor a waiver of defects therein. Likewise, no acceptance or waiver shall be inferred or implied due to payments made to contractor or by partial or entire occupancy of the work, or installation of materials that are not strictly in accordance with the Contract Specifications and Drawings.

Where tests are specifically called for in the Specifications, the Owner shall pay all costs of such tests and engineering services unless otherwise stated in the contract.

Where tests are not specifically called for in the Specifications, but are required by the Architect/Engineer or Consultant, the Owner shall pay all costs of such tests and engineering services unless the tests reveal that the workmanship or materials used by the Contractor are not in conformity with the Drawings, Specifications, and/or approved shop drawings. In such event, the Contractor shall pay for the tests, shall remove all work and materials so failing to conform and replace with work and materials that are in full conformity.

CLEAN-UP
The Contractor shall at all times keep the Owner's premises and the adjoining premises, driveways and streets clean of rubbish caused by the Contractor's operations and at the completion of the work shall remove all the rubbish, all of his tools, equipment, temporary work and surplus materials, from and about the premises, and shall leave the work clean and ready for use. If the contractor does not attend to such cleaning immediately upon request, the Architect/Engineer may cause such cleaning to be done by others and charge the cost of same to the Contractor.

The Contractor will be responsible for all damage from fire that originates in, or is propagated by, accumulations of rubbish or debris.

All rubbish and debris shall be disposed of off the Owner's property in an approved sanitary landfill site. No open burning of debris or rubbish will be permitted. Job site shall be left neat and clean at the completion of each day's operation.

PROJECT CLOSE-OUT

A. RECORD DRAWINGS

At beginning of job, provide one copy of Working Drawings, and record changes, between Working Drawings and "As Built", including changes made by Addenda, Change Orders, Shop Drawings, etc. These shall be kept up to date. Update to indicate make of all mechanical and electrical equipment and fixtures installed. Keep these Record Prints in good condition and available for inspection by the Architect/Engineer.

Upon completion of the job, turn over to the Architect/Engineer Record Prints of Working Drawings showing all job changes.

B. OPERATING AND MAINTENANCE DATA

Prepare and furnish to the Architect/Engineer three (3) bound copies of "Operating and Maintenance Manual" on all equipment installed under this Contract.

Manual shall include copies of all Manufacturers' "Operating and Service Instructions", including Parts List, Control Diagrams, Description of Control Systems, Operating, Electrical Wiring, and any other information needed to understand, operate and maintain the equipment. The names and addresses of all subcontractors shall be included. These instructions shall be custom-prepared for this job -- catalog cuts will not be accepted. Equipment shall be cross-referenced to Section of Specifications and to location shown and scheduled on drawings.


C. FINAL INSPECTION

Secure final inspections from the State of Michigan as soon as the work is completed and immediately submit such Certificates to the Architect/Engineer.

D. GUARANTEES (See Sections 00510 and 01781)

Guarantees on material and labor from the General Contractor and his subcontractors shall be as required in Sections 00510 and 01781.

E. SWORN STATEMENT AND WAIVER OF LIENS (revised 4-11-2012)

Prior to final payment, the General Contractor shall provide a Contractor's Sworn Statement and Full Unconditional Waivers of Liens from all subcontractors for material and labor and from all suppliers who provide materials exceeding $1,000. Sworn Statements and signed waivers from all Subcontractors must accompany Pay Applications or they will be returned for such documentation prior to approval.

ASBESTOS HAZARD

A. The contractor shall not start any work in any area that has not been inspected for asbestos by the Owner's Industrial Hygiene Department, or a qualified representative of the Owner and approval is given for work to be done. If asbestos is found, safety measures as recommended by the Owner's Industrial Hygiene Department, or a qualified representative of the
Owner, shall be completed, or approval given for work to be done before work is started. The contractor shall not perform any asbestos removal or containment work under the contract.

**KEYS**

A. The Owner shall provide the contractor keys on loan to have access to the various spaces in order to complete the contract. Contractor will sign for and be responsible for each key on loan, returnable to Owner upon completion of the contract. In case of any lost keys, the Owner will backcharge the contract $250.00 for each core change. In the event that a Contractor wants access to a secured area, he shall give the Owner a minimum 48-hour notice.
SUMMARY OF WORK

PROJECT: IBio RadioChemistry Facility
WSU PROJECT NO.: 211-277899
PROJECT MANAGER: Jason R. Davis

1. EXAMINATION

The Contractor shall visit the site and become familiar with conditions under which he will be working. Also meet with the project manager and review site access, storage areas, etc.

2. Description of Work – Project includes RadioChemistry Lab buildout including architectural, HVAC, plumbing, controls, power, lighting, fire alarm and fire suppression work.

3. The building is located at

Wayne State University
IBio Building, 6135 Woodward Ave
Detroit, Michigan 48202
Project Manual

Wayne State University
IBio Radio Chemistry Facility

at
Wayne State University
Detroit, Michigan

for
Wayne State University

WAYNE STATE UNIVERSITY

General Contract
HED Project No.: 2016-01118-000
WSU Project No.: 211-277899

Issued for Construction: June 10, 2016
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230529 Hangers And Supports For HVAC Piping And Equipment  
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SECTION 00015 - LIST OF DRAWINGS

1.1 CONTRACT DRAWINGS

A. The following Drawings, marked and dated as noted below, form a part of the Contract Documents:

1. Marked: Issued for Construction
2. Dated: June 10, 2016
3. List: Refer to Drawing AG-01, "Title Sheet", for complete list of drawings.

END OF SECTION
SECTION 012200 - UNIT PRICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Section includes administrative and procedural requirements for unit prices.
B. Related Sections:
  1. Division 9 Sections for work with unit prices.

1.3 DEFINITIONS
A. Unit price is an amount incorporated in the Agreement, applicable during the duration of the Work as a price per unit of measurement for materials, equipment, or services, or a portion of the Work, added to or deducted from the Contract Sum by appropriate modification, if the scope of Work or estimated quantities of Work required by the Contract Documents are increased or decreased.

1.4 PROCEDURES
A. Unit prices include all necessary material, plus cost for delivery, installation, insurance, applicable taxes, overhead, and profit.
B. Measurement and Payment: Refer to individual Specification Sections for work that requires establishment of unit prices.
C. Owner reserves the right to reject Contractor's measurement of work-in-place that involves use of established unit prices and to have this work measured, at Owner's expense, by an independent surveyor acceptable to Contractor.
D. List of Unit Prices: A schedule of unit prices is included in Part 3. Specification Sections referenced in the schedule contain requirements for materials described under each unit price.
PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SCHEDULE OF UNIT PRICES

A. Unit Price: Concrete Slab Preparation for Finish Flooring:

1. Description: Where concrete slab does not meet specified moisture testing requirements, provide remedial floor preparation. Preparation shall include finish flooring manufacturer recommended and approved surface applied sealer/moisture barrier and all related and required surface preparation. Such remediation shall be as required for finish flooring manufacturer to fully warrant any finish flooring adhesion failures for a period of one year after substantial completion of the Project. Any finish flooring adhesion failure during this time period shall be replaced or repaired without cost to the Owner.

2. Unit of Measurement: Per square foot (s.f.) of floor slab area requiring remediation.

END OF SECTION
DWH/BRP
SECTION 014010- TESTING AND INSPECTION SERVICES - BUILDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division -1 Specifications Sections, apply to this Section.

1.2 SUMMARY

A. MBC 2009 Chapter 17 Special Inspection and testing is specified in this Section.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 1 Section "Quality Control" for general requirements and responsibilities.

C. Related Documents: Special Inspection and Testing matrix shown on contract drawings.

1.3 SUBMITTALS

A. Copies of handwritten or otherwise prepared notes for Daily Reports:

1. Daily submittal: Prior to the close of the business submit to the Architect a scanned or photographed copy of the daily notes.

   a. Submit scans or photos by e-mail.

B. Written Reports (Typed):

1. Daily Reports: The Special Inspection and/or Independent Testing Agency shall submit within 10 calendar days, a certified report of each inspection, test or similar service.

   a. Exception: If the testing/inspection activity is found to be not in compliance with the contract documents, the Contractor shall be notified immediately.

      1) If the Contractor is unable to comply with required corrections in a timely manner, or if the Architect is required to provide direction, a written report shall be in the Architect’s and Contractor’s offices no later than 9:00 a.m., local time, the following morning. Delivery shall be by electronic mail, fax, or express mail.

      2) Provide photographs of the discrepancy and the specific location thereof.
3) If delivered by electronic mail or fax, the document shall be clearly marked or flagged that a discrepancy has occurred. Use the same marking for the entire job.

4) Attach a copy of photograph(s) for each item not in compliance.

2. Retest Reports: Reports for items that are retested shall be clearly marked or flagged. Use the same marking for the entire job.

3. Summary Reports: The Special Inspection and/or Independent Testing Agency shall submit a final certified report documenting completion of all required inspections (special inspections and other inspection/testing) and correction of irregularities and deficiencies noted in the inspections.

4. Submit one copy of the reports to the Owner, to the Architect, to the Contractor, and to the governing authority.

5. Each copy shall be suitable for reproduction on an electrostatic copier; the use of precarboned forms will not be acceptable.

6. Report Data: Written reports of each inspection, test or similar service shall include, but not be limited to:
   a. Date of issue.
   b. Report Number.
   c. Architect's Project Title.
   d. Architect's Project Number.
   e. Name, address and telephone number of Independent Testing Agency.
   f. Dates and locations of samples and tests or inspections.
   g. Names of individuals making the inspection or test.
   h. Designation of the Work and test method.
   i. Identification of product and/or test.
   j. Complete inspection or test data.
   k. Test results and an interpretation of test results.
   l. Ambient conditions at the time of sample-taking and testing.
   m. Professional evaluation as to whether inspected or tested Work complies with Contract Document requirements, including referenced codes.
   n. Name and signature of laboratory inspector.
   o. Recommendations on retesting.

7. Reports for drilled piers inspection shall include the following items:
   a. Project name and number.
   b. Name of Contractor.
   c. Dates of starting excavation, completion of excavation, inspection, testing, and placement of concrete (include any delays in concreting and location of construction joints in shafts).
   d. Accurate center-line location and dimensions of drilled piers.
   e. Variation of shaft from plumb.
   f. Accurate top and bottom elevations.
1) Bottom: To the nearest 3 inch.
2) Top: To the nearest ½ inch.

g. Description of soil materials encountered.
h. Depth of socket (if applicable).
i. Elevation at which bearing material encountered.
j. Bearing material including samples, tests and conclusions reached with regard to adequacy of bearing material.
k. Levelness of bottom.
l. Perched/ground-water encountered and its control.
m. Cleanout adequacy.
n. Location, type and dimensions of obstructions encountered and how removal was attained.
o. Properties of slurry and slurry test results at time of slurry placement and at time of concrete placement.
p. Concrete placement and consolidation methods.
q. Reinforcing Bars:

1) Condition.
2) Position.
3) Spacers.

r. Casing.

1) Elevation of bottom and top of any casing left in – place.

s. Length, wall thickness, diameter, top and bottom elevations of temporary casings.

1) Include anchorage and sealing methods.
2) Include condition and weather-tightness of splices, if any.

t. Soil and reinforcing movement, if any.
u. Concrete head during casing removal.
v. Construction joints if any.

1) Describe splices at construction joint.

w. Any unusual conditions.
x. Record of any deviations from specifications and difficulties encountered such as possible soil inclusion, possible voids, and shaft squeeze-in.
y. Summary statement that drilled pier meets the contract requirements.
1.4 ACCEPTABLE PROVIDERS FOR SPECIAL INSPECTION AND TESTING

A. The following companies are acceptable to provide testing and inspection services:

1. NTH Consultants, 41780 Six Mile Road, Northville, MI 48168, Contact: Mr. Hasam Yaldo, PE.
2. Somat Engineering, 26445 Northline Road, Taylor, MI 48180, Contact: Mr. Richard Anderson, PE.
3. Soils and Materials Engineers, 43980 Plymouth Oaks Blvd., Plymouth, MI 48170, Contact: Mr. Jerry Belian, PE.

PART 2 - PRODUCTS

(Not Applicable)

PART 3 - EXECUTION

3.1 GENERAL

A. Preconstruction Conferences:

1. Special Inspection and Independent Testing Agency Representatives consisting of field representative performing testing and his supervisor shall attend preconstruction conferences, called by the Contractor, in order to review the quality control, materials and procedures of the Section. Sections requiring preconstruction conferences shall include, but are not limited to, the following:

   a. Division 5 Section “Post-Installed Anchors”.
   b. Others as determined by the Contractor.
SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:

2. Field engineering and surveying.
3. Installation of the Work.
4. Cutting and patching.
5. Coordination of Owner-installed products.
6. Progress cleaning.
7. Starting and adjusting.
8. Protection of installed construction.

B. Related Requirements:

1. Section 011000 "Summary" for limits on use of Project site.
2. Section 013300 "Submittal Procedures" for submitting surveys.
3. Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Owner-accepted deviations from indicated lines and levels, and final cleaning.
4. Section 024119 "Selective Structure Demolition" for demolition and removal of selected portions of the building.

1.3 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of other work.

B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.
1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For professional engineer.

B. Certificates: Submit certificate signed by professional engineer certifying that location and elevation of improvements comply with requirements.

C. Cutting and Patching Plan: Submit plan describing procedures at least 15 days prior to the time cutting and patching will be performed. Include the following information:

   1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
   2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
   3. Products: List products to be used for patching and firms or entities that will perform patching work.
   4. Dates: Indicate when cutting and patching will be performed.
   5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.

      a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.

D. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.

1.5 QUALITY ASSURANCE

A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

B. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.

   1. Structural Elements: When cutting and patching structural elements, notify Architect of locations and details of cutting and await directions from Architect before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.

   2. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.
C. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

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

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.

1. For projects requiring compliance with sustainable design and construction practices and procedures, use products for patching that comply with requirements in Section 018113.13 "Sustainable Design Requirements - LEED for New Construction and Major Renovations.

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

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Architect for the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

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

1. Description of the Work.
2. List of detrimental conditions, including substrates.
3. List of unacceptable installation tolerances.
4. Recommended corrections.

D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

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

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

C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to Architect according to requirements in Section 013100 "Project Management and Coordination."
3.3 CONSTRUCTION LAYOUT

A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify and Construction Manager promptly.

B. General: Engage a professional engineer to lay out the Work using accepted surveying practices.

1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
2. Establish limits on use of Project site.
3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
4. Inform installers of lines and levels to which they must comply.
5. Check the location, level and plumb, of every major element as the Work progresses.
6. Notify Architect and Construction Manager when deviations from required lines and levels exceed allowable tolerances.
7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.

D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

E. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Construction Manager.

3.4 FIELD ENGINEERING

A. Identification: Owner will identify existing benchmarks, control points, and property corners.

B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.

1. Do not change or relocate existing benchmarks or control points without prior written approval of Construction Manager. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Construction Manager before proceeding.
2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.

C. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.

1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

D. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.

E. Final Property Survey: Engage a land surveyor to prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor, that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.

1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
2. Recording: At Substantial Completion, have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

3.5 INSTALLATION

A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

1. Make vertical work plumb and make horizontal work level.
2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
4. Maintain minimum headroom clearance of 96 inches (2440 mm) in occupied spaces and 90 inches (2300 mm) in unoccupied spaces.

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

C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

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

F. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

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

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

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

2. Allow for building movement, including thermal expansion and contraction.

3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

I. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

J. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.6 CUTTING AND PATCHING

A. Cutting and Patching, General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

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

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

C. Temporary Support: Provide temporary support of work to be cut.
D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching according to requirements in Section 011000 "Summary."

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

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
6. Proceed with patching after construction operations requiring cutting are complete.

G. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other work. Patch with durable seams that are as invisible as practicable. Provide materials and comply with installation requirements specified in other Sections, where applicable.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will minimize evidence of patching and refinishing.
   a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
   b. Restore damaged pipe covering to its original condition.
3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

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

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

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

3.7 OWNER-INSTALLED PRODUCTS

A. Site Access: Provide access to Project site for Owner's construction personnel.

B. Coordination: Coordinate construction and operations of the Work with work performed by Owner's construction personnel.

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

2. Preinstallation Conferences: Include Owner's construction personnel at preinstallation conferences covering portions of the Work that are to receive Owner's work. Attend preinstallation conferences conducted by Owner's construction personnel if portions of the Work depend on Owner's construction.

3.8 PROGRESS CLEANING

A. General: Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.


2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 80 deg F (27 deg C).

3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

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

4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
   1. Remove liquid spills promptly.
   2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

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

F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 015000 "Temporary Facilities and Controls" and Section 017419 "Construction Waste Management and Disposal."

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

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

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

3.9 STARTING AND ADJUSTING

A. Coordinate startup and adjusting of equipment and operating components with requirements in Section 019113 "General Commissioning Requirements."

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

C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements."

3.10 PROTECTION OF INSTALLED CONSTRUCTION

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

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

END OF SECTION 017300

BRP
SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes administrative and procedural requirements for the following:
   1. Recycling nonhazardous demolition and construction waste.
   2. Disposing of nonhazardous demolition and construction waste.
B. Related Requirements:
   1. Section 024119 "Selective Structure Demolition" for disposition of waste resulting from partial demolition of buildings, structures, and site improvements, and for disposition of hazardous waste.

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

A. General: Achieve end-of-Project rates for salvage/recycling of 75 percent by weight of total non-hazardous solid waste generated by the Work. Practice efficient waste management in the use of materials in the course of the Work. Use all reasonable means to divert construction and demolition waste from landfills and incinerators. Facilitate recycling and salvage of materials, including the following:

1. Demolition Waste:

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

a. Masonry and CMU.
b. Lumber.
c. Wood sheet materials.
d. Wood trim.
e. Metals.
f. Roofing.
g. Insulation.
h. Carpet and pad.
i. Gypsum board.
j. Piping.
k. Electrical conduit.
l. Packaging: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:

1) Paper.
2) Cardboard.
3) Boxes.
4) Plastic sheet and film.
5) Polystyrene packaging.
7) Plastic pails.

1.5 ACTION SUBMITTALS

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

1.6 INFORMATIONAL SUBMITTALS

A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. Use Form CWM-7 for construction waste and Form CWM-8 for demolition waste. Include the following information:

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

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

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

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

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

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

G. LEED Submittal: LEED letter template for Credit MR 2, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements for the credit have been met.

H. Qualification Data: For waste management coordinator and refrigerant recovery technician.

I. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

1.7 QUALITY ASSURANCE

A. Waste Management Coordinator Qualifications: Experienced firm, with a record of successful waste management coordination of projects with similar requirements, that employs a LEED-Accredited Professional, certified by the USGBC, as waste management coordinator. Waste management coordinator may also serve as LEED coordinator.

B. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.

C. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.

D. Waste Management Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:
1. Review and discuss waste management plan including responsibilities of waste management coordinator.
2. Review requirements for documenting quantities of each type of waste and its disposition.
3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
5. Review waste management requirements for each trade.

1.8 WASTE MANAGEMENT PLAN

A. General: Develop a waste management plan according to ASTM E 1609 and requirements in this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Distinguish between demolition and construction waste. Indicate quantities by weight or volume, but use same units of measure throughout waste management plan.

B. Waste Identification: Indicate anticipated types and quantities of demolition, site-clearing and construction waste generated by the Work. Use Form CWM-1 for construction waste and Form CWM-2 for demolition waste. 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. Use Form CWM-3 for construction waste and Form CWM-4 for demolition waste. 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 Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
2. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
3. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
4. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location where materials separation will be performed.

D. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there was no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Use Form CWM-5 for construction waste and Form CWM-6 for demolition waste. 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).
Construction

4. Revenue from salvaged materials.
5. Revenue from recycled materials.
7. Savings in hauling and tipping fees that are avoided.
8. Handling and transportation costs. Include cost of collection containers for each type of waste.
9. Net additional cost or net savings from waste management plan.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

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

1. Comply with operation, termination, and removal requirements in Section 015000 "Temporary Facilities and Controls."

B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan.

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

1. Distribute waste management plan to everyone concerned within seven days of submittal return.
2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

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 Section 015000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

E. Waste Management in Historic Zones or Areas: Hauling equipment and other materials shall be of size that clear surfaces within historic spaces, areas, rooms, and openings, by 12 inches (300 mm) or more.
3.2 SALVAGING DEMOLITION WASTE

A. Salvaged Items for Donation: As noted on drawings.

3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

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

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

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

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

1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.
   a. Inspect containers and bins for contamination and remove contaminated materials if found.

2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.

4. Store components off the ground and protect from the weather.

5. Remove recyclable waste from Owner's property and transport to recycling receiver or processor.

3.4 RECYCLING DEMOLITION WASTE

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

B. Concrete: Break up and transport to concrete-recycling facility.

C. Masonry: Break up and transport to concrete-recycling facility.

D. Metals: Separate metals by type.

1. Structural Steel: Stack members according to size, type of member, and length.
2. Remove and dispose of bolts, nuts, washers, and other rough hardware.
E. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.

F. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.

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

H. Carpet: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.
   1. Store clean, dry carpet in a closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.

I. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.

J. Conduit: Reduce conduit to straight lengths and store by type and size.

3.5 RECYCLING CONSTRUCTION WASTE

A. Packaging:
   1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
   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. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.
   1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.
      a. Comply with requirements in Section 329300 "Plants" for use of clean ground gypsum board as inorganic soil amendment.

3.6 DISPOSAL OF WASTE

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

B. Burning: Do not burn waste materials.

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

END OF SECTION 017419
BRP
SECTION 018113 - SUSTAINABLE DESIGN REQUIREMENTS - LEED FOR NEW CONSTRUCTION AND MAJOR RENOVATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general requirements and procedures for compliance with certain USGBC LEED prerequisites and credits needed for Project to obtain LEED Silver certification based on USGBC's "LEED 2009 for New Construction & Major Renovations."

1. Other LEED prerequisites and credits needed to obtain LEED certification depend on product selections and may not be specifically identified as LEED requirements. Compliance with requirements needed to obtain LEED prerequisites and credits may be used as one criterion to evaluate substitution requests and comparable product requests.

2. Additional LEED prerequisites and credits needed to obtain the indicated LEED certification depend on Architect's design and other aspects of Project that are not part of the Work of the Contract.

3. A copy of the LEED Project checklist is attached at the end of this Section for information only.

4. Specific requirements for LEED are included in greater detail in other Sections.

1.3 DEFINITIONS

A. Chain-of-Custody Certificates: Certificates signed by manufacturers certifying that wood used to make products was obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship." Certificates shall include evidence that manufacturer is certified for chain of custody by an FSC-accredited certification body.

B. Regional Materials: Materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site. If only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value.
C. Recycled Content: The recycled content value of a material assembly shall be determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.

1. "Post-consumer" material is defined as waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of the product, which can no longer be used for its intended purpose.
2. "Pre-consumer" material is defined as material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Respond to questions and requests from Architect and the USGBC regarding LEED credits that are the responsibility of the Contractor, that depend on product selection or product qualities, or that depend on Contractor's procedures until the USGBC has made its determination on the project's LEED certification application. Document responses as informational submittals.

1.5 ACTION SUBMITTALS

A. General: Submit additional LEED submittals required by other Specification Sections.

B. LEED submittals are in addition to other submittals. If submitted item is identical to that submitted to comply with other requirements, submit duplicate copies as a separate submittal to verify compliance with indicated LEED requirements.

C. LEED Documentation Submittals:

1. Credit MR 2: Comply with Section 017419 "Construction Waste Management and Disposal."
2. Credit MR 4: Product data and certification letter indicating percentages by weight of post-consumer and pre-consumer recycled content for products having recycled content. Include statement indicating cost for each product having recycled content.
3. Credit MR 5: Product data for regional materials indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating cost for each regional material and the fraction by weight that is considered regional.
5. Credit EQ 3.1:
   a. Construction indoor-air-quality management plan.
   b. Product data for temporary filtration media.
c. Product data for filtration media used during occupancy.
d. Construction Documentation: Six photographs at three different times during the construction period, along with a brief description of the SMACNA approach employed, documenting implementation of the indoor-air-quality management measures, such as protection of ducts and on-site stored or installed absorptive materials.

6. Credit IEQ 3.2:
   a. Signed statement describing the building air flush-out procedures including the dates when flush-out was begun and completed and statement that filtration media was replaced after flush-out.
   b. Product data for filtration media used during flush-out and during occupancy.
   c. Report from testing and inspecting agency indicating results of indoor-air-quality testing and documentation showing compliance with indoor-air-quality testing procedures and requirements.

7. Credit IEQ 4.1: Product data for adhesives and sealants used inside the weatherproofing system indicating VOC content of each product used.
8. Credit IEQ 4.2: Product data for paints and coatings used inside the weatherproofing system indicating VOC content of each product used.
9. Credit IEQ 4.4: Product data for products containing composite wood or agrifiber products or wood glues indicating that they do not contain urea-formaldehyde resin.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For LEED coordinator.

B. Project Materials Cost Data: Provide statement indicating total cost for materials used for Project. Costs exclude labor, overhead, and profit. Include breakout of costs for the following categories of items:

1. Furniture.
2. Plumbing.
3. Mechanical.
4. Electrical.
5. Specialty items such as elevators and equipment.

C. LEED Action Plans: Provide preliminary submittals within 30 days of date established for commencement of the Work indicating how the following requirements will be met:
1. Credit MR 2: Waste management plan complying with Section 017419 "Construction Waste Management and Disposal."
2. Credit MR 4: List of proposed materials with recycled content. Indicate cost, post-consumer recycled content, and pre-consumer recycled content for each product having recycled content.
3. Credit MR 5: List of proposed regional materials. Identify each regional material, including its source, cost, and the fraction by weight that is considered regional.
4. Credit MR 7: List of proposed certified wood products. Indicate each product containing certified wood, including its source and cost of certified wood products.
5. Credit IEQ 3.1: Construction indoor-air-quality management plan.

D. LEED Progress Reports: Concurrent with each Application for Payment, submit reports comparing actual construction and purchasing activities with LEED action plans for the following:

2. Credit MR 3: Salvaged, refurbished, and reused materials.
3. Credit MR 4: Recycled content.
4. Credit MR 5: Regional materials.
5. Credit MR 7: Certified wood products.

1.7 QUALITY ASSURANCE

A. LEED Coordinator: Engage an experienced LEED-Accredited Professional to coordinate LEED requirements. LEED coordinator may also serve as waste management coordinator.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

A. Provide products and procedures necessary to obtain LEED credits required in this Section. Although other Sections may specify some requirements that contribute to LEED credits, the Contractor shall determine additional materials and procedures necessary to obtain LEED credits indicated.

2.2 RECYCLED CONTENT OF MATERIALS

A. Credit MR 4: Building materials shall have recycled content such that post-consumer recycled content plus one-half of pre-consumer recycled content for Project constitutes a minimum of 10 percent of cost of materials used for Project.
1. Cost of post-consumer recycled content plus one-half of pre-consumer recycled content of an item shall be determined by dividing weight of post-consumer recycled content plus one-half of pre-consumer recycled content in the item by total weight of the item and multiplying by cost of the item.

2. Do not include furniture, plumbing, mechanical and electrical components, and specialty items such as elevators and equipment in the calculation.

2.3 REGIONAL MATERIALS

A. Credit MR 5: Not less than 10 percent of building materials (by cost) shall be regional materials.

2.4 CERTIFIED WOOD

A. Credit MR 7: Not less than 50 percent (by cost) of wood-based materials shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

1. Wood-based materials include, but are not limited to, the following materials when made from wood, engineered wood products, or wood-based panel products:
   a. Rough carpentry.
   b. Miscellaneous carpentry.
   c. Heavy timber construction.
   d. Wood decking.
   e. Metal-plate-connected wood trusses.
   f. Structural glued-laminated timber.
   g. Finish carpentry.
   h. Architectural woodwork.
   i. Wood paneling.
   j. Wood veneer wall covering.
   k. Wood flooring.
   l. Wood lockers.
   m. Wood cabinets.
   n. Furniture.

2.5 LOW-EMITTING MATERIALS

A. Credit IEQ 4.1: For field applications that are inside the weatherproofing system, adhesives and sealants shall comply with the following VOC content limits when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1. Wood Glues: 30 g/L.
2. Metal-to-Metal Adhesives: 30 g/L.
3. Adhesives for Porous Materials (Except Wood): 50 g/L.
4. Subfloor Adhesives: 50 g/L.
5. Plastic Foam Adhesives: 50 g/L.
6. Carpet Adhesives: 50 g/L.
7. Carpet Pad Adhesives: 50 g/L.
8. VCT and Asphalt Tile Adhesives: 50 g/L.
9. Cove Base Adhesives: 50 g/L.
10. Gypsum Board and Panel Adhesives: 50 g/L.
11. Rubber Floor Adhesives: 60 g/L.
12. Ceramic Tile Adhesives: 65 g/L.
13. Multipurpose Construction Adhesives: 70 g/L.
14. Fiberglass Adhesives: 80 g/L.
15. Contact Adhesive: 80 g/L.
16. Structural Glazing Adhesives: 100 g/L.
17. Wood Flooring Adhesive: 100 g/L.
18. Structural Wood Member Adhesive: 140 g/L.
19. Single-Ply Roof Membrane Adhesive: 250 g/L.
20. Special-Purpose Contact Adhesive (contact adhesive that is used to bond melamine-covered board, metal, unsupported vinyl, rubber, or wood veneer 1/16 inch or less in thickness to any surface): 250 g/L.
21. Top and Trim Adhesive: 250 g/L.
22. Plastic Cement Welding Compounds: 250 g/L.
23. ABS Welding Compounds: 325 g/L.
24. CPVC Welding Compounds: 490 g/L.
25. PVC Welding Compounds: 510 g/L.
26. Adhesive Primer for Plastic: 550 g/L.
27. Sheet-Applied Rubber Lining Adhesive: 850 g/L.
30. Special-Purpose Aerosol Adhesive (All Types): 70 percent by weight.
31. Other Adhesives: 250 g/L.
32. Architectural Sealants: 250 g/L.
33. Nonmembrane Roof Sealants: 300 g/L.
34. Single-Ply Roof Membrane Sealants: 450 g/L.
35. Other Sealants: 420 g/L.
36. Sealant Primers for Nonporous Substrates: 250 g/L.
37. Sealant Primers for Porous Substrates: 775 g/L.
38. Modified Bituminous Sealant Primers: 500 g/L.
39. Other Sealant Primers: 750 g/L.

B. Credit IEQ 4.2: For field applications that are inside the weatherproofing system, paints and coatings shall comply with the following VOC content limits when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1. Flat Paints and Coatings: VOC not more than 50 g/L.
2. Nonflat Paints and Coatings: VOC not more than 150 g/L.
3. Dry-Fog Coatings: VOC not more than 400 g/L.
4. Primers, Sealers, and Undercoaters: VOC not more than 200 g/L.
5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
6. Zinc-Rich Industrial Maintenance Primers: VOC not more than 340 g/L.
7. Pretreatment Wash Primers: VOC not more than 420 g/L.
8. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
9. Clear Wood Finishes, Lacquers: VOC not more than 550 g/L.
10. Floor Coatings: VOC not more than 100 g/L.
11. Shellacs, Clear: VOC not more than 730 g/L.
12. Shellacs, Pigmented: VOC not more than 550 g/L.
13. Stains: VOC not more than 250 g/L.

C. Credit IEQ 4.4: Composite wood, agrifiber products, and adhesives shall not contain urea-formaldehyde resin.

PART 3 - EXECUTION

3.1 CONSTRUCTION WASTE MANAGEMENT

A. Credit MR 2: Comply with Section 017419 "Construction Waste Management and Disposal."

3.2 CONSTRUCTION INDOOR-AIR-QUALITY MANAGEMENT

A. Credit IEQ 3.1: Comply with SMACNA's "SMACNA IAQ Guideline for Occupied Buildings under Construction."

1. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period as specified in Section 015000 "Temporary Facilities and Controls," install filter media having a MERV 8 according to ASHRAE 52.2 at each return-air inlet for the air-handling system used during construction.

2. Replace all air filters immediately prior to occupancy.

B. Credit IEQ 3.2:

1. After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by supplying a total volume of 14000 cu. ft. (4 300 000 L) of outdoor air per sq. ft. (sq. m) of floor area while maintaining an internal temperature of at least 60 deg F (16 deg C) and a relative humidity no higher than 60 percent.
2. Air-Quality Testing:

   a. Conduct baseline indoor-air-quality testing, after construction ends and prior to occupancy, using testing protocols consistent with the EPA's "Compendium of Methods for the Determination of Air Pollutants in Indoor Air," and as additionally detailed in the USGBC's "Green Building Design and Construction Reference Guide."

   b. Demonstrate that the contaminant maximum concentrations listed below are not exceeded:

      1) Formaldehyde: 27 ppb.
      2) Particulates (PM10): 50 micrograms/cu. m.
      3) Total Volatile Organic Compounds (TVOC): 500 micrograms/cu. m.
      4) 4-Phenylcyclohexene (4-PH): 6.5 micrograms/cu. m.
      5) Carbon Monoxide: 9 ppm and no greater than 2 ppm above outdoor levels.

   c. For each sampling point where the maximum concentration limits are exceeded, conduct additional flush-out with outside air and retest the specific parameter(s) exceeded to indicate the requirements are achieved. Repeat procedure until all requirements have been met. When retesting noncomplying building areas, take samples from same locations as in the first test.

   d. Air-sample testing shall be conducted as follows:

      1) All measurements shall be conducted prior to occupancy but during normal occupied hours, and with building ventilation system starting at the normal daily start time and operated at the minimum outside air flow rate for the occupied mode throughout the duration of the air testing.
      2) Building shall have all interior finishes installed including, but not limited to, millwork, doors, paint, carpet, and acoustic tiles. Nonfixed furnishings such as workstations and partitions are encouraged, but not required, to be in place for the testing.
      3) Number of sampling locations varies depending on the size of building and number of ventilation systems. For each portion of building served by a separate ventilation system, the number of sampling points shall not be less than one per 25,000 sq. ft. (2300 sq. m) or for each contiguous floor area, whichever is larger, and shall include areas with the least ventilation and greatest presumed source strength.
      4) Air samples shall be collected between 3 and 6 feet (0.9 and 1.8 m) from the floor to represent the breathing zone of occupants, and over a minimum four-hour period.
SECTION 024119 - SELECTIVE STRUCTURE 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. Section Includes:
   1. Demolition and removal of selected portions of building or structure.
   2. Demolition and removal of selected site elements.
   3. Salvage of existing items.

B. Related Requirements:
   1. Section 011000 "Summary" for restrictions on the use of the premises, Owner-occupancy requirements, and phasing requirements.
   2. Section 017300 "Execution" for cutting and patching procedures.

1.3 DEFINITIONS

A. Remove: Detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

B. Remove and Salvage: Carefully detach from existing construction, in a manner to prevent damage, and deliver to Owner.

C. Remove and Reinstall: Detach items from existing construction, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Existing items of construction that are not to be permanently removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

1.4 MATERIALS OWNERSHIP

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

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

1.5 PREINSTALLATION MEETINGS

A. Predemolition Conference: Conduct conference at Project site.

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.
6. Review sequencing and shoring requirements.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For refrigerant recovery technician.

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

C. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Project shoring and bracing plans, calculations and sequence of work. All shoring and bracing plans and calculations shall be signed and sealed by a registered professional engineer in the State of Michigan.

D. Inventory: Submit a list of items to be removed and salvaged and deliver to Owner prior to start of demolition.

E. Predemolition Photographs or Video: Submit before Work begins.

F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was recovered and that
recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

G. Warranties: Documentation indicated that existing warranties are still in effect after completion of selective demolition.

1.7 CLOSEOUT SUBMITTALS

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

B. Landfill Records: Indicate receipt and acceptance of hazardous wastes by a landfill facility licensed to accept hazardous wastes.

1.8 QUALITY ASSURANCE

A. Refrigerant Recovery Technician Qualifications: Certified by an EPA-approved certification program.

1.9 FIELD CONDITIONS

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

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

C. Hazardous Materials: Hazardous materials are present in buildings and structures to be selectively demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.

1. Hazardous material remediation is specified elsewhere in the Contract Documents.
2. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
3. Owner will provide material safety data sheets for suspected hazardous materials that are known to be present in buildings and structures to be selectively demolished because of building operations or processes performed there.

D. Historic Areas: Demolition and hauling equipment and other materials shall be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, including temporary protection, by 12 inches (300 mm) or more.

E. Storage or sale of removed items or materials on-site is not permitted.
PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

B. Standards: Comply with ANSI/ASSE A10.6 and NFPA 241.

C. LEED Requirements for Building Reuse:

1. Credit MR 1.1: Maintain existing building structure (including structural floor and roof decking) and envelope (exterior skin and framing, excluding window assemblies and nonstructural roofing material) not indicated to be demolished; do not demolish such existing construction beyond indicated limits.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review record documents of existing construction provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in record documents.

1. The owner furnished drawings have known discrepancies. The contractor must field verify all framing and associated items to remain. Base all sequence activities, calculations and conclusions on field verification.

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

D. When unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure the nature and extent of conflict. Promptly submit a written report to Architect.

E. Engage a professional engineer to perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.
F. Survey of Existing Conditions: Record existing conditions by use of measured drawings.

1. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final Work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

1. Comply with requirements for existing services/systems interruptions specified in Section 011000 "Summary."

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off indicated utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
2. Arrange to shut off indicated utilities with utility companies.
3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated to be removed.

   a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
   b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
   c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
   d. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.

C. Refrigerant: Remove refrigerant from mechanical equipment to be selectively demolished according to 40 CFR 82 and regulations of authorities having jurisdiction.

3.3 PREPARATION

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

1. Comply with requirements for access and protection specified in Section 015000 "Temporary Facilities and Controls."
B. Temporary Facilities: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. 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.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 015000 "Temporary Facilities and Controls."

C. Temporary Shoring: Provide and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

3.4 SELECTIVE DEMOLITION, GENERAL

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

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain fire watch and portable fire-suppression devices during flame-cutting operations.
5. Maintain adequate ventilation when using cutting torches.
6. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly 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.

B. Reuse of Building Elements: Project has been designed to result in end-of-Project rates for reuse of building elements as follows. Do not demolish building elements beyond what is indicated on Drawings without Architect's approval.

1. Building Structure and Shell: 75 percent.

C. Removed and Salvaged Items:

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 designated by Owner.
5. Protect items from damage during transport and storage.

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

3.5 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in sections. Cut concrete full depth at junctures with construction to remain and at regular intervals using power-driven saw, then remove concrete between saw cuts.

B. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, then remove masonry between saw cuts.

C. Concrete Slabs-on-Grade: Saw-cut perimeter of area to be demolished, then break up and remove.

D. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCT's "Recommended Work Practices for the Removal of Resilient Floor Coverings." Do not use methods requiring solvent-based adhesive strippers.

E. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight.

1. Remove existing roof membrane, flashings, copings, and roof accessories.
2. Remove existing roofing system down to substrate.
3.6 DISPOSAL OF DEMOLISHED MATERIALS

A. General: Except for items or materials indicated to be recycled, reused, salvaged, reinstalled, or otherwise indicated to remain Owner's property, remove demolished materials from Project site and legally dispose of them in an EPA-approved landfill.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
4. Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

B. Burning: Do not burn demolished materials.

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

3.7 CLEANING

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

3.8 SELECTIVE DEMOLITION SCHEDULE

A. Existing Construction to Be Removed: Refer to Drawings.

B. Existing Items to Be Removed and Salvaged: Refer to Drawings.

C. Existing Items to Remain: Refer to Drawings.

END OF SECTION 024119
SIR/GAR/JAC/BRP
SECTION 058010 - POST-INSTALLED ANCHORS

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. Division 5 Metals.
2. Division 9 Ceiling Suspension Systems.
3. Division 21 Fire Suppression.
4. Division 22 Plumbing.
5. Division 23 Heating, Ventilation and Air Conditioning.
6. Division 26 Electrical.

1.2 SUMMARY

A. Section including requirements pertaining to post-installed anchors for hanger connections, and other structural attachments to concrete-slabs on steel-deck for Steel-Framed Buildings. This section pertains to all other sections of these specifications that require post-installed anchors, unless specified otherwise.

B. Section including requirements pertaining to post-installed anchors for hanger connections, and other structural attachment to concrete slabs, concrete joists and concrete beams for Concrete-Framed Buildings for Mechanical and Electrical suspended items.

C. Extent of Post-Installed Anchor – architectural, mechanical, electrical and structural work as required in specifications and drawings.

1.3 DEFINITIONS

A. Life Safety Systems include the following:

1. Fire-suppression lines greater than 2.5 inch outside diameter.

2. Heavy suspended pipes (75 pounds per linear foot or more for pipe plus or including content).

3. Piping systems intended to carry flammable, combustible or highly toxic contents.

4. Ductwork containing hazardous materials.
5. Utilities in Hospitals containing Operating Rooms or Emergency Treatment facilities in the building.


7. Systems/elements having an Importance Factor, Ip, greater than 1 per IBC and as indicated by mechanical, electrical and architectural specifications and drawings.

1.4 SUBMITTALS

A. Product data depicting specific type, physical properties and installation procedures of proposed anchor with the details of the structural element to which Post-Installed Anchors are attached.

1. A general catalog of anchors without specific references is not acceptable.

2. Submittal for all anchor types with proposed loading and conditions.

B. International Code Council (ICC) Evaluation Service Reports (ESR):

1. Required for “life-safety” classified items.

C. Where specific post-installed anchor, manufacturer, type, size and embedment requirements are given on the drawings or in specifications, substitutions are not acceptable.

1. For Substitutions:

   a. Signed and sealed calculations shall be provided indicating the substituted anchor meets the capacity requirements of the specified/detailed anchor.
   b. Assume the specified anchor is loaded to 100% capacity.
   c. Include appropriate load adjustment factors applicable to loading conditions, including but not limited to, anchor geometry, embedment depth, spacing, and edge distance.
   d. Calculations shall be prepared by a licensed Professional Engineer in the State of Michigan.

1.5 QUALITY ASSURANCE

A. Installers to be properly trained and certified by manufacturer of Post-Installed Anchor.

B. Codes and Standards:


   a. ACI 318-08, Appendix D.
   b. Michigan Building Code -09
1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle Post-Installed-Anchors in strict accordance with their manufacturer’s written instructions.

1.7 LOAD LIMITATIONS

A. The drawings indicate the maximum total for suspended loads. The Contractor is required to coordinate the suspended load requirements for the various items for the various trades; where loads are in excess of stated limits, provide supplemental framing at no additional cost to Owner or Architect.

PART 2 - PRODUCTS

2.1 ANCHOR TYPES NOT PERMITTED

A. The following types of anchors are not permitted for the support of suspended loads from slabs-on-steel floor-deck, concrete floor slabs, concrete joists and concrete beams:

1. Adhesive anchors
2. Powder actuated anchors without predrilled holes:
   a. In life-safety applications.
   b. In non-life-safety application with loads in excess of 20 pounds.

2.2 ANCHORS SUPPORTING LIFE SAFETY SYSTEMS

A. General: Anchors for this category support utilities classified as “Life Safety System”.

1. Applies to anchors used in Seismic Design Category B.

B. Approvals and Listings: Anchors shall:

1. For buildings in Seismic Design Category B:
   a. Have an ICC-ES Report and test qualified with AC-193 or ACI 355.2.
   b. Have an ES Report with compliance with AC-308 or ACI 355.2 for non-suspended application only.

C. Anchor Rating: Anchors shall be rated for “cracked concrete”, including those not applied at the theoretical “tension zone”.

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POST-INSTALLED ANCHORS 058010 - 3
D. Attachment to Steel Framed Buildings (underside of steel floor deck)

1. Load Limitation:
   a. Maximum suspended load for each anchor shall be 500 pounds (un-factored) or less.

2. Anchor attachment to underside of composite steel floor deck slabs:
   a. At lower flute of composite deck: Use only anchors that have published capacities for embedment in lower flutes.
      1) Locate anchors at center of flute

   b. At upper flute of composite deck: Verify cover meets or exceeds minimum slab thickness requirements for size, embedment and type of proposed anchor. Use only anchors that have published capacities for embedment in upper flutes.

E. Attachment to Concrete-Frame-Building:

1. Load Limitations:
   a. Slabs: 500 pounds (un-factored).

   b. Joists and Beams: 1000 pounds (un-factored).

      1) Attachment of Post-Installed Anchors to bottom of concrete joists and beam is not permitted for loads in excess of 250 pounds (unfactored).
2.3 ANCHORS SUPPORTING NON-LIFE SAFETY SYSTEMS – Seismic Design Category B

A. General:

1. Anchors for this category support utilities not specifically classified as “Life Safety System”.

2. Refer to structural drawings or other specifications sections for seismic design category.

B. Attachment to Steel-Framed Buildings (Underside of Steel Floor Deck):

1. Load Limitation:
   a. Maximum suspended load for each anchor shall be 500 pounds (un-factored) or less.

2. Anchor attachment to underside of composite steel floor deck slabs:
   a. At lower flute of composite deck: Use only anchor that have published capacities for embedment in lower flutes. Use only anchors that have published capacities for embedment in lower flutes.
      1) Locate anchors at center of flute.

   b. At upper flute of composite deck: Verify cover meets or exceeds minimum slab thickness requirements for size, embedment and type of proposed anchor. Use only anchors that have published capacities for embedment in upper flutes.

3. Anchor Ratings: approved/listed
   a. Anchor tested per AC-193 or ACI 355.2 and having an ES-Report may be used with published “cracked concrete” values and other required modifications for SDC, embedment edge distances, no-inspection etc.
      1) “Certification pending” and “ESR pending”, either one or both, does not qualify.
b. Anchor tested per AC-308 or ACI 355.2 and having an ES-Report may be used with published “cracked concrete” values and other required modifications for SDC, edge distances, no-inspection etc, for non-suspended applications only.

1) “Certification pending” and “ESR pending”, either one or both, does not qualify.

4. Anchor Ratings: Not approved/not listed

a. Anchors not tested by AC-193/ACI 355.2 and not having an ICC-ES Report, either one or both, may be used provided the following additional criteria are met:

1) Anchor allowable loads shall meet each of the following additional criteria:

a) Additional Factor of Safety (F.S.): Provide additional F.S. of 2 (two) for the manufacturer’s published values.


b) Load Test: For every type and every application test 10 anchors at the job site. The applied load shall be six (6) times the maximum proposed load. Every anchor shall pass; failure of one or more of the 10 anchors will result in rejection of that type of anchor/slab combination.

Example: The contractors proposes 1/4 diam. Drop-in anchors applied at the top flute of metal deck; 5/16” dia. drop-in anchors and 3/8” diameter screw anchors applied at the center of flutes. The job has both light-weight concrete and normal weight concrete slabs. Summary: Three setups are required each for the normal weight and light weight concrete, for a total of six (6) test-setups. Each set-up shall test 10 anchors. Total number of anchors to be tested and required to pass: 60 (sixty).

(1) Test locations to be spread out over the entire job; do not limit to one or two bays for test-areas.
(2) Test areas shall be approved by the Architect.
(3) Tests shall be conducted by the Owner’s Testing and Inspection Agency, in accordance with applicable ASTM Standards.
(4) Payment for tests is the responsibility of the contractor.
C. Attachment to Concrete-Frame-Building:

1. Load Limitations:
   a. Slabs: 500 pounds (un-factored).

   b. Joists and Beams: 1000 pounds (un-factored).

   1) Attachment of Post-Installed Anchors to bottom of concrete joists and beam
      is not permitted for loads in excess of 250 pounds (un-factored).

2. Anchor Ratings: Approved/Listed
   a. Anchor tested per AC-193/ACI 355.2 and having an ES-Report may be used with
      published “cracked concrete” values and other required modifications for SDC,
      embedment edge distances, no-inspection etc.

      1) “Testing pending” and “ESR pending”, either one or both, does not qualify.

   b. Anchor tested per AC-1308/ACI 355.2 and having an ES-Report may be used with
      published “cracked concrete” values and other required modifications for SDC,
      edge distances, no-inspection etc, for non suspended applications only.

      1) “Testing pending” and “ESR pending”, either one or both, does not qualify.

   c. Anchor Ratings: Not Approved/Not Listed

      1) Anchors not tested per AC-193/ACI 355.2 and not having an ICC-ES
         Report, either one or both, may be used provided the following additional
         criteria are met:

         a) Additional Factor of Safety (F.S.): Provide an additional F.S. of four
            (4) for the manufacturer’s published values.

b) Load Test: For every type and application test 10 anchors at the job-site. The applied load shall be 12 (twelve) times the maximum proposed load. Every anchor shall pass; failure of one or more of the 10 anchors will result in rejection of that type of anchor/slab combination.

(1) Test locations to be spread out over the entire job; do not use one or two bays for test-areas.
(2) Test areas shall be approved by Architect.
(3) Tests shall be conducted by the Owner’s Testing and Inspection Agency, in accordance with applicable ASTM Standards.
(4) Payment for test is the responsibility of the contractor.

Example: The Contractor proposes to use ¼” diameter and ½” diameter Drop-in anchors and 3/8” diameter Screw-anchors to attach to slabs. Slab thicknesses and design concrete strength are consistent thru-out the structure. In addition, 3/8” diameter drop-in anchors are proposed as shear attachment for joist and beams. Summary: A total four (4) test-set-ups are required. Each set-up shall test 10 anchors. Total number of anchors to be tested and required to pass: forty (40).

2.4 MANUFACTURERS

A. Acceptable Manufacturers:

1. Hilti (www.us.hilti.com)
2. Powers (www.powers.com)
3. ITW-Redhead (www.itw-redhead.com)
PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation of Post-Installed Anchors shall be in strict accordance with manufacturer’s written instructions and ICC – ES Report.

3.2 QUALITY CONTROL TESTING

A. Testing Agency:

1. Refer to Division 1 Section “Quality Control General” for Contractor’s and Independent Testing Agency’s administrative requirements.

B. Quality Control and Testing:

1. Refer to Drawings and Division 1 Section(s) “Quality Control – General” and “Testing and Inspection Services – Building and Site Work” for requirements.

END OF SECTION
GWH/BRP
SECTION 061001 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Wood furring, grounds, nailers, and blocking.
2. Plywood nailers.

1.3 DEFINITIONS

A. Rough Carpentry:

1. Carpentry work not specified in other Sections and not exposed, unless otherwise specified.

1.4 SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
1. Include data for adhesives, including printed statement of VOC content.

B. LEED Submittals:
1. Certificates for Credit MR 7: Chain-of-custody certificates indicating that products specified to be made from certified wood comply with forest certification requirements. Include documentation that manufacturer is certified for chain of custody by an FSC-accredited certification body. Include statement indicating cost for each certified wood product.
2. Product Data for Credit IEQ 4.1: For adhesives, documentation including printed statement of VOC content.

C. Shop Drawings:
Construction

1. None required.
D. Material Certificates:

1. Material certificates for dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the American Lumber Standards Committee's (ALSC) Board of Review.

1.5 QUALITY ASSURANCE

A. Forest Certification: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, “FSC Principles and Criteria for Forest Stewardship”:

1. Dimension lumber framing.
2. Miscellaneous lumber.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Keep materials under cover and dry. Protect from weather and contact with damp or wet surfaces. Stack lumber, plywood, and other panels. Provide for air circulation within and around stacks and under temporary coverings.

PART 2 - PRODUCTS

2.1 GENERAL

A. Certified Wood: Materials shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

B. Lumber Standards:


C. Plywood Standards:

1. Comply with DOC PS 1, "U.S. Product Standard for Construction and Industrial Plywood”.

D. Inspection Agencies:
1. Inspection agencies, and the abbreviations used to reference them, include the following:
2. NELMA - Northeastern Lumber Manufacturers Association.
3. NLGA - National Lumber Grades Authority (Canadian).
4. RIS - Redwood Inspection Service.
5. SPIB - Southern Pine Inspection Bureau.
6. WCLIB - West Coast Lumber Inspection Bureau.
7. WWPA - Western Wood Products Association.

E. Grade Stamps:
   1. Provide lumber with each piece factory marked with grade stamp of inspection agency
evidencing compliance with grading rule requirements and identifying grading agency,
grade, species, moisture content at time of surfacing, and mill.
   2. Factory mark plywood panels to indicate compliance with applicable standard.

F. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture
content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry
lumber.
   1. Provide dressed lumber, S4S, unless otherwise indicated.
   2. Provide dry lumber with 19 percent maximum moisture content at time of dressing for 2-inch
nominal (38-mm actual) thickness or less, unless otherwise indicated.

2.2 MISCELLANEOUS LUMBER

A. General:
   1. Provide lumber for support or attachment of other construction, including cant strips,
bucks, nailers, blocking, furring, grounds, stripping, and similar members.
   2. Fabricate miscellaneous lumber from dimension lumber of sizes indicated and into
shapes shown.

B. Moisture Content:
   1. 19 percent maximum for lumber items not specified to receive wood preservative
treatment.

C. Grade:
   1. For board-size lumber, provide No. 3 Common grade per NELMA, NLGA, or WWPA;
No. 2 grade per SPIB; or Standard grade per NLGA, WCLIB or WWPA of any species.
2.3 PLYWOOD NAILERS

A. Exterior Grade Plywood:

1. For use as nailers for copings, at underside of miscellaneous structural members at window heads and where indicated, provide DOC PS 1, Exterior, A-C plywood in thickness indicated or, if not otherwise indicated, not less than \( \frac{3}{8} \)-inch thick.
2.4 FASTENERS

A. General:

1. Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
   a. Where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners with a hot-dip zinc coating per ASTM A 153 or of Type 304 stainless steel.


D. Wood Screws: ASME B18.6.1.

E. Lag Bolts: ASME B18.2.1. (ASME B18.2.3.8M)

F. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.

G. Screws for Fastening Plywood to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
   1. Provide screws with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 765 hours according to ASTM B 117.

2.5 MISCELLANEOUS MATERIALS

A. Adhesives for Gluing to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.

   1. Use adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Discard units of material with defects that impair quality of rough carpentry and that are too small to use with minimum number of joints or optimum joint arrangement.
B. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted.

C. Fit rough carpentry to other construction; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds, and similar supports to allow attachment of other construction.

D. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.
2. "Table 2304.9.1--Fastening Schedule" of the ICC’s International Building Code.

E. Use common wire nails, unless otherwise indicated. Use finishing nails for finish work. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; predrill as required.

F. Use hot-dip galvanized or stainless-steel nails where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity.

3.2 WOOD GROUNDS, NAILERS, BLOCKING, AND SLEEPERS

A. Install wood grounds, nailers, blocking, and sleepers where shown and where required for screeding or attaching other work. Form to shapes shown and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated. Build into masonry during installation of masonry work. Where possible, anchor to formwork before concrete placement.

3.3 WOOD FRAMING, GENERAL

A. Framing Standard:


3.4 INSTALLATION OF PLYWOOD NAILERS

A. General:
B. Fastening Methods:

1. Exterior Grade Plywood Nailers:
   a. For attachment to cold-formed metal framing, secure plywood with screws.
   b. For attachment to structural steel, secure plywood with powder-actuated fasteners.
      1) Hilti X-AL-H or X-ZF, 1/8-inch diameter (minimum).
   c. For attachment to CMU, secure plywood with post-installed expansion anchors.

END OF SECTION
DWH/BRP
SECTION 072102 - THERMAL 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. Glass-fiber blanket insulation.
   B. Related Sections:
      1. Division 09 Section(s): Gypsum Board” and "Gypsum Board Shaft Wall Assemblies" for
         installation in metal-framed assemblies of insulation specified by referencing this
         Section.

1.3 SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. LEED Submittals:
      1. Product Data for Credit MR 4.1 and Credit MR 4.2: For products having recycled
         content, documentation indicating percentages by weight of postconsumer and
         preconsumer recycled content. Include statement indicating costs for each product
         having recycled content.
   C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified
      testing agency, for each product.
   D. Research/Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.4 QUALITY ASSURANCE
   A. Surface-Burning Characteristics: As determined by testing identical products according to
      ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of
      applicable testing agency.
1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

PART 2 - PRODUCTS

2.1 GLASS-FIBER BLANKET INSULATION

A. Type J: Unfaced Mineral Fiber Batt Insulation (Acoustic in walls, ceilings): Acoustic insulation produced by combing glass fibers with thermosetting resins to comply with ASTM C 665 for Type 1 (batts without membrane facing); and as follows:

1. Thickness: 3-1/2 inches unless otherwise indicated on the drawings.
2. Products: Subject to compliance with requirements, provide one of the following:
   a. Sonobatts Insulation (Fiberglass); Owens Corning Insulating Systems, LLC
   b. Sound Attenuation Batts (Fiberglass); Owens Corning Insulating Systems, LLC
   c. Sound Attenuation Fire Batts (Mineral Wool); Owens Corning Insulating Systems, LLC
   d. Sound Attenuation Fire Blankets (Mineral Wool); Thermafiber LLC
   e. CertaPro AcoustaTherm Batts (Fiberglass); CertainTeed Corp.
   f. Sound Control Batts (Fiberglass); Johns Manville, Building Insulation Division

3. Surface Burning Characteristics: Maximum flame spread and smoke developed values of 25 and 50, respectively.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions with Installer present, for compliance with requirements of the Sections in which substrates and related work are specified and to determine if other conditions affecting performance of insulation are satisfactory. Do not proceed with installation of insulation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of substances that are harmful to insulation or that interfere with insulation attachment.
3.3 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated. If printed instructions are not available or do not apply to project conditions, consult manufacturer's technical representative for specific recommendations before proceeding with installation of insulation.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.4 PROTECTION

A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

3.5 INSULATION SCHEDULE

<table>
<thead>
<tr>
<th>TYPE</th>
<th>FORM</th>
<th>USE</th>
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<tbody>
<tr>
<td>J</td>
<td>Unfaced Glass Fiber Batt/Blanket</td>
<td>Acoustic in walls, ceilings.</td>
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END OF SECTION 072101

DWHBRP
SECTION 078413 - PENETRATION FIRESTOPPING

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. Penetrations in fire-resistance-rated walls.
   2. Penetrations in horizontal assemblies.
   3. Penetrations in smoke barriers.

B. Related Sections:
   1. Division 7 Section "Fire-Resistive Joint Systems" for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.
   2. Division 21 Sections specifying fire-suppression piping penetrations.
   3. Division 22 and 23 Sections specifying duct and piping penetrations.
   4. Division 26 Sections specifying cable and conduit penetrations.

1.3 ACTION SUBMITTALS

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

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For penetration firestopping sealants and sealant primers, documentation including printed statement of VOC content.

C. Product Schedule: For each penetration firestopping system. Include location and design designation of qualified testing and inspecting agency.
   1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.
1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

B. Installer Qualifications: A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.

C. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:

1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.

2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:

   a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.

   b. Classification markings on penetration firestopping correspond to designations listed by the following:

      1) UL in its "Fire Resistance Directory."
      2) Intertek ETL SEMKO in its "Directory of Listed Building Products."
      3) FM Global in its "Building Materials Approval Guide."

D. Preinstallation Conference: Conduct conference at Project site.
1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

C. Notify Owner's testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hilti, Inc.
2. RectorSeal Corporation.
3. Specified Technologies Inc.
4. 3M Fire Protection Products.

2.2 PENETRATION FIRESTOPPING

A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).
1. Fire-resistance-rated walls include fire walls, fire-barrier walls, smoke-barrier walls and fire partitions.
2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).

1. Horizontal assemblies include floors, floor/ceiling assemblies and ceiling membranes of roof/ceiling assemblies.
2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.

D. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. (0.025 cu. m/s per sq. m) of penetration opening at 0.30-inch wg (74.7 Pa) at both ambient and elevated temperatures.

E. W-Rating: Provide penetration firestopping showing no evidence of water leakage when tested according to UL 1479.

F. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

G. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

H. Low-Emitting Materials: Penetration firestopping sealants and sealant primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

I. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.

1. Permanent forming/damming/backing materials, including the following:
a. Slag-wool-fiber or rock-wool-fiber insulation.
b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
c. Fire-rated form board.
d. Fillers for sealants.

2. Temporary forming materials.
5. Steel sleeves.

2.3 FILL MATERIALS

A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.

E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.

I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

2.4 MIXING

A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.

2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.

3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.3 INSTALLATION

A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.

C. Install fill materials for firestopping by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.
3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections.

B. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.

C. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

END OF SECTION 078413
DWHBRP
SECTION 078446 - FIRE-RESISTIVE JOINT SYSTEMS

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 fire-resistive joint systems for the following:

1. Floor-to-wall joints.
2. Head-of-wall joints.
3. Wall-to-wall joints.
4. Perimeter fire-resistive joint systems consisting of floor-to-wall joints between perimeter edge of fire-resistance-rated floor assemblies and exterior curtain walls.

B. Related Sections include the following:

1. Division 7 Section "Thermal Insulation" for floor-to-wall joints indicated as perimeter fire-containment systems between perimeter edge of fire-resistance-rated floor assemblies and back of non-fire-resistance-rated exterior curtain walls.
2. Division 7 Section "Through-Penetration Firestop Systems" for systems installed in openings in walls and floors with and without penetrating items.
3. Division 7 Section "Joint Sealants" for non-fire-resistive joint sealants.

1.3 PERFORMANCE REQUIREMENTS

A. General: Provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly in which fire-resistive joint systems are installed.

B. Joint Systems in and between Fire-Resistance-Rated Constructions: Provide systems with assembly ratings equaling or exceeding the fire-resistance ratings of construction that they join, and with movement capabilities and L-ratings indicated as determined by UL 2079.

C. Perimeter Fire-Resistive Joint Systems: For joints between edges of fire-resistance-rated floor assemblies and exterior curtain walls, provide systems of type and with ratings indicated below and those indicated on the drawings, as determined by NFPA 285 and UL 2079.
1. UL-Listed, Perimeter Fire-Containment Systems: Integrity ratings equaling or exceeding fire-resistance ratings of floor or floor/ceiling assembly forming one side of joint.

2. OPL-Listed, Perimeter Fire-Barrier Systems: F-ratings equaling or exceeding fire-resistance ratings of floor or floor/ceiling assembly forming one side of joint.

D. For fire-resistive systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

1.4 SUBMITTALS

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

B. LEED Submittals:

1. Product Data for Credit IEQ 4. For fire-resistive joint system sealants, documentation including printed statement of VOC content.

C. Shop Drawings: For each fire-resistive joint system, show each kind of construction condition in which joints are installed; also show relationships to adjoining construction. Include fire-resistive joint system design designation of testing and inspecting agency acceptable to authorities having jurisdiction that demonstrates compliance with requirements for each condition indicated.

1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each fire-resistive joint system configuration for construction and penetrating items.

2. Where project conditions require modification to a qualified testing and inspecting agency’s illustration for a particular fire-resistive joint system, submit illustration, with modifications marked, approved by fire-resistive joint system manufacturer’s fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

D. Product Certificates: For each type of fire-resistive joint system, signed by product manufacturer.

E. Qualification Data: For Installer.

F. Research/Evaluation Reports: For each type of fire-resistive joint system.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A firm that has been approved by FMG according to FMG 4991, "Approval of Firestop Contractors."

B. Source Limitations: Obtain fire-resistive joint systems, for each kind of joint and construction condition indicated, through one source from a single manufacturer.
C. Fire-Test-Response Characteristics: Provide fire-resistive joint systems that comply with the following requirements and those specified in Part 1 "Performance Requirements" Article:

1. Fire-resistance tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL, OPL or another agency performing testing and follow-up inspection services for fire-resistive joint systems acceptable to authorities having jurisdiction.

2. Fire-resistive joint systems are identical to those tested per methods indicated in Part 1 "Performance Requirements" Article and comply with the following:
   a. Fire-resistive joint system products bear classification marking of qualified testing and inspecting agency.
   b. Fire-resistive joint systems correspond to those indicated by referencing system designations of the qualified testing and inspecting agency.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fire-resistive joint system products to Project site in original, unopened containers or packages with qualified testing and inspecting agency's classification marking applicable to Project and with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials for fire-resistive joint systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not install fire-resistive joint systems when ambient or substrate temperatures are outside limits permitted by fire-resistive joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate fire-resistive joint systems per manufacturer's written instructions by natural means or, if this is inadequate, forced-air circulation.

1.8 COORDINATION

A. Coordinate construction of joints to ensure that fire-resistive joint systems are installed according to specified requirements.

B. Coordinate sizing of joints to accommodate fire-resistive joint systems.

C. Do not cover up fire-resistive joint system installations that will become concealed behind other construction until Owner's inspecting agency and building inspector of authorities having jurisdiction have examined each installation.
PART 2 - PRODUCTS

2.1 FIRE-RESISTIVE JOINT SYSTEMS

A. Where required, provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which fire-resistive joint systems are installed. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.

B. Joints in or between Fire-Resistance-Rated Construction: Provide fire-resistive joint systems with ratings determined per ASTM E 1966 or UL 2079:

1. Joints include those installed in or between fire-resistance-rated walls, floor or floor/ceiling assemblies and roofs or roof/ceiling assemblies.
2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.
3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hilti, Inc.
   b. Specified Technologies Inc.
   c. 3M Fire Protection Products.

C. Joints at Exterior Curtain-Wall/Floor Intersections: Provide fire-resistive joint systems with rating determined by ASTM E 119 based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa) or ASTM E 2307.

1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hilti, Inc.
   b. Specified Technologies Inc.
   c. 3M Fire Protection Products.

D. Joints in Smoke Barriers: Provide fire-resistive joint systems with ratings determined per UL 2079.

1. L-Rating: Not exceeding 5.0 cfm/ft (0.00775 cu. m/s x m) of joint at 0.30 inch wg (74.7 Pa) at both ambient and elevated temperatures.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hilti, Inc.
   b. Specified Technologies Inc.
c. 3M Fire Protection Products.

E. Exposed Fire-Resistive Joint Systems: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

F. VOC Content: Provide fire-resistive joint systems that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Architectural Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

G. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing and inspecting agency for systems indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of work.

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

3.2 PREPARATION

A. Surface Cleaning: Clean joints immediately before installing fire-resistive joint systems to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:

1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.
2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by fire-resistive joint system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to
remove smears from fire-resistant joint system materials. Remove tape as soon as possible without disturbing fire-resistant joint system's seal with substrates or damaging adjoining surfaces.

3.3 INSTALLATION

A. General: Install fire-resistant joint systems to comply with Part 1 "Performance Requirements" Article and fire-resistant joint system manufacturer's written installation instructions for products and applications indicated.

B. Install forming/packing/backing materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

C. Install fill materials for fire-resistant joint systems by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings and forming/packing/backing materials as required to achieve fire-resistance ratings indicated.
2. Apply fill materials so they contact and adhere to substrates formed by joints.
3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

A. Identify fire-resistant joint systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of joint edge so labels will be visible to anyone seeking to remove or penetrate joint system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

2. Contractor's name, address, and phone number.
3. Designation of applicable testing agency.
4. Date of installation.
5. Manufacturer's name.
6. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Inspecting Agency: Owner may engage a qualified independent inspecting agency to inspect fire-resistant joint systems and prepare inspection reports.
B. Testing Services: Inspecting of completed installations of fire-resistive joint systems shall take place in successive stages as installation of fire-resistive joint systems proceeds. Do not proceed with installation of joint systems for the next area until inspecting agency determines completed work shows compliance with requirements.

1. Inspecting agency shall state in each report whether inspected fire-resistive joint systems comply with or deviate from requirements.

C. Remove and replace fire-resistive joint systems where inspections indicate that they do not comply with specified requirements.

D. Additional inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

E. Proceed with enclosing fire-resistive joint systems with other construction only after inspection reports are issued and fire-resistive joint systems comply with requirements.

3.6 CLEANING AND PROTECTING

A. Clean off excess fill materials adjacent to joints as Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure fire-resistive joint systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

END OF SECTION 078446
DWH/BRP
SECTION 079201 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. Intent of this Section is to seal all exposed joints for a neat and finished appearance and where joints are subject to weather and other wet type conditions, joints shall be additionally sealed air tight.
B. This Section includes, but is not limited to, cold applied building joint sealants, for work in which joints are not fabricated, for the following locations:
   1. Interior joints in vertical surfaces and horizontal non-traffic surfaces as indicated below:
      a. Control and expansion joints in exposed interior surfaces of exterior walls.
      b. Joints at vanities and surface mounted toilet/wash room fixtures and accessories.
      c. Vertical control joints on exposed surfaces of interior unit masonry walls and concrete walls, and partitions.
      d. Perimeter joints between interior wall surfaces and frames of interior doors, windows, and elevator entrances.
      e. Other joints as indicated.
C. Related Sections: The following Sections contain requirements that relate to this Section:
   1. Division 9 Section "Gypsum Board Assemblies" for sealing concealed perimeter joints of gypsum board partitions to reduce sound transmission.
   2. Division 9 Section "Acoustical Ceilings" for sealing edge moldings at perimeter of acoustical ceilings.

1.3 PERFORMANCE REQUIREMENTS
A. Provide joint sealants that have been produced and installed to establish and to maintain watertight and airtight continuous seals without causing staining or deterioration of joint substrates.
1.4 SUBMITTALS

A. Product Data:

1. Submit product data from manufacturers for each joint sealant product required. Include schedule indicating location or use for each type of sealant to be provided.

   a. Submit “Sealant Joint Schedule” that identifies each sealant joint location (condition based on adjacent materials and finish colors on each side of the joint) and the sealant joint product and color that will be used at each location. Sealant joint product and color shall be based on this specification section and information indicated on the Drawings.

B. Samples:

1. Submit samples for verification purposes of each type and color of joint sealant required. Install joint sealant samples 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. Certifications, Qualification Data, and Reports:

1. Certifications:

   a. Submit certifications from manufacturers of joint sealants attesting that their products comply with specification requirements and are suitable for the use indicated.

2. Qualification Data:

   a. Submit qualification data complying with requirements specified in "Quality Assurance" article. Include list of completed projects with project names addresses, names of Associates and Owners, plus other information specified.

3. Test Reports:

   a. Submit compatibility and adhesion test reports from elastomeric sealant manufacturer indicating that materials forming joint substrates and joint sealant backings have been tested for compatibility and adhesion with joint sealants. Include sealant manufacturer's interpretation of test results relative to sealant performance and recommendations for primers and substrate preparation needed to obtain adhesion.

   b. Submit product test reports for each type of joint sealants indicated, evidencing compliance with requirements specified.

   c. Submit preconstruction field test reports indicating which products and joint preparation methods demonstrate acceptable adhesion to joint substrates.
1.5 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Engage an experienced Installer who has completed joint sealant applications similar in material, design, and extent to that indicated for Project that have resulted in construction with a record of successful in-service performance.
   2. When required by sealant manufacturer's warranty, installer shall also be approved or licensed by the sealant manufacturer.

B. Testing Laboratory Qualifications:
   1. To qualify for acceptance, an independent testing laboratory must demonstrate to the Owner's satisfaction, based on evaluation of laboratory-submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct satisfactorily the testing indicated without delaying progress of the Work.

C. Single Source Responsibility for Joint Sealant Materials:
   1. Obtain joint sealant materials from a single manufacturer for each different product required.

D. Preconstruction Compatibility and Adhesion Testing:
   1. Submit samples of materials that will contact or affect joint sealants to joint sealant manufacturers for compatibility and adhesion testing.
   2. Use test methods standard with manufacturer to determine if priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
   3. Submit not less than 9 pieces of each type of material, including joint substrates, shims, joint sealant backings, secondary seals, and miscellaneous materials.
   4. Schedule sufficient time for testing and analysis of results to prevent delay in the progress of the Work.
   5. Investigate materials failing compatibility or adhesion tests and obtain joint sealant manufacturer's written recommendations for corrective measures, including use of specially formulated primers.
   6. Testing will not be required when joint sealant manufacturer is able to submit joint preparation data required above that are acceptable to the Owner’s Representative, and are based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

E. Product Testing:
   1. Provide comprehensive test data for each type of joint sealant based on tests conducted by a qualified independent testing laboratory on current product formulations within a 24-month period preceding date of Contractor's submittal of test results to the Owner’s Representative.
2. Test elastomeric sealants for compliance with requirements specified by reference to ASTM C 920. Include test results for hardness, stain resistance, adhesion and cohesion under cyclic movement (per ASTM C 719), low-temperature flexibility, modulus of elasticity at 100 percent strain, effects of heat aging, and effects of accelerated weathering.

F. Preconstruction Field Testing:

1. Prior to installation of joint sealants, field-test their adhesion to joint substrates as follows:
   a. Locate test joints where indicated or, if not indicated, as directed by the Owner’s Representative.

2. Conduct field tests for each application indicated below:
   a. Each type of elastomeric sealant and joint substrate indicated.
   b. Each type of non-elastomeric sealant and joint substrate indicated.
   c. Test joint sealant between stone units to determine whether priming will be required.

3. Notify the Owner’s Representative one week in advance of the dates and times when mock-ups will be erected.

4. Test Method: Test joint sealants by hand pull method described below:
   a. Install joint sealants in 5-feet joint lengths using same materials and methods for joint preparation and joint sealant installation required for completed Work. Allow sealants to cure fully before testing.
   b. Make knife cuts horizontally from one side of joint to the other followed by 2 vertical cuts approximately 2 inches long at side of joint and meeting horizontal cut at top of 2-inch cuts. Place a mark 1 inch from top of 2-inch piece.
   c. Use fingers to grasp 2-inch piece of sealant just above 1-inch mark; pull firmly down at a 90-degree angle or more while holding a ruler along side of sealant. Pull sealant out of joint to the distance recommended by sealant manufacturer for testing adhesive capability, but not less than that equaling specified maximum movement capability in extension; hold this position for 10 seconds.

5. Report whether or not 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.

6. Evaluation of Field Test Results:
   a. 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.
1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

B. Store and handle materials in compliance with manufacturer's recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.7 PROJECT CONDITIONS

A. Environmental Conditions:

1. Do not proceed with installation of joint sealants under the following conditions:
   
a. When ambient and substrate temperature conditions are outside the limits permitted by joint sealant manufacturer.
   
b. When joint substrates are wet.

B. Joint Width Conditions:

1. Do not proceed with installation of joint sealants where joint widths are less than allowed by joint sealant manufacturer for application indicated.

C. Joint Substrate Conditions:

1. Do not proceed with installation of joint sealants until contaminants capable of interfering with their adhesion are removed from joint substrates.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide one of the products specified 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.
B. VOC Content of Interior Sealants: Provide interior sealants and sealant primers that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

C. Colors:

1. Provide color of exposed joint sealants to comply with the following:
   a. Provide selections made by the Architect from manufacturer's full range of colors for products of type indicated. Exterior colors shall match adjacent surfaces.

D. Location and Use:

1. Refer to Part 3 heading "Joint Construction and Sealant Type Location Schedule" for requirements.

2.3 ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealant Standard:

1. Provide manufacturer's standard chemically curing elastomeric sealants that comply with ASTM C 920 and other requirements indicated below, including those requirements referencing ASTM C 920 classifications for Type, Grade, Class, and Uses.
2. Single-Part Nonsag Urethane Sealants:
   a. Maximum Movement Capacity +/- 25%; Type S; Grade NS; Class 25; Uses T, NT, M, G, A, O:
      1) Sika Corp.; Sikaflex - 1a
      2) Sonneborn Bldg. Prod. Div., ChemRex Inc.; SONOLASTIC NP 1
   b. Maximum Movement Capacity +/- 25%; Type S; Grade NS; Class 25; Uses T, NT, M, A, O:
      1) Tremco, Inc.; Vulkem 116
      2) LymTal International, Inc.; ISO-FLEX 830, ISO-FLEX 881
   c. Maximum Movement Capacity +/- 25%; Type S; Grade NS; Class 25; Uses NT, M, A, O:
      1) Tremco, Inc., Vulkem 921
      2) Pecora Corp.; Dynatrol I
3. Single-Part Pourable Urethane Sealants:

a. Maximum Movement Capacity +/- 25%; Type S; Grade P; Class 25: Uses T, NT, M, A, O:

1) Sonneborn Bldg. Prod. Div., ChemRex Inc.: SONOLASTIC SL 1

b. Maximum Movement Capacity +/- 25%; Type S; Grade P; Class 25: Uses T, M, A, O:

1) Tremco, Inc.; Vulkem 45
2) Pecora Corp.; NR - 201 Urexpan

2.4 MILDEW RESISTANT SEALANTS

A. General:

1. Provide manufacturer's standard one-part, nonsag, mildew-resistant, acid-curing silicone sealant of formulation indicated that is recommended for exposed applications on interior locations and that accommodates indicated percentage change in joint width existing at time of installation without failing either adhesively or cohesively.

B. Single-Part Acid-Curing Silicone Sealant:

1. Provide product complying with ASTM C 719 that accommodates joint movement of not more than 25 percent in both extension and compression for a total of 50 percent.

a. Single-Part Acid-Curing Silicone Sealants:

1) Maximum Movement Capacity +/- 25%; Type S; Grade NS; Class 25: Uses NT, G, A, O:

a) Dow Corning Corp.; 786 Mildew Resistant
b) General Electric Co., GE Silicones; SANITARY 1700

2.5 LATEX JOINT SEALANTS

A. General:

1. Provide manufacturer's standard one-part, nonsag, mildew-resistant, paintable latex sealant of formulation indicated that is recommended for exposed applications on interior locations and that accommodates indicated percentage change in joint width existing at time of installation without failing either adhesively or cohesively.
B. Acrylic-Emulsion Sealant:
   1. Provide product complying with ASTM C 834 that accommodates joint movement of not more than 5 percent in both extension and compression for a total of 10 percent.
   2. Products: Subject to compliance with requirements, provide one of the following:
      a. Pecora Corp.; AC-20
      b. Sonneborn Building Products Div., ChemRex, Inc.; Sonlac
      c. Tremco, Inc.; Tremco Acrylic Latex 834

2.6 ACOUSTICAL SEALANTS
   A. Products:
      1. Acoustical Sealant for Exposed and Concealed Joints:
         a. Pecora Corp.; AC-20 FTR Acoustical and Insulation Sealant.
      2. Acoustical Sealant for Concealed Joints:
         a. Ohio Sealants, Inc.; Pro-Series SC-170 Rubber Base Sound Sealant.
         b. Pecora Corp.; BA-98.
      3. Acoustical Sealant for Exposed and Concealed Joints:
         a. Nonsag, paintable, nonstaining, latex sealant complying with ASTM C 834 that effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
      4. Acoustical Sealant for Concealed Joints:
         a. Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant recommended for sealing interior concealed joints to reduce airborne sound transmission.

2.7 JOINT SEALANT BACKING
   A. General:
      1. Provide sealant backings of material and type that are nonstaining; are bond breakers; 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. Plastic Foam Joint Fillers:

1. Preformed, compressible, resilient, nonstaining, nonwaxing, nonextruding strips of flexible plastic foam of material indicated below and of size, shape, and density to control sealant depth and otherwise contribute to producing optimum sealant performance:

   a. Closed-cell polyethylene foam, nonabsorbent to liquid water and gas, nonoutgassing in unruptured state.
   b. Proprietary, reticulated, closed-cell polymeric foam, nonoutgassing, with a density of 2.5 pcf and tensile strength of 35 psi per ASTM D 1623, and with water absorption less than 0.02 gms/cc per ASTM C 1083.
   c. Open-cell polyurethane foam.
   d. Any material indicated above, subject to approval of the sealant manufacturer.

C. Bond-Breaker Tape:

1. Polyethylene tape or other plastic tape as 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.

2.8 MISCELLANEOUS MATERIALS

A. Primer:

1. 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:

1. Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming in any way joint substrates and adjacent nonporous surfaces, and formulated to promote optimum adhesion of sealants with joint substrates.

C. Masking Tape:

1. 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. Do not proceed with installation of joint sealants until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints:

1. Clean out joints immediately before installing joint sealants to comply with recommendations of joint sealant manufacturer.
2. 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.
3. Clean concrete, masonry, unglazed surfaces of ceramic tile, and similar 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 from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.
4. Remove laitance and form release agents from concrete.
5. Clean metal, glass, glazed surfaces of ceramic tile, and other 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.

B. Joint Priming:

1. Prime joint substrates where recommended by joint sealant manufacturer based on preconstruction joint sealant-substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's recommendations. Confine primers to areas of joint sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape:

1. 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:

1. Comply with joint sealant manufacturer's printed installation instructions applicable to products and applications indicated, except where more stringent requirements apply.

B. Sealant Installation Standard:

1. Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Acoustical Sealant Application Standard:

1. Comply with recommendations of ASTM C 19 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.

D. Installation of Sealant Backings:

1. Install joint fillers of type indicated to provide support of sealants during application and at position required to produce the cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
   a. Do not leave gaps between ends of joint fillers.
   b. Do not stretch, twist, puncture, or tear joint fillers.
   c. Remove absorbent joint fillers that have become wet prior to sealant application and replace with dry material.

2. Install bond breaker tape between sealants where backer rods are not used between sealants and joint fillers or back of joints.

E. Installation of Sealants:

1. Install sealants by proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability. Install sealants at the same time sealant backings are installed.

2. Seal construction at perimeters, behind control and expansion joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and manufacturer’s written recommendations for locating edge trim and closing off sound-flanking paths around or through gypsum board assemblies, including sealing partitions above acoustical ceilings.

F. Tooling of Nonsag Sealants:
Construction

1. Immediately after sealant application and prior to time skinning or curing begins, tool sealants to form smooth, uniform beads of configuration indicated, to eliminate air pockets, and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

2. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.
   a. Using masking tape to protect adjacent surfaces of recessed tooled joints.

3.4 JOINT CONSTRUCTION AND SEALANT TYPE LOCATION SCHEDULE
   A. All joints on building interior, other than floor joints, that abut construction that is part of a system or assembly that is exposed to building exterior shall be sealed with non-sag grade, single component urethane sealant.
   B. All joints on building interior, other than floor joints, not abutting construction that is part of a system or assembly that is exposed to building exterior shall be sealed with latex sealant.
   C. All floor joints on building interior, that are not sealed as part of the work of Division 3 Sections, shall be sealed with pourable grade, single component urethane sealant.
   D. All joints at vanities, sinks, fixtures and accessories in toilet rooms, wash rooms, kitchens, and other areas where standing water can enter joints shall be sealed with mildew resistant silicone sealant.
   E. Joints shown or specified to be acoustic in nature shall be sealed with acoustic sealant.

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

3.6 PROTECTION
   A. Protect joint sealants during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so that they are without deterioration or damage at time of Final Acceptance. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so that and installations with repaired areas are indistinguishable from original work.
SECTION 081113- STEEL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Steel doors.
2. Steel door frames.
3. Fire-rated door and frame assemblies.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 8 Section "Hardware" for door hardware and weatherstripping.
2. Division 9 Section "Gypsum Board Assemblies" and “Gypsum Board Shaft Wall Assemblies” for spot grouting frames in gypsum board partitions.
3. Division 9 Section "Painting" for field finish painting shop primed steel and shop primed A60 and G60 galvanized doors and frames and field priming and finish painting of A25 galvanized doors and frames.

1.3 DEFINITIONS

A. Steel Sheet Thicknesses: Thickness dimensions, including those referenced in ANSI A250.8, are minimums as defined in referenced ASTM standards for both uncoated steel sheet and the uncoated base metal of metallic-coated steel sheets.

1.4 SUBMITTALS

A. General:

1. Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data:
1. Submit Product Data for each type of door and frame specified, including details of construction, materials, dimensions, hardware preparation, core, label compliance, sound ratings, profiles, and finishes.

C. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

D. Shop Drawings:

1. Include the following.
   a. Elevations of each door design.
   b. Details of doors including vertical and horizontal edge details.
   c. Frame details for each frame type including dimensioned profiles.
   d. Details and locations of reinforcement and preparations for hardware.
   e. Details of each different wall opening condition.
   f. Details of anchorages, accessories, joints, and connections.
   g. Coordination of glazing frames and stops with glass and glazing requirements.

E. Samples:

1. None required.

F. Door Schedule:

1. Submit schedule of doors and frames using same reference numbers for details and openings as those on Drawings.
2. Indicate coordination of glazing frames and stops with glass and glazing requirements.

1.5 QUALITY ASSURANCE

A. General:

1. Steel Door and Frame Standard: Comply with ANSI A 250.8, unless more stringent requirements are indicated.

B. Fire-Rated Door Assemblies:

1. Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252.
   a. Test Pressure: Test at atmospheric pressure.
C. Fire-Rated Window Assemblies:
   1. Assemblies complying with NFPA 80 that are listed and labeled by a testing and
      inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated,
      based on testing according to NFPA 257.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver doors and frames cardboard-wrapped or crated to provide protection during transit and
   job storage.

B. Frames shall include shipping bar at bottom to insure frame integrity during shipping. All
   shipping bars shall be removed prior to frame installation. Install frames per manufacturer’s
   and SDI (Steel Door Institute) standards and instructions.

C. Inspect doors and frames on delivery for damage. Minor damages may be repaired provided
   refinished items match new work and are acceptable to Architect; otherwise, remove and
   replace damaged items as directed.

D. Store doors and frames at building site under cover. Place units on minimum 4-inch- (100-mm-)
   high wood blocking. Avoid using nonvented plastic or canvas shelters that could create a
   humidity chamber. If cardboard wrappers on doors become wet, remove cartons immediately.
   Provide minimum 1/4-inch (6-mm) spaces between stacked doors to promote air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the
   following:

   1. Steel Doors and Frames:
      a. Amweld Building Products, Inc.
      b. Ceco Door Products.
      c. Curries Co.
      d. Mesker Door, Inc.
      e. Pioneer Industries.
      f. Republic Builders Products.
      g. Steelcraft; a division of Ingersoll-Rand.
2.2 MATERIALS

A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. Hot-Rolled Steel Sheets and Strip:
   1. ASTM A 569/A 569M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Cold-Rolled Steel Sheets:
   1. ASTM A 366/A 366M, Commercial Steel (CS), or ASTM A 620/A 620M, Drawing Steel (DS), Type B; stretcher-leveled standard of flatness.

D. Metallic-Coated Steel Sheets:
   1. Fabricated items for use on building exterior shall be provided with A 60 or G 60 coating designation, mill phosphatized.
   2. Fabricated items for use in building interior, where shown, shall be provided with A 60 or G 60 coating designation, mill phosphatized.
   3. Fabricated items for use in general building interior areas where prime painted steel is specified, at Contractor's option, may be provided with A 25 coating designation, mill phosphatized.
      a. Electrolytic zinc-coated steel sheet is not acceptable.

E. Supports and Anchors:
   1. Fabricate from not less than 18 gage, minimum 0.0478-inch- (1.2-mm-) thickness, steel sheet where used with prime painted steel frames.
   2. Fabricate from not less than 18 gage, minimum 0.0516-inch- (1.3-mm-) thickness, galvanized steel where used with galvanized steel frames.

F. Inserts, Bolts, and Fasteners:
   1. Manufacturer's standard units. Where items are to be built into exterior walls, hot-dip galvanize complying with ASTM A 153, Class C or D as applicable.

2.3 DOORS

A. General:
   1. Provide 1-3/4-inch- (44-mm-) thick doors of materials and ANSI/SDI 100 grades and models specified below, or as indicated on Drawings or schedules:

B. Interior Doors:
1. Provide doors complying with requirements indicated below by referencing ANSI 250.8 for level and model and ANSI A250.4 for physical-endurance level.

2. Level 2 and Physical Performance Level B (Heavy Duty), Model 2 (Seamless), 18 gage [0.042 inch (1.0 mm) minimum uncoated steel thickness].

2.4 FRAMES

A. General:

1. Provide steel frames for doors, transoms, sidelights, borrowed lights, and other openings that comply with ANSI A250.8 and with details indicated for type and profile. Conceal fastenings, unless otherwise indicated.

B. Frames of 16 gauge, 0.053-inch- (1.3-mm-) thick minimum steel sheet for:

1. Level 2 steel doors, unless otherwise indicated.
2. Wood doors, unless otherwise indicated.

C. Frames of 14 gauge, 0.067-inch- (1.7-mm-) thick minimum steel sheet for:

1. Level 3 steel doors, unless otherwise indicated.
2. Door openings over 48 inches (1220 mm) wide.

D. Frame Corner Fabrication:

1. Fabricate full weld flush knock down frames with mitered and continuously welded and finished smooth face seam and edges and full wire welded backside of web members joining head and jamb, for all locations, unless otherwise noted.

E. Door Silencers:

1. Except on weatherstripped frames, drill stops to receive 3 silencers on strike jambs of single door frames and 2 silencers on heads of double door frames.

F. Plaster Guards:

1. Provide 26 gage, minimum 0.0179-inch- (0.45-mm-) thickness, steel plaster guards or mortar boxes at back of hardware cutouts where mortar or other materials might obstruct hardware operation and to close off interior of openings.

G. Supports and Anchors:

1. Fabricated from not less than 0.042-inch- (1.0-mm-) thick, electrolytic zinc-coated or metallic-coated steel sheet.

   a. Wall Anchors in Masonry Construction:
1) 0.177-inch-(4.5-mm-) diameter, steel wire complying with ASTM A 510 (ASTM A 510M) may be used in place of steel sheet.

H. Inserts, Bolts, and Fasteners:

1. Manufacturer's standard units. Where zinc-coated items are to be built into exterior walls, comply with ASTM A 153/A 153M, Class C or D as applicable.

2.5 FABRICATION

A. General:

1. Fabricate steel door and frame units to comply with ANSI A250.8 and shall be rigid, neat in appearance, and free from defects, warp, or buckle. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site. Comply with ANSI/SDI 100 requirements.

2. Weld exposed joints continuously, grind, dress and make smooth, flush and invisible. Weld edges and ends, fill and grind flush.

3. Close top and bottom edges of exterior doors as integral part of door construction or by addition of minimum 16 gage, minimum 0.0635-inch-(1.6-mm-) thickness, galvanized steel sheet channels. Channel legs at door top shall face downward to provide a flush surface.

4. Reinforce and close exposed bottom edge of transom panels with 16 gage, minimum 0.0598-inch-(1.5-mm-) thickness, steel channel. Channel legs shall face upward to provide a flush surface.

5. Fabricate exposed faces of doors from only cold-rolled steel sheet and galvanized for exterior locations.

6. Fabricate concealed stiffeners, reinforcement, edge channels, louvers, and moldings from either cold- or hot-rolled steel sheet.

B. Core Construction:

1. Unless otherwise noted elsewhere herein, provide any one of the following manufacturer's standard core materials according to SDI standards and additionally as required for thermal rated doors:

   a. Resin-impregnated paper honeycomb.
   b. Rigid polyurethane.
   c. Rigid polystyrene.
   d. Vertical steel stiffeners.
   e. Rigid mineral fiber with internal sound deadener on inside of face sheets.

C. Clearances:

1. Non-Fire Rated Doors:
a. Not more than 1/8 inch (3.2 mm) at jambs and heads, except not more than 1/4 inch (6.4 mm) between non-fire-rated pairs of doors. Not more than 3/4 inch (19 mm) at bottom.

2. Fire Rated Doors:
   a. Provide clearances according to NFPA 80.

D. Tolerances:

E. Exposed Fasteners:
   1. Provide countersunk flat or oval head screws and bolts for locations that require exposed fasteners.

F. Thermal-Rated (Insulating) Assemblies:
   1. Where shown or scheduled, provide doors fabricated as thermal-insulating door and frame assemblies and tested according to ASTM C 236 or ASTM C 976 on fully operable door assemblies.
   2. Unless otherwise indicated, provide thermal-rated assemblies with U-value rating of 0.41 Btu/sq. ft. x h x deg F (2.33 W/sq. m x K) or better.

G. Hardware Preparation:
   1. Prepare doors and frames to receive finish hardware according to final door hardware schedule and templates provided by hardware supplier. Comply with applicable requirements of SDI 107 and ANSI A115 Series specifications for door and frame preparation for hardware.
   2. For concealed overhead door closers, provide space, cutouts, reinforcing, and provisions for fastening in top rail of doors or head of frames, as applicable.
   3. Reinforce doors and frames and make other provisions to receive hardware. Drilling and tapping for surface-applied hardware may be done at Project Site.
   4. Locate hardware as specified in Division 8 Section "Hardware", as indicated on Shop Drawings or, if not indicated, according to the Door and Hardware Institute (DHI) Publication "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."

H. Astragals:
   1. Fabricated from not less than 14 gage, minimum 0.0747 thickness, cold-rolled steel sheet at doors fabricated from steel sheet to receive factory prime paint finish or A25 designation galvanized steel sheet at doors fabricated from A25 designation galvanized steel sheet.
2.6 DOOR OPENING IDENTIFICATION

A. Each door shall be provided with a tag placed on the hinge side or on top identifying its opening location in the same manner as Architect’s Door Schedule.

2.7 FINISHES, GENERAL

A. Comply with NAAMM's "Metal Finishes Manual" for recommendations relative to applying and designating finishes.

B. Use of lead or chromate based paints are not acceptable.

C. Apply primers to doors and frames after fabrication.

2.8 STEEL SHEET FINISHES

A. Surface Preparation:

1. Solvent-clean surfaces to comply with SSPC-SP 1 to remove dirt, oil, grease, and other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel to comply with SSPC-SP 5 (White Metal Blast Cleaning) or SSPC-SP 8 (Pickling).

B. Pretreatment:

1. Immediately after surface preparation, apply a conversion coating of type suited to coating applied over it.

C. Factory Priming for Field-Painted Finish:

1. Apply air-dried or baked-on shop primer immediately after surface preparation and pretreatment providing a smooth nontextured base for final finish.

2. Shop Primer:

   a. Paint shall comply with ANSI A224.1 acceptance criteria, is compatible with finish paint systems indicated, and has capability to provide a proper foundation for field-applied topcoats.

   b. Primer shall be white or light grey in color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
1. Install steel doors, frames, and accessories according to approved Shop Drawings, manufacturer's data, and as specified.

B. Placing Frames:

1. Comply with provisions of SDI 105, unless otherwise indicated. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders, leaving surfaces smooth and undamaged.
2. Except for frames located in existing concrete, masonry, or gypsum board assembly construction, place frames before constructing enclosing walls and ceilings.
3. Provide not less than 3 wall anchors per vertical frame side for frames up to 7'-6" high and an additional anchor for each additional 30" of frame height. Anchors shall be equally spaced. Anchors at door jambs shall be located adjacent to hinge location on hinge jamb and at the corresponding location on the strike side of jamb.
4. In masonry construction, acceptable anchors include masonry wire anchors and masonry T-shaped anchors.
5. At existing concrete or masonry construction, set frames and secure to adjacent construction with bolts and frame anchorage devices.
6. In metal-stud partitions, attach wall anchors to studs with screws.
7. Install fire-rated frames according to NFPA 80.

C. Grout:

1. When frames are in masonry construction, as specified in Division 4 Section "Unit Masonry Assemblies."
2. When frames are in gypsum board construction, as specified in Division 9 Section "Gypsum Board Assemblies" and "Gypsum Board Shaft-Wall Assemblies", as applicable.

D. Door Installation:

1. General:
   a. Fit hollow-metal doors accurately in frames, within clearances specified in ANSI/SDI 100.
2. Fire-Rated Doors:
   a. Install with clearances specified in NFPA 80.

E. Astragals:

1. Provide astragal on all pairs of doors, where indicated.
2. Provide an overlapping astragal on pairs of doors having a fire protection rating.
Construction

a. Attach astragals on one leaf so as to protect approximately 3/4 in. of the opposite door or as may be otherwise required by authorities having jurisdiction.

3. Do not provide astragals that inhibit the free use of either leaf on doors when located on doors within a means of egress.

3.2 ADJUSTING AND CLEANING

A. Immediately after erection, sand smooth any rusted or damaged areas of prime coat or galvanized finish and apply touchup of compatible air-drying primer suitable for field applied finish paint.

B. Protection Removal:

1. Immediately before final inspection, remove protective wrappings, if any, from doors and frames.

END OF SECTION
DWH/BRP
SECTION 083113 - ACCESS DOORS AND FRAMES

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. Access doors and frames for walls and ceilings.

B. Related Requirements:
   1. Division 23 Section “Air Duct Accessories” for heating and air-conditioning duct access doors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include construction details, materials, individual components and profiles, and finishes.

B. Shop Drawings:
   1. Include plans, elevations, sections, details, and attachments to other work.
   2. Detail fabrication and installation of access doors and frames for each type of substrate.

C. Product Schedule: Provide complete access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

PART 2 - PRODUCTS

2.1 ACCESS DOORS AND FRAMES FOR WALLS AND CEILINGS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

   1. Babcock-Davis.
   5. Milcor Inc.
   6. Nystrom, Inc.
B. Source Limitations: Obtain each type of access door and frame from single source from single manufacturer.

C. Flush Access Doors with Exposed Flanges:
   1. Assembly Description: Fabricate door to fit flush to frame. Provide manufacturer's standard-width exposed flange, proportional to door size.
   2. Locations: Wall and ceiling.
   3. Door Size: As indicated on the Drawings.
   4. Metallic-Coated Steel Sheet for Door: Nominal 0.064 inch (1.63 mm), 16 gage.
   5. Frame Material: Same material, thickness, and finish as door.
   7. Hardware: Cam latch.

D. Recessed Access Doors:
   1. Assembly Description: Fabricate door in the form of a pan recessed 5/8 inch (16 mm) for gypsum board infill. Provide frame with gypsum board bead for concealed flange installation.
   2. Locations: Wall and ceiling.
   3. Door Size: As indicated on the Drawings.
   4. Metallic-Coated Steel Sheet for Door: Nominal 0.064 inch (1.63 mm), 16 gage.
   5. Frame Material: Same material and thickness as door.

E. Hardware:
   1. Latch: Cam latch operated by screwdriver.

2.2 MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 (Z180) or A60 (ZF180) metallic coating.

C. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329.

2.3 FABRICATION

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.

B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access doors to types of supports indicated.
   1. For concealed flanges with drywall bead, provide edge trim for gypsum board securely attached to perimeter of frames.
   2. Provide mounting holes in frames for attachment of units to metal framing.
   3. Provide mounting holes in frame for attachment of masonry anchors.

D. Recessed Access Doors: Form face of panel to provide recess for application of applied finish. Reinforce panel as required to prevent buckling.

E. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
   1. For cylinder locks, furnish two keys per lock and key all locks alike.
   2. For recessed panel doors, provide access sleeves for each locking device. Furnish plastic grommets and install in holes cut through finish.

2.4 FINISHES

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

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

D. Steel and Metallic-Coated-Steel Finishes:
   1. Factory Prime: Apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing access doors and frames.

B. Install doors flush with adjacent finish surfaces or recessed to receive finish material.
3.3 ADJUSTING

A. Adjust doors and hardware, after installation, for proper operation.

B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 083113
DWH/BRP
SECTION 087111 - DOOR HARDWARE

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. Extent of hardware required is indicated on drawings and in schedules.

B. Related Work Specified in other Sections:

1. Division 5 Section "Metal Fabrications" for cast abrasive thresholds.
2. Division 6 Section "Interior Architectural Woodwork" for casework hardware.
3. Division 8 Series Sections for overhead doors and grilles, coiling doors, folding doors, revolving doors, and other specialized doors for associated hardware.

1.3 QUALITY ASSURANCE

A. Definition:

1. "Hardware" includes items known commercially as finish hardware which are required for swing, sliding and folding doors, except special types of unique and non-matching hardware specified in the same section as the door and door frame. Hardware shall be furnished and installed as part of the work of this section.

B. Requirements of Regulatory Agencies:

1. Provide hardware to comply with the requirements of laws, codes, ordinances, and regulations of governmental agencies having jurisdiction. Where such requirements exceed the requirements of the Specifications, furnish the most stringent.
2. Hardware to hazardous areas of public buildings shall comply with the requirements of the governmental agencies having jurisdiction. For public building accommodations, comply with governmental laws and regulations for the physically handicapped.

C. Hardware Supplier:

1. An established hardware supplier who is a factory authorized distributor for all products required, and has display samples, inventory, and qualified personnel trained and experienced in preparing Hardware Schedules, issuing templates, and ordering,
furnishing, and servicing hardware for architecturally designed projects, who employs an experienced Architectural Hardware Consultant who is available to Owner, Architect and Contractor, at reasonable times during the course of the work, for consultation about project's hardware requirements.

D. Preconstruction Meeting:

1. Prior to commencement of the Hardware Supplier's development of the Hardware Schedule, a Hardware Meeting will be held at the Architect's office. The Contractor/Construction Manager and the Hardware Supplier's personnel directly responsible for preparing the Hardware Schedule shall meet with the Architect and the Architect's Hardware Consultant. Attendance at this meeting is mandatory.

   a. Purpose of the meeting is to review the Contract Documents' hardware schedule requirements and will include, but not be limited to, the following:

       1) Review specification requirements for hardware schedule, formats, hardware locations, opening descriptions, and other information specified.
       2) Review products specified versus products proposed.
       3) Hardware Supplier shall distribute, at the meeting, samples of schedules from other projects of similar nature prepared by the same person as will prepare schedule for this Project.

E. Preinstallation Seminar:

1. Before the installation of hardware begins, the Contractor/Construction Manager shall request that a hardware installation seminar for the installation of door closers exit devices, and locksets be conducted by the manufacturer's representative of these products. Seminar to be held at job site and attended by all installers of hardware, such as aluminum doors and carpentry installers. Seminar will address proper coordination and installation of exit devices, door closers, and weatherstripping, as detailed in the hardware schedule for this Project, with the use of installation manuals, hardware schedule, templates, physical product samples, and exit device installation videos.

F. Fire-Rated Openings:

1. Provide hardware for fire-rated openings in compliance with NFPA Standard No. 80 and local building code requirements. Provide only hardware which has been tested and listed by UL for types and sizes of doors required and complies with requirements of door and door frame labels.

2. Where emergency exit devices are required on fire-rated doors that carry supplementary marking on the doors UL labels indicating "Fire door to be equipped with fire exit hardware", provide UL label on exit devices indicating "Fire Exit Hardware".
1.4 SUBMITTALS

A. General:

1. Submit the following according to Conditions of the Contract and Division 1 Specification Sections.

B. Product Data:

1. None required.

C. Shop Drawings:

1. None required, except as may be noted under Section "Door Schedule" or under heading "Hardware Schedule".

D. Samples:

1. None required, except as may be noted under Section "Door Schedule" or under heading "Hardware Schedule".

E. Hardware Schedules:

1. Submit proper number of Hardware Schedules to allow the Architect to retain two copies for his use, a copy for the Owner for his use, plus the number of copies required by the Contractor for its distribution and use. Include the following information in vertical format only. Horizontal format schedule will be returned without review noted "Not Approved".

2. Submit as an integral part of the Hardware Schedule a complete riser and wiring diagram for each different application of all the electrical components being provided for doors with electrical components.

3. Elevation and Wiring Drawings:

a. Submit elevation drawing showing relationship of all electrical and pneumatic hardware components to door and frame. Indicate number and gage of wires required. Indicate size of air tubing required. Indicate PSI requirements.

b. Submit wiring drawing showing point to point wire hook up for all components.

c. Submit drawing showing point to point hookup of air tubing for all components.

d. Submit system operations descriptions for each of opening; describe each possible condition.

4. Door Index, using Architect's Door Numbers, Hardware Set numbers and page numbers where hardware is listed.

5. Preface sheet listing category only and manufacturers' names of items being furnished, as follows:
Construction

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>SPECIFIED</th>
<th>SCHEDULED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hinges</td>
<td>Manufacturer A</td>
<td>Manufacturer B</td>
</tr>
<tr>
<td>Locksets</td>
<td>Manufacturer X</td>
<td>Manufacturer X</td>
</tr>
<tr>
<td>Kick Plates</td>
<td>Open</td>
<td>Manufacturer Z</td>
</tr>
</tbody>
</table>

6. Opening Description:
   a. Single or pair, number, room locations, hand, active leaf, degree of swing, size, material, frame material, and UL Listed.

7. Hardware Description:
   a. Quantity, category, product number, fasteners, and finish.

8. Headings that refer to the specified Hardware Set Numbers.
9. Scheduling sequence shown in Hardware Sets.
10. Product data of each hardware item, and shop drawings where required, for items to be connected to the electrical or fire alarm systems complete with power requirements and wiring diagrams and for other special conditions and specialty hardware.
11. Typed copy.
12. Double spacing.
13. 8-1/2 x 11 inch sheets.
15. Consecutively numbered pages.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Label each item of hardware with the appropriate door number and Hardware Schedule heading number, and deliver individually packaged hardware items at the proper times to the proper locations (shop or project site) for installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:

1. Provide each category with the products of only one manufacturer, unless specified otherwise; this requirement is mandatory whether various manufacturers are listed or not.
2. Manufacturers named under each heading item are acceptable subject to compliance with requirements directly specified or by means of meeting requirements for the listed manufacturer.
   a. Where only one manufacturer or product is specified, the phrase "No Substitution" shall apply.

3. Provide hardware made to template.

B. Hinges:
   1. Numbers listed are Ives. Provide Class 5BB1 and size 4-1/2 x 4-1/2 inches, unless specified otherwise:
      a. Equal products from any B.H.M.A. member will also be acceptable.
   2. Continuous: Provide in door height less one inch.
   3. Provide fire rated hinges at label openings.
   4. Products listed in sets are Ives Heavy Duty series.
      a. Pemko
      b. Markar
      c. McKinney
      d. Select Products
   5. Electric hinges are specified by electrical function only, provide same class and size as other hinges in the same set. Coordinate voltage requirements with Electrical Drawings and Electrical Specifications. Provide switch hinges having three wires and current hinges having four wires.
   6. Spring hinges sets are specified by series only. Provide sizes and quantities per manufacturer's selector sheet.

C. Pivot Sets:
   1. Offset: Omit intermediate pivot when electric intermediate is specified.
   2. Products listed in sets are Ives.
      a. Equal products from any B.H.M.A. member will also be acceptable.
   3. Electric:
      a. Series and functions as specified. Coordinate voltage requirements with Electrical Drawings and Electrical Specifications.
D. Flush Bolts:
   1. Products listed in sets are Ives FB series.
      a. Equal products from any B.H.M.A. member will also be acceptable.

E. Dust Proof Strikes:
   1. Shall include flat, rectangular mounting plates, and be provided with all flush bolts, except at openings having thresholds.
      a. Equal products from any B.H.M.A. member will also be acceptable.

F. Locksets and Latchsets - Mortise Type:
   1. Function numbers listed are Corbin-Russwin ML2000 series with LSM lever trim. (No substitutions)
   2. At lead lined doors supply lead wrapped cases.
   3. Provide strikes with extended lips where required to protect trim from being marred by latch bolt. Provide strike lips which do not project more than 1/8" beyond door-frame trim at single doors and have 7/8" lip to center at pairs of 1-3/4" doors.

G. Coordinators:
   1. Stop Mounted: Provide fillers for full jamb openings and mounting brackets for stop applied hardware.
   2. Products listed in sets are Ives COR series with FL filler bars.
      a. Equal products from any B.H.M.A. member will also be acceptable.

H. Closers:
   1. Review the door frame and plan details to determine the proper length of arm and the degree of swing. The degree of swing must be indicated in the Hardware Schedule. Provide accessories such as drop plates, panel adapters, spacers and supports as required to correctly install door closers.
   2. Size in accordance with LCN's Selector Chart. Provide one Shoe Support with each closer 4111-Cush. where required. When used with weatherstripping, provide special shoe or Stop Spacer for arm to pass below stop and weatherstripping.
   3. ADA Special Closers; Electric:
      a. Where "Low Energy Power Operated Door" as defined by ANSI Standard A156.19, is indicated for doors required to be accessible to the disabled, provide electrically powered 4642 Series operators complying with the ADA requirements for opening force and time to close standards.
      b. Full closing force shall be provided when the power or assist cycle ends.
c. Modular design, adjustments easily accessible from the front, UL listed for use on labeled doors.

d. Shall have "Second Chance" function to accommodate momentary resistance, "Breakaway" function in the electronically controlled clutch, "Soft Start" motor control function and "Maintain Hold-Open Switch" to hold the door open at 90 deg.

e. Shall have built-in 12V and 24V power supply for actuators, card readers, electric strikes and magnetic door locks, inputs for both swing and stop side sensors available to accept either 120VAC or 220VAC input power. All wiring connections between operator modules made by easy-to-handle electrical connectors. Shall comply with both UL and NEC requirements for Class 1 and Class 2 wiring by providing separate conduits for each.

f. Shall have seven independent electronic adjustments to tailor the operator for specific site conditions. Opening speed, holding force at 90 deg., sequential trigger and time delay, hold-open time at 90 deg., opening force, clutch "breakaway" force setting, electric strike trigger and time delay.

g. Shall have separate and independent adjustments for backcheck, main speed and latch speed.

h. Furnish actuators and other controls as shown in Hardware sets.

4. Closers listed are LCN. (No substitutions)

I. Overhead Holders and Stops:

1. Function numbers listed are Glynn-Johnson. Size: Per Manufacturer's Selector Chart.
   a. Equal products from any B.H.M.A. member will also be acceptable.

J. Kickplates:

1. 10" high x .050" thick x door width less 2 inches at single doors and less one inch at pairs. Where glass or louvers prevent this height, supply with height equal to height of bottom rail less one inch. When specified to be installed above surface mounted automatic door bottoms, deduct height of door bottoms.

K. Magnetic Switches:

1. Coordinate voltage requirements with Electrical Drawings and Electrical Specifications.
2. Products listed in sets are Schlage Electronics (Locknetics) 679-05 series.
   a. Sentrol

L. Folding Door Set:

1. Products listed in sets are Hager.
   a. Equal products from any B.H.M.A. member will also be acceptable.
M. Stop Seals:
   1. Apply, with no interruptions, to head and jambs at integral frame stops. Provide similar type classified by UL for use on fire rated openings.
   2. Numbers specified are National Guard. Products from other manufacturers are acceptable if equal in material, shape, thickness, and contain equal gasket material.
      a. National Guard
      b. Penko
      c. Reese

N. Miscellaneous:
   1. Provide items not categorized in the above descriptions, but specified by manufacturers' names in hardware sets.
   2. Provide frame marking jigs, if required, for Continuous Hinges.

O. Fasteners:
   1. Provide fasteners of the proper type, size, quantity, and finish. Provide machine screws and expansion shields for attaching hardware to concrete or masonry, and wall grip inserts at hollow wall construction.

P. Finishes:
   1. Furnish finish for each item as indicated in sets.

Q. Templates and Hardware Location:
   1. Provide hardware made to template. Supply required templates and hardware locations to the door and frame manufacturers.
   2. Refer to Article "INSTALLATION", "Locations" and coordinate with templates.

R. Cylinders and Keying:
   1. Provide cylinders factory master and grand master keyed to existing Best system, according to Owner's instructions. Furnish two change keys for each cylinder and master and grand master keys as required by Owner.
   2. Provide cylinders with standard construction cores for use during the construction period. When so directed, and in the presence of the Owner's Security Department or Representative, convert construction cores to final cores.
   3. Furnish construction master keys as required by Contractor / Construction Manager.
PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Install hardware according to manufacturer's printed instructions and to template dimensions. Refer to Cylinders and Keying regarding replacement of construction cores with final cores.
2. Install hardware according to manufacturers' printed instructions and to template dimensions. Refer to Cylinders and Keying regarding conversion of construction cores to final cores.
3. Apply stop seals with no interruptions at head and jambs.
4. Apply weatherstripping to head and jamb stops with no cutouts for stop applied hardware.
5. Closers shall be inspected and adjusted after installation and after the HVAC System is in operation by the Factory Representative to insure proper adjustment in operation. The Manufacturer's Representative shall prepare written report stating compliance, and also recording locations and kind of non-compliance. The original report shall be forwarded to the Architect with a copy to the Contractor and Hardware Distributor.
6. Drill and countersink screw holes for oval head undercut screws.
7. Door edgings shall have cutouts made for bottom flush bolts and for lock and latch fronts and strikes. Bevel top edges to continue bevel pattern in armor and niche plates.
8. When faces of door frames are flush with adjacent walls, thresholds shall be coped at stops and mullions, but not in front of faces of frames.
9. Attach closers with wood screws at wood doors and machine screws at metal doors.

   a. Attach closers with wood screws at wood doors and machine screws at metal doors.

B. Templates and Hardware Locations:

1. Provide required templates and hardware locations to the door and frame manufacturers.
2. Mortising is not required for steel channel or tube steel frames.
3. Dimensions are from finish floor to center line of items.
4. Include this list in Hardware Schedule.

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>DIMENSION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Hinges</td>
<td>Center Hinge</td>
</tr>
<tr>
<td>Hinges</td>
<td>Door Manufacturer's Standard</td>
</tr>
<tr>
<td>Levers</td>
<td>Door Manufacturer's Standard</td>
</tr>
<tr>
<td>Exit Device Touch Bars</td>
<td>Manufacturer's Template</td>
</tr>
<tr>
<td>Pulls</td>
<td>Suitable for Exit Devices</td>
</tr>
<tr>
<td>Wall Stops</td>
<td>At head with sloped portion on top</td>
</tr>
</tbody>
</table>
C. Quantities:

1. Provide one hinge for each 30 inches of door height, or fraction thereof, except where quantities are specified otherwise.
2. Provide one additional intermediate pivot for doors over 90 inches.
3. Provide hinges, electric hinges, pivot sets, electric pivots, roller latches, exit devices, push and pull hardware, closers, overhead holders, kick plates, armor plates, door edgings, bumpers, stops, seals, automatic bottoms, bottom seals, weatherstripping, and thresholds for both leaves of pairs and batteries unless specified otherwise.

3.2 ADJUST, CHECK, AND CLEAN

A. Adjust, Check, and Clean:

1. Adjust and check each operating item of hardware and each door, to ensure proper operation or function of every unit, prior to Owner's occupancy. Replace units which cannot be adjusted to operate freely and smoothly as intended for the application made. Clean hardware to restore finish.
2. Adjust hardware to meet ADA and other pertinent code and regulatory requirements.

B. Final Adjustment:

1. Return to the Project 30 calendar days after Owner's occupancy and make final check and adjustment of all hardware items. Replace units which cannot be adjusted to operate freely and smoothly as intended for the application made. Clean hardware to restore finish. Adjust door control devices to compensate for final operation of heating and ventilating equipment.
2. Instruct Owner's Personnel in proper adjustment and maintenance of hardware and hardware finishes, during the final adjustment of hardware.
3.3 HARDWARE SETS

HW SET: 101

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Quantity</th>
<th>Model/Brand</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 SET</td>
<td>OFFSET PIVOT</td>
<td>7230</td>
<td>626 IVE</td>
</tr>
<tr>
<td>2 EA</td>
<td>INT. OFFSET PIVOT</td>
<td>7230-INT</td>
<td>626 IVE</td>
</tr>
<tr>
<td>1 SET</td>
<td>AUTO FLUSH BOLT</td>
<td>FB31P</td>
<td>630 IVE</td>
</tr>
<tr>
<td>1 EA</td>
<td>DUST PROOF STRIKE</td>
<td>DP2</td>
<td>626 IVE</td>
</tr>
<tr>
<td>1 EA</td>
<td>ELECTRIC LOCK</td>
<td>ML20905 M92 LSM X LC</td>
<td>626 C-R</td>
</tr>
<tr>
<td>1 EA</td>
<td>MORTISE CYLINDER</td>
<td>1E74</td>
<td>626 BES</td>
</tr>
<tr>
<td>1 EA</td>
<td>COORDINATOR</td>
<td>COR X FL</td>
<td>628 IVE</td>
</tr>
<tr>
<td>1 EA</td>
<td>SURFACE CLOSER</td>
<td>4111 SCUSH X ST-1496 (ACTIVE)</td>
<td>689 LCN</td>
</tr>
<tr>
<td>1 EA</td>
<td>SURFACE CLOSER</td>
<td>4021 (INACTIVE)</td>
<td>689 LCN</td>
</tr>
<tr>
<td>2 EA</td>
<td>KICK PLATE</td>
<td>8400 10&quot; X 1&quot; LDW</td>
<td>630 IVE</td>
</tr>
<tr>
<td>1 SET</td>
<td>SEALS</td>
<td>2525B</td>
<td>BRN NGP</td>
</tr>
<tr>
<td>1 EA</td>
<td>SEALS</td>
<td>5070CL</td>
<td>CLR NGP</td>
</tr>
<tr>
<td>2 EA</td>
<td>MAGNETIC CONTACT</td>
<td>1078</td>
<td>SEN</td>
</tr>
<tr>
<td>1 EA</td>
<td>CARD READER</td>
<td>BY SECURITY CONTRACTOR</td>
<td>B/O</td>
</tr>
<tr>
<td>1 EA</td>
<td>POWER SUPPLY</td>
<td>BY SECURITY CONTRACTOR</td>
<td>B/O</td>
</tr>
</tbody>
</table>

NOTE: TEMPLATE THE INACTIVE LEAF CLOSER FOR SWING REQUIRE IN ORDER TO LOCATE THE CLOSER ON A 1’-6” WIDE LEAF.

HW SET: 102

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Quantity</th>
<th>Model/Brand</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 EA</td>
<td>HINGE</td>
<td>5BB1 4.5 X 4.5</td>
<td>652 IVE</td>
</tr>
<tr>
<td>1 EA</td>
<td>STOREROOM LOCK</td>
<td>ML2057 LSM X LC</td>
<td>626 C-R</td>
</tr>
<tr>
<td>1 EA</td>
<td>MORTISE CYLINDER</td>
<td>1E74</td>
<td>626 BES</td>
</tr>
<tr>
<td>1 EA</td>
<td>SURFACE CLOSER</td>
<td>4011</td>
<td>689 LCN</td>
</tr>
<tr>
<td>1 EA</td>
<td>KICK PLATE</td>
<td>8400 10&quot; X 2&quot; LDW</td>
<td>630 IVE</td>
</tr>
<tr>
<td>1 EA</td>
<td>WALL STOP</td>
<td>WS33</td>
<td>626 IVE</td>
</tr>
<tr>
<td>1 SET</td>
<td>SEALS</td>
<td>2525B</td>
<td>BRN NGP</td>
</tr>
</tbody>
</table>
HW SET: 103

1 EA ELECTRIC HINGE 5BB1 4.5 X 4.5 ETW-4 652 IVE
1 EA ELECTRIC LOCK ML20905 M92 LSM X LC 626 C-R
1 EA MORTISE CYLINDER 1E74 626 BES
1 EA MAGNETIC CONTACT 1078 SEN
1 EA CARD READER BY SECURITY CONTRACTOR B/O
1 EA POWER SUPPLY BY SECURITY CONTRACTOR B/O

NOTE: MODIFY, PATCH AND REPAIR THE EXISTING DOOR AND FRAME FOR THE NEW HARDWARE. REPLACE THE CENTER HINGE WITH THE THROUGH WIRE HINGE.

OPERATION: THE CARD READER WILL UNLOCK THE OUTSIDE LEVER FOR ENTRY. THE INSIDE LEVER WILL PERMIT EGRESS AT ALL TIMES. THE REQUEST TO EXIT AND DOOR POSITION SWITCHES ARE MONITORED BY THE SECURITY SYSTEM.

END OF SECTION
SECTION 092900- GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Interior gypsum wallboard.

B. Related Sections include the following:

1. Division 7 Section "Building Insulation" for insulation and vapor retarders installed in gypsum board assemblies.

1.3 DEFINITIONS

A. Gypsum Board Terminology:

1. Refer to ASTM C 11 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

1.4 SUBMITTALS

A. Product Data:

1. For each type of product indicated.

B. LEED Submittals:

1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.
2. Product Certificates for Credit MR 5: For products and materials required to complying with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include...
statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.

3. Product Certificates for Credit MR 5: For products and materials complying with requirements for regionally manufactured and regionally extracted and manufactured materials. Include statement indicating cost for each regionally manufactured material.

   a. Include statement indicating location of manufacturer and distance to Project for each regionally manufactured material.
   b. Include statement indicating location of manufacturer and point of extraction, harvest, or recovery for each raw material used in regionally extracted and manufactured materials. Indicate distance to Project and fraction by weight of each regionally manufactured material that is regionally extracted.

4. Product Data for Credit IEQ 4.1: For adhesives used to laminate gypsum board panels to substrates, documentation including printed statement of VOC content.

C. Shop Drawings:

   1. None required.

D. Samples:

   1. For the following products:

      a. Trim Accessories:

         1) Full-size sample in 12-inch- (300-mm-) long length for each trim accessory indicated.

1.5 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics:

   1. For gypsum board assemblies with fire-resistance ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.
   2. Fire-Resistance-Rated Assemblies:

      a. Indicated by design designations from UL's "Fire Resistance Directory" or GA-600, "Fire Resistance Design Manual".

B. Sound Transmission Characteristics:

   1. For gypsum board assemblies with STC ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by a qualified independent testing agency.
2. STC-Rated Assemblies:
   a. Indicated by design designations from GA-600, "Fire Resistance Design Manual".

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.

B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Stack gypsum panels flat to prevent sagging.

1.7 PROJECT CONDITIONS

A. Environmental Limitations:

   1. Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products of the following:

   1. Steel Framing and Furring:

      b. Marino/Ware.
      c. MBA Metal Framing.
      d. Scafco Corporation.
      e. Steel Network, Inc.
      f. State Building Products, Inc.
      g. Telling Industries.

   2. Gypsum Board and Related Products:

      a. American Gypsum Co.
      b. G-P Gypsum Corp.
      c. Lafarge Gypsum
      e. United States Gypsum Co.
Construction

1. Recycled Content: Provide gypsum panel products with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 10 percent by weight.

2. Regional Materials: Gypsum panel products shall be manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.

3. Recycled Content: Provide steel sheet with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

2.2 STEEL SUSPENDED CEILING FRAMING

A. Components, General:

1. Comply with ASTM C 754 for conditions indicated.

B. Tie Wire:

1. ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- (1.59-mm-) diameter wire, or double strand of 0.0475-inch- (1.21-mm-) diameter wire.

C. Hangers: As follows:

1. Wire Hangers:

   a. ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch (4.12-mm) diameter.

D. Carrying Channels:

1. Material:

   a. Material:

      1) Cold-rolled, commercial-steel sheet with a base metal thickness of 0.0538 inch (1.37 mm), a minimum 1/2-inch- (12.7-mm-) wide flange.

   b. Protective Finish:

      1) Manufacturer’s standard corrosion-resistant zinc coating.

2. Depth:

   a. 1-1/2 inches (38.1 mm), unless otherwise indicated.

E. Furring Channels (Furring Members):

1. Material:
   1) Manufacturer's standard corrosion-resistant zinc coating.

2. Cold Rolled Channels:
a. Material:
   1) 0.0538-inch (1.37-mm) bare steel thickness, with minimum 1/2-inch- (12.7-mm-) wide flange, 3/4 inch (19.1 mm) deep.

3. Steel Studs:
a. Standard:
   1) ASTM C 645.
b. Minimum Base Metal Thickness:
   1) 20 gage (0.0312 inch) minimum thickness.
c. Depth:
   1) 3-5/8 inches (92.1 mm), unless otherwise indicated.

4. Hat-Shaped, Rigid Furring Channels:
a. Material:
   1) Standard:
      a) ASTM C 645.
b. Depth:
   1) 7/8 inch (22.2 mm) deep.
c. Minimum Base Metal Thickness:
   1) 20 gage (0.0312 inch minimum thickness).

5. Resilient Furring Channels:
a. Depth:
   1) 1/2-inch- (12.7-mm-) deep members designed to reduce sound transmission.
b. Configuration:
Construction

1) Asymmetrical or hat shaped, with face attached to single flange by a slotted leg (web) or attached to two flanges by slotted or expanded metal legs.

F. Grid Suspension System for Interior Ceilings:

1. General:
   a. ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.

2. Products:
   a. Subject to compliance with requirements, provide one of the following:
      1) USG Interiors, Inc.; Drywall Suspension System.

2.3 STEEL PARTITION FRAMING

A. Components

1. General:
   a. Comply with ASTM C 754 for conditions indicated.

2. Steel Sheet Components:
   a. Complying with ASTM C 645 requirements for metal.
   b. Protective Finish:
      1) Manufacturer's standard corrosion-resistant zinc coating.

B. Steel Studs and Runners:

1. Standard:
   a. ASTM C 645.

2. Minimum Base Metal Thickness:
   a. 20 gage (0.0312 inch minimum thickness).

3. Depth:
   a. 3-5/8 inches (92.1 mm), unless otherwise indicated.

C. Deep-Leg Deflection Track:

1. ASTM C 645 top runner with 3-inch deep flanges.
D. Proprietary Deflection Track:
   1. Steel sheet top runner manufactured to prevent cracking of gypsum board applied to interior partitions resulting from deflection of structure above; in thickness indicated for studs and in width to accommodate depth of studs.
   2. Product: Subject to compliance with requirements, provide the following:
      a. Delta Star, Inc., Superior Metal Trim; Superior Flex Track System (SFT).
      b. Metal-Lite, Inc.; Slotted Track.
E. Proprietary Firestop Track:
   1. Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
      a. Fire Trak Corp.; Profile as indicated on drawings.
F. Flat Strap and Backing Plate:
   1. Use:
      a. Steel sheet for blocking and bracing in length and width indicated.
   2. Minimum Base Metal Thickness:
      a. 16 gage (0.0538 inch minimum thickness), unless otherwise indicated.
G. Cold-Rolled Channel Bridging.
   1. Material:
      a. 0.0538-inch (1.37-mm) bare steel thickness, with minimum 1/2-inch- (12.7-mm-)
         wide flange.
   2. Depth:
      a. 1-1/2 inches (38.1 mm), unless otherwise indicated.
   3. Clip Angle:
      a. 1-1/2 by 1-1/2 inch (38.1 by 38.1 mm), 0.068-inch- (1.73-mm-) thick, galvanized steel.
H. Hat-Shaped, Rigid Furring Channels:
   1. General:
      a. ASTM C 645.
2. Minimum Base Metal Thickness:
   a. 20 gage (0.0312 inch minimum thickness), unless otherwise indicated.

3. Depth:
   a. 1-1/2 inches (38.1 mm), unless otherwise indicated.

I. Resilient Furring Channels:
   1. General:
      a. 1/2-inch- (12.7-mm-) deep, steel sheet members designed to reduce sound transmission.
   2. Configuration:
      a. Asymmetrical or hat shaped, with face attached to single flange by a slotted leg (web) or attached to two flanges by slotted or expanded metal legs

J. Cold-Rolled Furring Channels:
   1. General:
      a. 0.0538-inch (1.37-mm) bare steel thickness, with minimum 1/2-inch- (12.7-mm-) wide flange.
   2. Depth:
      a. 3/4 inch (19.1 mm), unless otherwise indicated.
   3. Furring Brackets:
      a. Adjustable, corrugated-edge type of steel sheet with minimum bare steel thickness of 0.0312 inch (0.79 mm).
   4. Tie Wire:
      a. ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- (1.59-mm-) diameter wire, or double strand of 0.0475-inch- (1.21-mm-) diameter wire.

K. Z-Shaped Furring:
   1. With slotted or nonslotted web, face flange of 1-1/4 inches (31.8 mm), wall attachment flange of 7/8 inch (22.2 mm), minimum bare metal thickness of 20 gage (0.0312 inch minimum thickness), and depth required to fit insulation thickness indicated.

L. Fasteners for Metal Framing:
1. Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

2.4 INTERIOR GYPSUM WALLBOARD

A. Panel Size:
   1. Provide in maximum lengths and widths available that will minimize joints in each area and correspond with support system indicated.

B. Gypsum Wallboard:
   1. Standard:
      a. ASTM C 1396/ASTM C 1396M.
   2. Core:
      a. 1/2 inch (12.7mm), regular type, only where designated.
      b. 5/8 inch (15.9 mm), Type X, typical.
   3. Long Edges:
      a. Tapered.
   4. Location:
      a. Vertical surfaces, unless otherwise indicated.

C. Flexible Gypsum Board: ASTM C 1396/C 1396M. Manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.
   1. Thickness: 1/4 inch (6.4 mm).
   2. Long Edges: Tapered.
   3. Location:
      a. Apply in double layer at curved assemblies and elsewhere as indicated.

2.5 TRIM ACCESSORIES

A. Interior Trim:
   1. Standard:
      a. ASTM C 1047.
2. Material:
   a. Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized steel sheet.

3. Shapes:
   a. Cornerbead:
      1) Use at outside corners, unless otherwise indicated.
   b. LC-Bead (J-Bead):
      1) Use at exposed panel edges.
   c. L-Bead:
      1) Use where indicated.
   d. U-Bead:
      1) Use where indicated.
   e. Expansion (Control) Joint:
      1) Use where indicated.
   f. Curved-Edge Cornerbead:
      1) With notched or flexible flanges; use at curved openings.

2.6 JOINT TREATMENT MATERIALS
A. General:

B. Joint Tape:
   1. Interior Gypsum Wallboard: Paper.
   2. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Wallboard:
   1. General:
      a. For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
2. Prefilling:
   a. At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.

3. Embedding and First Coat:
   a. For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound or drying-type, all-purpose compound.
   b. Use setting-type compound for installing paper-faced metal trim accessories.

4. Fill Coat:
   a. For second coat, use setting-type, sandable topping compound or drying-type, all-purpose compound.

5. Finish Coat:
   a. For third coat, use setting-type, sandable topping compound or drying-type, all-purpose compound.

6. Skim Coat:
   a. For final coat of Level 5 finish, use setting-type, sandable topping compound or drying-type, all-purpose compound.

2.7 ACOUSTICAL SEALANT

A. As specified in Division 7 Section “Joint Sealants”.

B. Provide sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.8 AUXILIARY MATERIALS

A. General:
   1. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Laminating Adhesive:
   1. Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
   2. Use adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
C. Steel Drill Screws:
   1. ASTM C 1002, unless otherwise indicated.
   2. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
   3. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

D. Sound Attenuation Blankets:
   1. As specified in Division 7 Section "Building Insulation".
   3. Recycled Content: Provide blankets with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 10 percent by weight.

E. Thermal Insulation:
   1. As specified in Division 7 Section "Building Insulation".
   2. Recycled Content: Provide blankets with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 10 percent by weight.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION
A. Suspended Ceilings: Coordinate installation of ceiling suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive ceiling hangers at spacing required to support ceilings and that hangers will develop their full strength.
   1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

B. Coordination with Sprayed Fire-Resistive Materials:
1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed-on fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches (600 mm) o.c.
2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of gypsum board assemblies and without reducing the fire-resistive material thickness below that which is required to obtain fire-resistance rating indicated. Protect remaining fire-resistive materials from damage.

3.3 INSTALLING STEEL FRAMING, GENERAL

A. Installation Standards: ASTM C 754, and ASTM C 840 requirements that apply to framing installation.

B. Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction. Comply with details indicated and with gypsum board manufacturer's written recommendations or, if none available, with United States Gypsum's "Gypsum Construction Handbook."

C. Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement.

1. Isolate ceiling assemblies where they abut or are penetrated by building structure.
2. Isolate partition framing and wall furring where it abuts structure, except at floor. Install slip-type joints at head of assemblies that avoid axial loading of assembly and laterally support assembly.
   a. Use deep-leg deflection track where indicated.
   b. Use proprietary deflection track where indicated.
   c. Use proprietary firestop track where indicated.

D. Do not bridge building control and expansion joints with steel framing or furring members. Frame both sides of joints independently.

3.4 INSTALLING STEEL SUSPENDED CEILING FRAMING

A. Suspend ceiling hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with the location of hangers 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.

3. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause them to deteriorate or otherwise fail.

4. Secure hangers to structure, including intermediate framing members, by attaching to inserts, eyescrews, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.

5. Do not support ceilings directly from permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.

6. Do not attach hangers to steel deck tabs.

7. Do not attach hangers to steel roof deck. Attach hangers to structural members.

8. Do not connect or suspend steel framing from ducts, pipes, or conduit.

B. Installation Tolerances:

1. Install steel framing components for suspended ceilings so members for panel attachment are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member and transversely between parallel members.

C. Sway-brace suspended steel framing with hangers used for support.

D. Wire-tie or clip furring channels to supports, as required to comply with requirements for assemblies indicated.

E. Install suspended steel framing components in sizes and spacings indicated, but not less than that required by the referenced steel framing and installation standards.

1. Hangers:
   a. 48 inches (1219 mm) o.c..

2. Carrying Channels (Main Runners):
   a. 48 inches (1219 mm) o.c.

3. Furring Channels (Furring Members):
   a. 16 inches (406 mm) o.c.

F. Grid Suspension System:

1. Attach perimeter wall track or angle where grid suspension system meets vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
3.5 INSTALLING STEEL PARTITION FRAMING

A. Install tracks (runners) at floors, ceilings, and structural walls and columns where gypsum board assemblies abut other construction.

1. Where studs are installed directly against exterior walls, install asphalt-felt or foamp-gasket isolation strip between studs and wall.

B. Install each steel framing and furring member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by the faces of adjacent framing.

C. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.

1. Cut studs 1 inch short of full height to provide perimeter relief.
2. For fire-resistance-rated and STC-rated partitions that extend to the underside of floor/roof slabs and decks or other continuous solid-structure surfaces to obtain ratings, install framing around structural and other members extending below floor/roof slabs and decks, as needed to support gypsum board closures and to make partitions continuous from floor to underside of solid structure.
   a. Terminate partition framing at suspended ceilings where indicated.

D. Install steel studs so flanges point in the same direction and leading edge or end of each panel can be attached to open (unsupported) edges of stud flanges first.

E. Curved Partitions:

1. Cut top and bottom track (runners) through leg and web at 2-inch (50-mm) intervals for arc length. In cutting lengths of track, allow for uncut straight lengths of not less than 12 inches (300 mm) at ends of arcs.
2. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
3. Support outside (cut) leg of track by clinching steel sheet strip, 1-inch- (25-mm-) high-by-thickness of track metal, to inside of cut legs using metal lock fasteners.
4. Begin and end each arc with a stud, and space intermediate studs equally along arcs at stud spacing recommended in writing by gypsum board manufacturer for radii indicated. On straight lengths of not less than 2 studs at ends of arcs, place studs 6 inches (150 mm) o.c.

F. Frame door openings to comply with GA-600 and with gypsum board manufacturer's applicable written recommendations, unless otherwise indicated. Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
1. Install two studs at each jamb, unless otherwise indicated.
2. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint.
3. Extend jamb studs through suspended ceilings and attach to underside of floor or roof structure above.
4. Spot grout door frames. Apply spot grout at each anchor clip and immediately insert gypsum board into frames.

G. Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.

H. Z-Furring Members:
   1. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (600 mm) o.c.
   2. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches (300 mm) from corner and cut insulation to fit.

I. Insulation:
   1. Install in accordance with requirements of Division 7 Section “Building Insulation”.

3.6 APPLYING AND FINISHING PANELS, GENERAL

A. Gypsum Board Application and Finishing Standards:
   1. ASTM C 840 and GA-216.

B. Install sound attenuation blankets before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.

C. Install ceiling board panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in the central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

D. Install gypsum panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.

E. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered
edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

F. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

G. Attach gypsum panels to framing provided at openings and cutouts.

H. Form control and expansion joints with space between edges of adjoining gypsum panels.

I. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- (6.4- to 9.5-mm-) wide joints to install sealant.

J. Isolate perimeter of non-load-bearing gypsum board partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations, and trim edges with U-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

K. STC-Rated Assemblies:

1. Seal construction at perimeters, behind control and expansion joints, and at openings and penetrations with a continuous bead of acoustical sealant, in accordance with requirements of Division 7 Section “Joint Sealants”.

L. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's written recommendations.

1. Space screws a maximum of 12 inches (304.8 mm) o.c. for vertical applications.

M. Space fasteners in panels that are tile substrates a maximum of 8 inches (203.2 mm) o.c.

3.7 PANEL APPLICATION METHODS

A. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to the greatest extent possible and at right angles to framing, unless otherwise indicated.
2. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
   a. Stagger abutting end joints not less than one framing member in alternate courses of board.
   b. At stairwells and other high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.

3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.

B. Multilayer Application on Partitions/Walls:

1. Apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.

2. Apply base layer over Z-furring members vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.

C. Single-Layer Fastening Methods:

1. Apply gypsum panels to supports with steel drill screws.

D. Multilayer Fastening Methods:

1. Fasten base layers and face layers separately to supports with screws.

E. Laminating to Substrate:

1. Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer’s written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

F. Curved Partitions:

1. Install panels horizontally and unbroken, to the extent possible, across curved surface plus 12-inch- (300-mm-) long straight sections at ends of curves and tangent to them.

2. Wet gypsum panels on surfaces that will become compressed where curve radius prevents using dry panels. Comply with gypsum board manufacturer’s written recommendations for curve radii, wetting methods, stacking panels after wetting, and other preparations that precede installing wetted gypsum panels.
3. On convex sides of partitions, begin installation at one end of curved surface and fasten gypsum panels to studs as they are wrapped around curve. On concave side, start fastening panels to stud at center of curve and work outward to panel ends. Fasten panels to framing with screws spaced 12 inches (300 mm) o.c.

4. For double-layer construction, fasten base layer to studs with screws 16 inches (400 mm) o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 12 inches (300 mm) o.c.

5. Allow wetted gypsum panels to dry before applying joint treatment.

G. Tile Backing Panels:

1. Glass-Mat, Water-Resistant Backing Panel:
   a. Comply with manufacturer’s written installation instructions and install at all locations scheduled to receive wall tile. Install with ¼-inch (6.4-mm) gap where panels abut other construction or penetrations.

2. Cementitious Backer Units:
   a. Comply with manufacturer’s written installation instructions and install at locations indicated to receive floor tile that are identified to have cementitious backer units.

3.8 INSTALLING TRIM ACCESSORIES

A. General:

1. For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints:

1. Install control joints at locations indicated on Drawings
2. Where not shown on the Drawings, install control joints according to ASTM C 840 and in specific locations noted below and approved by Architect for visual effect.

   a. At all changes in type of gypsum support construction.
   b. At transitions from floor supported metal framing to overhead supported framing.
   c. At control joints occurring on building construction.
   d. In walls at maximum spacing of 30 feet.
   e. Where wallboard abuts a wall or ceiling of dissimilar construction.
   f. At door jamb where the wallboard joint is less than 12" from jamb.
   g. In ceiling areas to limit area to not more than 2500 sq.ft. and not more than 50 feet o.c.
   h. In ceilings where support framing changes direction.
3.9 FINISHING GYPSUM BOARD ASSEMBLIES

A. General:

1. Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
2. Prefill open joints, rounded or beveled edges, and damaged surface areas.
3. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

B. Gypsum Board Finish Levels:

1. General:
   a. Finish panels to levels indicated below, according to ASTM C 840, for locations indicated.

2. Level 1:
   a. Embed tape at joints in ceiling plenum areas, concealed areas, and elsewhere indicated, unless a higher level of finish is required for fire-resistance-rated assemblies and sound-rated assemblies.

3. Level 2:
   a. Embed tape and apply separate first coat of joint compound to tape, fasteners, and trim flanges where panels are substrate for tile panels are substrate for acoustical tile and elsewhere as indicated.

4. Level 4:
   a. Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges at panel surfaces that will be exposed to view, unless otherwise indicated and for surfaces receiving light-textured finish wallcoverings and flat paints. Unless otherwise indicated, this is the standard exposed finish.

5. Level 5:
   a. Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges, and apply skim coat of joint compound over entire surface for panels a high quality gypsum board finish. Areas to receive Level 5 finish include surfaces receiving gloss and semi-gloss sheen paints, surfaces subject to severe lighting levels and other additional areas specifically indicated on the Drawings.
C. Tile Backing Panels:
   1. Finish according to manufacturer's written instructions.

3.10 COPPER MESH SHIELDING INSTALLATION
   A. Install copper mesh shielding in full accordance with manufacturer’s written instructions at locations indicated on the Drawings.

3.11 FIELD QUALITY CONTROL
   A. Above-Ceiling Observation: Before Contractor installs gypsum board ceilings, Architect will conduct an above-ceiling observation and report deficiencies in the Work observed. Do not proceed with installation of gypsum board to ceiling support framing until deficiencies have been corrected.

   1. Notify Owner seven days in advance of date and time when Project, or part of Project, will be ready for above-ceiling observation.
   2. Before notifying Architect, complete the following in areas to receive gypsum board ceilings:
      a. Installation of 80 percent of lighting fixtures, powered for operation.
      b. Installation, insulation, and leak and pressure testing of water piping systems.
      c. Installation of air-duct systems.
      d. Installation of air devices.
      e. Installation of mechanical system control-air tubing.
      f. Installation of ceiling support framing.

END OF SECTION 092900
DWH/BRP
SECTION 095113 - ACOUSTICAL PANEL CEILINGS

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:
      1. Acoustical panels and exposed suspension systems for ceilings.

1.3 SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. LEED Submittals:
      1. Product Data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating costs for each product having recycled content.
      2. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.
   C. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.
      1. Acoustical Panel: Set of 6-inch- (150-mm) square Samples of each type, color, pattern, and texture.
      2. Exposed Suspension System Members, Moldings, and Trim: Set of 12-inch- (300-mm-) long Samples of each type, finish, and color.
   D. Research/Evaluation Reports: For each acoustical panel ceiling and components and anchor and fastener type.
   E. Maintenance Data: For finishes to include in maintenance manuals.
1.4 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. 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. Fire-Resistance Characteristics: Where indicated, provide acoustical panel ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
      a. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency acceptable to authorities having jurisdiction.
      b. Identify materials with appropriate markings of applicable testing and inspecting agency.
   2. Surface-Burning Characteristics: Provide acoustical panels with the following surface-burning characteristics complying with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84:
      a. Smoke-Developed Index: 450 or less.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.5 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 a stabilized moisture content.

C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.
1.6 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.

1.7 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.

1.8 EXTRA MATERIALS

A. Furnish extra material that match and are from same production funs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish full size units in amount equal to 2.0% of each acoustic panel type installed (no suspension system units).

PART 2 - PRODUCTS

2.1 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.

1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface per ASTM E 795.

B. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 10 percent.

C. 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.

D. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

2.2 ACOUSTICAL PANELS FOR ACOUSTICAL PANEL CEILING

A. Products: Subject to compliance with requirements, provide the products indicated in the “Finish Materials List” on the Drawings.

2.3 METAL SUSPENSION SYSTEMS, GENERAL

A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

B. 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.

1. Intermediate-duty system unless otherwise indicated.

C. 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. Color: White, unless otherwise indicated.

D. Attachment Devices: Size for 5 times design load indicated in ASTM C 635, Table 1, Direct Hung, except powder actuated devices shall be sized for ten (10) times design load per ASTM E 1190 and be imbedded a minimum of 1-1/4”.

1. Powder actuated devices shall have 10% of fasteners tested for pullout: tested to 300 pound load for general areas and 500 pound load in corridors. If 10% of fasteners fail, test all fasteners.

E. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:


2. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 12 gage 0.106-inch- (2.69-mm-) minimum diameter wire.
2.4 METAL SUSPENSION SYSTEM FOR ACOUSTICAL PANEL CEILING

A. Products: Subject to compliance with requirements, provide the product indicated in the “Finish Materials List” on the Drawings.

2.5 METAL EDGE MOLDINGS AND TRIM

A. Products: Same as metal suspension system manufacturer unless otherwise indicated.

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; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.

1. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners, unless otherwise indicated.

2. 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.

3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

C. Extruded Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer’s extruded aluminum edge moldings and trim of profile indicated or referenced by manufacturer’s designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements and the following:

1. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 (ASTM B 221M) for Alloy and Temper 6063-T5.

2. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.


   a. Organic Coating: Thermosetting, primer/topcoat system with a minimum dry film thickness of 0.8 to 1.2 mils (0.02 to 0.03 mm).

2.6 ACOUSTICAL SEALANT

A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant, with a VOC content of 250 g/L or less when calculated
Construction

according to 40 CFR 59, Subpart D (EPA Method 24), complying with ASTM C 834 and
effective in reducing airborne sound transmission through perimeter joints and openings in
building construction as demonstrated by testing representative assemblies according to
ASTM E 90.

B. Acoustical Sealant for Concealed Joints: Manufacturer's standard nondrying, nonhardening,
nonskinning, nonstaining, gammable, synthetic-rubber sealant, with a VOC content of 250 g/L or
less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), recommended for
sealing interior concealed joints to reduce airborne sound transmission.

1. Acoustical sealant shall have a VOC content of 250 g/L or less when calculated
   according to 40 CFR 59, Subpart D (EPA Method 24).

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.

1. 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

A. General: Install acoustical panel ceilings to comply with ASTM C 636 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 and, if permitted with fire-resistance-rated ceilings, 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.

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. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.

7. Do not attach hangers to steel deck tabs.

8. Do not attach hangers to steel roof deck. Attach hangers to structural members.

9. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers, unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.

10. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building’s structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. 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 (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.

3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. 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. As indicated on reflected ceiling plans; or if not indicated, Install panels with pattern running in one direction either parallel to long or short axis of space.
2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension system runners and moldings.

3. For reveal-edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.

4. For reveal-edged panels on suspension system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension system surfaces and panel faces flush with bottom face of runners.

5. 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.

6. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

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
DWH/BRP
SECTION 096513 - RESILIENT WALL BASE AND ACCESSORIES

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. Section Includes:
      1. Resilient base.

1.3 SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. LEED Submittals:
      1. Product Data for Credit IEQ 4.1: For adhesives, documentation including printed statement of VOC content.
      C. Samples for Verification: For each type of product indicated, in manufacturer's standard-size Samples but not less than 12 inches (300 mm) long, of each resilient product color, texture, and pattern required.
      D. Product Schedule: For resilient products. Use same designations indicated on Drawings.

1.4 QUALITY ASSURANCE
   A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
      1. Critical Radiant Flux Classification: Class I, not less than 0.45 W.

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 (10 deg C) or more than 90 deg F (32 deg C).
1.6  PROJECT CONDITIONS

A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F (21 deg C) or more than 95 deg F (35 deg C), in spaces to receive resilient products during the following time periods:

1. 48 hours before installation.
2. During installation.
3. 48 hours after installation.

B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).

C. Install resilient products after other finishing operations, including painting, have been completed.

1.7  EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish not less than 10 linear feet (3 linear m) for every 500 linear feet (150 linear m) or fraction thereof, of each type, color, pattern, and size of resilient product installed. Verify requirement with University of Pittsburgh Medical Center Project Manager.

PART 2 - PRODUCTS

2.1  RESILIENT BASE

A. Manufacturers: Provide products as indicated in the “Finish Materials List” on the Drawings:


1. Material Requirement: Type TS (rubber, vulcanized thermoset).
3. Style: Cove (base with toe) and Straight (flat or toeless) refer to Drawings for location.

C. Minimum Thickness: 0.125 inch (3.2 mm).

D. Height: 4 inches (102 mm).

E. Lengths: Coils in manufacturer's standard length.

F. Outside Corners: Job formed or preformed.

G. Inside Corners: Job formed.
H. Colors and Patterns: As indicated on the “Finish Materials List” on the Drawings.

I. Type:
   1. Straight at carpet and carpet tile.
   2. Cove at all other locations, unless otherwise indicated.

2.2 INSTALLATION MATERIALS

   A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.

   B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.

      1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

         a. Cove Base Adhesives: Not more than 50 g/L.

PART 3 - EXECUTION

3.1 EXAMINATION

   A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

   B. 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.

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

3.2 PREPARATION

   A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

   B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

   C. Do not install resilient products until they are same temperature as the space where they are to be installed.
1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

D. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

### 3.3 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.

C. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. Preformed Corners: Install preformed corners before installing straight pieces.

G. Job-Formed Corners:
   1. Outside Corners: Use straight pieces of maximum lengths possible. Form without producing discoloration (whitening) at bends.
   2. Inside Corners: Use straight pieces of maximum lengths possible.

### 3.4 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protection of resilient products.

B. 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.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
D.  Cover resilient products until Substantial Completion.

END OF SECTION 096513
DWH/BRP
SECTION 096723 - RESINOUS FLOORING

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 three resinous flooring systems.

   1. EPX-1 Application Method: Epoxy Mortar, metal, power or hand troweled.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include manufacturer's technical data, application instructions, and recommendations for each resinous flooring component required.

B. Samples for Verification: For each resinous flooring system required, 6 inches (150 mm) square, applied to a rigid backing by Installer for this Project.

C. Product Schedule: Use resinous flooring designations indicated in Part 2 and room designations indicated on Drawings in product schedule.

D. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.

E. Maintenance Data: For resinous flooring to include in maintenance manuals.

F. Product Certificates: Signed by manufacturer of floor-covering system certifying that resinious flooring is compatible with cementitious underlayment.

G. Minutes of pre-installation conference.

1.4 QUALITY ASSURANCE

A. No request for substitution shall be considered that would change the generic type of floor system specified. Request will be subject to specification requirements described in this section.

B. Installer Qualifications: Engage an experienced installer (applicator) who is experienced in applying resinous flooring systems similar in material, design, and extent to those indicated for
Construction

this Project, whose work has resulted in applications with a record of successful in-service performance, and who is acceptable to resinous flooring manufacturer.

1. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.
2. Contractor shall have completed at least 10 projects of similar size and complexity.

C. Source Limitations: Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, through one source from a single manufacturer, with not less than ten years of successful experience in manufacturing and installing principal materials described in this section. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.

D. Manufacturer Field Technical Service Representatives: Resinous flooring manufacture shall retain the services of Field Technical Service Representatives who are trained specifically on installing the system to be used on the project and must be present on site during installation of flooring system.

1. Field Technical Services Representatives shall be employed by the system manufacture to assist in the quality assurance and quality control process of the installation and shall be available to perform field problem solving issues with the installer.

E. Mockups: Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Apply full-thickness mockups on 48-inch- (1200-mm-) square floor area selected by Architect.
   a. Include 48-inch (1200-mm) length of integral cove base.
2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

F. Pre-installation Conference:

1. General contractor shall arrange a meeting not less than thirty days prior to starting work.
2. Attendance:
   a. General Contractor
   b. Architect/Owner's Representative.
   c. Manufacturer/Installer's Representative.
1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating brand name and directions for storage and mixing with other components.

B. Store materials to prevent deterioration from moisture, heat, cold, direct sunlight, or other detrimental effects.

C. All materials used shall be factory pre-weighed and pre-packaged in single, easy to manage batches to eliminate on site mixing errors. No on site weighing or volumetric measurements allowed.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Comply with resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation, and other conditions affecting resinous flooring application.

1. Maintain material and substrate temperature between 65 and 85 deg F (18 and 30 deg C) during resinous flooring application and for not less than 24 hours after application.

B. Lighting: Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.

C. Close spaces to traffic during resinous flooring application and for not less than 24 hours after application, unless manufacturer recommends a longer period.

D. Concrete substrate shall be properly cured for a minimum of 30 days. A vapor barrier must be present for concrete subfloors on or below grade. Otherwise, an osmotic pressure resistant grout must be installed prior to the resinous flooring.

1.7 WARRANTY

A. Manufacturer shall furnish a single, written warranty covering both material and workmanship for a period of (2) full years from date of installation, or provide a joint and several warranty signed on a single document by material manufacturer and applicator jointly and severally warranting the materials and workmanship for a period of (2) full year from date of installation. A sample warranty letter must be included with bid package or bid may be disqualified.

1. Written and signed documentation is required by resinous flooring manufacturer stating and ensuring compatibility and warranty coverage of resinous flooring placement over placed cementitious underlayment.
PART 2 - PRODUCTS

2.1 EPOXY MORTAR FLOORING (EPX-1)

A. Manufacturers: Subject to compliance with requirements, manufacturers that may be incorporated into the Work include,

1. Basis of Design manufacturer is Stonhard, product as indicated or comparable products by:
   a. Dudick, Inc.
   b. Sherwin-Williams Company, General Polymers.
   c. Rez-Stone, Hoover Wells

2. Build of broadcast or liquid rich type systems will not be accepted.

B. Products: Subject to compliance with requirements:

1. Stonhard, Inc.; Stonclad GS® with Stonkote GS4, and Stonseal CF7
   a. Contact: 419-367-1111.

C. System Characteristics:

1. Color and Pattern: Choose from Mfg. Standards
3. Integral Cove Base: 4 inches.
4. Overall System Thickness: nominal 1/4”

D. System Components: Manufacturer's standard components that are compatible with each other and as follows:

1. Primer:
   a. Material Basis: Stonhard Standard Primer
   b. Resin: Epoxy
   c. Formulation Description: (2) two component, 100 percent solids.
   d. Application Method: Squeegee and roller.
   e. Number of Coats: (1) one.

2. Mortar Base:
   a. Material design basis: Stonclad GS
   b. Resin: Epoxy.
   c. Formulation Description: (3) three component, 100 percent solids.
   d. Application Method: Metal Trowel.
1) Thickness of Coats: nominal 1/4 inch (6.4 mm).
2) Number of Coats: One.

e. Aggregates: Pigmented Blended aggregate.

3. Top Coat:

a. Material design basis: Stonkote GS4
b. Resin: Epoxy.
c. Formulation Description: (2) two component 100 percent solids.
d. Type: pigmented.
e. Finish: standard.
f. Number of Coats: one

4. Seal Coat: Chemical resistant and high UV stability.

a. Material design basis: Stonseal CF7
b. Resin: Water-based, aliphatic polyurethane topcoat. VOC below 100g/l.
c. Formulation Description: two-component
d. Type: Clear
e. Finish: Matte.
f. Number of Coats: (1) one, Optional (2) two.

Note: Components listed above are the basis of design intent; all bids will be compared to this standard including resin chemistry, color, wearing surface, thickness, and installation procedures, including number of coats. Contractor shall be required to comply with all the requirements of the Specifications and all of the components required by the Specifications, whether or not such products are specifically listed above.

E. System Physical Properties: Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:

1. Compressive Strength: 10,000 psi after 7 days per ASTM C 579.
2. Tensile Strength: 1,750 psi per ASTM C 307.
3. Flexural Strength: 4,000 psi per ASTM C 580.
4. Water Absorption: < 1% per ASTM C 413.
7. Hardness: 85 to 90, Shore D per ASTM D 2240.

2.2 ACCESSORY MATERIALS

A. Patching and Fill Material: Resinous product of or approved by resinous flooring manufacturer and recommended by manufacturer for application indicated.
B. Joint Sealant: Type recommended or produced by resinous flooring manufacturer for type of service and joint condition indicated. Allowances should be included for Stonflex MP7 joint fill material, and CT5 concrete crack treatment.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with installer present, for condition affecting performance.

1. Proceed with application only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Prepare and clean substrates according to resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry, and neutral Ph substrate for resinous flooring application.

B. Concrete Substrates: Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil, and other contaminants incompatible with resinous flooring.

1. Remove existing coatings, and mechanically prepare substrates as follows:

   a. Shot-blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.

   b. Comply with ASTM C 811 requirements, unless manufacturer's written instructions are more stringent.

2. Repair damaged and deteriorated concrete according to resinous flooring manufacturer's written recommendations.

3. Verify that concrete substrates are dry.

   a. Perform in situ probe test, ASTM F 2170. Proceed with application only after substrates do not exceed a maximum potential equilibrium relative humidity of 75 percent.

   b. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with application only after substrates have maximum moisture-vapor-emission rate of 5 lb of water/1000 sq. ft. of slab in 24 hours.

   c. Perform additional moisture tests recommended by manufacturer. Proceed with application only after substrates pass testing.
4. Verify that concrete substrates have neutral pH and that resinous flooring will adhere to them. Perform tests recommended by manufacturer. Proceed with application only after substrates pass testing.

C. Resinous Materials: Mix components and prepare materials according to resinous flooring manufacturer's written instructions.

D. Use patching and fill material to fill holes and depressions in substrates according to manufacturer's written instructions.

E. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to manufacturer's written recommendations. Allowances should be included for Stonflex MP7 joint fill material, and CT5 concrete crack treatment.

3.3 APPLICATION

A. General: Apply components of resinous flooring system according to manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.

1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate, and optimum intercoat adhesion.

2. Cure resinous flooring components according to manufacturer's written instructions. Prevent contamination during application and curing processes.

3. At substrate expansion and isolation joints, provide joint in resinous flooring to comply with resinous flooring manufacturer's written recommendations.

   a. Apply joint sealant to comply with manufacturer's written recommendations.

B. Apply primer where required by resinous system, over prepared substrate at manufacturer's recommended spreading rate.

C. Integral Cove Base: Stonclad GS mortar, apply cove base mix to wall surfaces before applying flooring. Apply according to manufacturer's written instructions and details including those for taping, mixing, priming, troweling, sanding, of cove base. Round internal and external corners.

   1. Integral Cove Base: 4 inches high.

D. Apply metal trowel single mortar coat in thickness indicated for flooring system. Hand or power trowel and grout to fill voids. When cured, sand to remove trowel marks and roughness.

E. Apply topcoat(s) in number of coats indicated for flooring system and at spreading rates recommended in writing by manufacturer.

3.4 TERMINATIONS

A. Chase edges to “lock” the flooring system into the concrete substrate along lines of termination.
B. Penetration Treatment: Lap and seal resinous system onto the perimeter of the penetrating item by bridging over compatible elastomer at the interface to compensate for possible movement.

C. Trenches: Continue flooring system into trenches to maintain monolithic protection. Treat cold joints to assure bridging of potential cracks.

D. Treat floor drains by chasing the flooring system to lock in place at point of termination.

3.5 JOINTS AND CRACKS

A. Treat control joints to bridge potential cracks and to maintain monolithic protection.

B. Treat cold joints and construction joints to bridge potential cracks and to maintain monolithic protection on horizontal and vertical surfaces as well as horizontal and vertical interfaces.

C. Discontinue floor coating system at vertical and horizontal contraction and expansion joints by installing backer rod and compatible sealant after coating installation is completed. Provide sealant type recommended by manufacturer for traffic conditions and chemical exposures to be encountered.

3.6 FIELD QUALITY CONTROL

A. Material Sampling: Owner may at any time and any numbers of times during resinous flooring application require material samples for testing for compliance with requirements.

1. Owner will engage an independent testing agency to take samples of materials being used. Material samples will be taken, identified, sealed, and certified in presence of Contractor.

2. Testing agency will test samples for compliance with requirements, using applicable referenced testing procedures or, if not referenced, using testing procedures listed in manufacturer's product data.

3. If test results show applied materials do not comply with specified requirements, pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reapply flooring materials to comply with requirements.

3.7 CLEANING, PROTECTING, AND CURING

A. Cure resinous flooring materials in compliance with manufacturer's directions, taking care to prevent contamination during stages of application and prior to completion of curing process. Close area of application for a minimum of 18 hours.

B. Protect resinous flooring materials from damage and wear during construction operation. Where temporary covering is required for this purpose, comply with manufacturer's recommendations for protective materials and method of application. General Contractor is responsible for protection and cleaning of surfaces after final coats.
C. Cleaning: Remove temporary covering and clean resinous flooring just prior to final inspection. Use cleaning materials and procedures recommended by resinous flooring manufacturer.
SECTION 099100- PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division -1 Specification Sections, apply to Work of this Section.

1.2 SUMMARY
   A. Extent of painting work is indicated on Drawings and schedules, and as herein specified.
   B. This Section includes surface preparation, field painting of the following:
      1. Exposed interior items and surfaces.
      2. Surface preparation, priming of unprimed or incompatible primer finished surfaces, and touching up of damaged shop primed surfaces specified in this Section are in addition to shop surface preparation and priming specified in other Sections, when surface preparation and primer are not adequate to provide proper surface to receive specified finish coats specified in this Section.
   C. Paint exposed surfaces of all new work whether or not colors are designated in "Finish and Color Schedules" on the Drawings, except where a surface or material is specifically indicated not to be painted or is to remain natural. If the "Finish and Color Schedules" do not specifically mention an item or a surface, paint the item or surface the same as similar adjacent materials or surfaces whether or not "Finish and Color Schedules" indicate colors. If the "Finish and Color Schedules" do not indicate color or finish, the Architect will select from standard colors and finishes available.
      1. Painting includes field painting of interior exposed bare and covered pipes and ducts, except for pipe identification which is work of Division 15, hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment, except as otherwise indicated.
   D. Access Panels and Electric Panelboards: Paint access panels and electric panelboards to match adjacent wall or ceiling.
   E. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels, unless otherwise specified.
1. Prefinished items include the following factory-finished components (except as otherwise specified):
   a. Architectural woodwork and casework.
   b. Metal lockers.
   c. Wood doors.
   d. Finished mechanical and electrical equipment.
   e. Light fixtures.
   f. Distribution cabinets.

F. Concealed surfaces include walls or ceilings in the following generally inaccessible spaces:
   a. Furred areas.
   b. Ceiling plenums.
   c. Pipe spaces.
   d. Duct shafts.

2. Finished metal surfaces include the following:
   a. Anodized aluminum.
   b. Stainless steel.
   c. Chromium plate.
   d. Copper.
   e. Bronze.
   f. Brass.

3. Operating parts include moving parts of operating equipment and the following:
   a. Valve and damper operators.
   b. Linkages.
   c. Sensing devices.
   d. Motor and fan shafts.

4. Labels: Do not paint over Underwriter's Laboratories (UL), Factory Mutual (FM) or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.

G. Painting will be required on the following prefinished items that do not blend with color scheme of the Architect.

1. Grilles.
2. Diffusers.
3. Door closers.
H. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 8 Section "Steel Doors and Frames" for shop priming steel doors and frames.
2. Division 9 Section "Gypsum Board Assemblies" for surface preparation for gypsum board.
3. Divisions 21, 22, 23 and 26: Prime painting of shop-fabricated or factory built mechanical and electrical equipment or accessories.

1.3 DEFINITIONS

A. General: Standard coating terms defined in ASTM D 16 apply to this Section.

1. Flat is a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.
2. Eggshell is a low-sheen finish with a gloss range between 5 and 20 when measured at a 60-degree meter.
3. Satin is a low-sheen finish with a gloss range between 15 and 35 when measured at a 60-degree meter.
4. Semigloss is a medium-sheen finish with a gloss range between 30 and 65 when measured at a 60-degree meter.
5. Full gloss is a high-sheen finish with a gloss range more than 65 when measured at a 60-degree meter.

B. "Exposed" shall refer to items and surfaces not concealed by ceilings or chases or insulation covering or similar permanent sight barriers.

C. "Exposed surfaces" includes areas visible when permanent or built-in fixtures, 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.

1. This includes areas above the ceiling plane that are visible from standing or seated position.

D. "Finished Areas" shall refer to areas of building with tile or painted or otherwise finished walls, or with resilient tile or terrazzo or otherwise finished floor, or with painted plaster or painted drywall, or suspended acoustical or otherwise finished ceilings.

E. "Paint" includes coating systems materials, primers, emulsions, enamels, stains, sealers and fillers, and other applied materials whether used as prime, intermediate or finish coats.

1.4 SUBMITTALS

A. Product Data:
1. Material List:
   a. Provide an inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.

2. Manufacturer's Information:
   a. Provide manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material proposed for use.

B. LEED Submittals:
   1. Product Data for Credit EQ 4.2: For interior paints and coatings, including printed statement of VOC content.

C. Shop Drawings:
   1. None required.

D. Samples:
   1. Submit samples for verification purposes. Provide samples of each color and material to be applied, with texture to simulate actual conditions, on representative samples of the actual substrate.
   2. Provide stepped Samples, defining each separate coat, including block fillers and primers. Use representative colors when preparing samples for review. Resubmit until required sheen, color, and texture are achieved.
   3. Provide a list of material and application for each coat of each sample. Label each sample as to location and application.

E. Qualification Data:
   1. Submit Qualification Data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

F. Record Documents:
   1. As part of the requirements of Section "Closeout Procedures" for marking up the Project Manual to show actual materials used, provide paint manufacturer's paint color names and technical information for each paint used on the Project.
1.5 QUALITY ASSURANCE

A. Applicator Qualifications:
   1. Engage an experienced applicator who has completed painting system applications similar in material and extent to that indicated for this Project with a record of successful in-service performance.

B. Coordination of Work:
   1. Review other sections in which primers are to be provided to ensure compatibility of total system for various substrates. On request, furnish information or characteristics of finish materials to ensure use of compatible primers.
   2. Notify the Architect of problems anticipated using the materials specified.

C. Supervision:
   1. Provide at least one person who shall be present at all times during execution of the work of this Section, who shall be thoroughly familiar with the specified requirements and the materials and methods needed for their execution, and who shall direct all work performed under this Section.

D. Job Staffing and Workmen Qualifications:
   1. Provide adequate numbers of workmen skilled in the necessary crafts and properly informed of the methods and materials to be used. In acceptance or rejection of the work of this Section, the Architect will make no allowance for lack of skill on the part of workmen.

1.6 DELIVERY AND STORAGE

A. Deliver materials to job site in the manufacturer's original, new and unopened packages and containers bearing manufacturer's name and label, and following information:
   1. Product name or title of material.
   2. Product description (generic classification or binder type).
   3. Manufacturer's stock number and date of manufacturer.
   4. Contents by volume, for pigment and vehicle constituents.
   5. Thinning instructions.
   6. Application instructions.
   7. Color name and number.
   8. VOC content.
**Construction**

B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg. F (7 deg C). Maintain containers used in storage in a clean condition, free of foreign materials and residue.

1. Protect from freezing.
2. Keep storage area neat and orderly.
3. Remove oily rags and waste daily.
4. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing and application.

1.7 **PROJECT CONDITIONS**

A. Apply water-base paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 degrees F. (10 degrees C) and 90 degrees F. (32 degrees C), unless otherwise permitted by paint manufacturer's printed instructions.

B. Apply solvent-thinned paints only when the temperature of surfaces to be painted and surrounding air temperature are between 45 degrees F. (7 degrees C) and 95 degrees F. (35 degrees C), unless otherwise permitted by paint manufacturer's printed instructions.

C. Do not apply paint in snow, rain, fog or mist or when relative humidity exceeds 85 percent, at temperatures less than 5 degrees F (3 degrees C) above the dew point; or to damp or wet surfaces; unless otherwise permitted by paint manufacturer's printed instructions.

1. Painting may be continued during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by paint manufacturer during application and drying periods.

1.8 **EXTRA MATERIALS**

A. Furnish extra paint materials from the same production run as the materials applied in the quantities described below. Package paint materials in unopened, factory-sealed containers for storage and identify with labels describing contents. Deliver extra materials to the Owner.

1. Quantity:
   a. Furnish the Owner with an additional 5 percent, but not less than 1 gal. (3.785 L) or 1 case, as appropriate, of each material and color applied.

**PART 2 - PRODUCTS**

2.1 **MANUFACTURERS**

A. Subject to compliance with requirements, provide products of one of the following:

**PROJECT NO.: 2016-01118-000**
**WAYNE STATE UNIVERSITY**
**WSU PROJECT NO.: 211-277899**
**IBIO RADIO CHEMISTRY FACILITY**

**PAINTING**
**099100-6**
1. Even though many manufacturers are listed in each "Paint System" category, it is the intent of this specification that all paint materials be part of a single system supplied by one manufacturer.

2. In the list which follows, the word or phrase in parenthesis after each name is the designation by which the particular manufacturer will be referred to:
   b. Glidden Pro.
   c. PPG Industries, Inc. (PPG).
   d. The Sherwin-Williams Company (S-W).

2.2 PAINT MATERIALS, GENERAL

A. Material Compatibility:
   1. Provide block fillers, primers, undercoats, and finish-coat materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.

B. Material Quality:
   1. Provide manufacturer's best-quality paint material of the various coating types specified. Paint-material containers not displaying manufacturer's product identification will not be acceptable.

C. Trade Names:
   1. Where the trade name or other designation of a product of a named manufacturer has been changed by the manufacturer from that specified, submit a statement giving the specified identification and the new identification for the same product.

D. VOC Content of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24); these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:
   1. Flat Paints and Coatings: VOC content of not more than 50 g/L.
   2. Non-Flat Paints and Coatings: VOC content of not more than 150 g/L.
   3. Dry-Fog Coatings: 400 g/L.
   4. Primers, Sealers, and Undercoaters: 200 g/L.
   5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
   7. Pretreatment Wash Primers: 420 g/L.
   8. Floor Coatings: 100 g/L.

E. Colors:
1. Provide colors as indicated in “Finish Material List” on the Drawings, or, if not indicated, as selected by the Architect from the manufacturer’s full range.

PART 3 - EXECUTION

3.1 EXAMINATION

A. General:
1. Examine substrates, areas, and conditions, with the Applicator present, under which painting will be performed for compliance with paint application requirements.
2. Do not begin to apply paint until unsatisfactory conditions have been corrected and surfaces receiving paint are thoroughly dry.
3. Start of painting will be construed as the Applicator's acceptance of surfaces and conditions within a particular area.

B. Coordination of Work:
1. Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of finish materials to ensure use of compatible primers.
2. Notify the Architect about anticipated problems using the materials specified over substrates primed by others.

3.2 PREPARATION

A. General:
1. Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of the size or weight of the item, provide surface-applied protection before surface preparation and painting.
2. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

B. Cleaning:
1. Before applying paint or other surface treatments, clean the substrates of substances that could impair the bond of the various coatings. Remove oil and grease before cleaning.
2. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.

C. Surface Preparation:
1. Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.
2. Provide barrier coats over incompatible primers or remove and reprime.
3. Cementitious Materials:
   a. Prepare concrete masonry block surfaces to be painted.
      1) Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze. If hardeners or sealers have been used to improve curing, use mechanical methods of surface preparation.
      2) Level surface imperfections by grinding, stoning or scraping. Clean free of efflorescence, dirt and dust.
   b. Use abrasive blast-cleaning methods if recommended by the paint manufacturer.
   c. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause blistering and burning of finish paint, correct this condition before application. Do not paint over surfaces where moisture content exceeds that permitted in manufacturer's printed directions.
4. Gypsum Board Surfaces:
   a. Surfaces shall be dry and shall have all loose dirt and dust removed by brushing with a soft brush or rubbing with a dry cloth prior to application of the first coat material.
5. Ferrous Metals:
   a. Clean un-galvanized ferrous metal surfaces that have not been shop-coated; remove oil, grease, dirt, loose mill scale and other foreign substances. Use solvent or mechanical cleaning methods that comply with the Steel Structures Painting Council's (SSPC) recommendations.
   b. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with the same primer as the shop coat.
6. Galvanized Surfaces:
   a. Clean galvanized surfaces with non-petroleum based solvent so that the surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods.
D. Materials Preparation:
1. Mix and prepare painting materials according to manufacturer's written instructions.
2. Maintain containers used in mixing and application of paint in a clean condition, free of foreign materials and residue.
3. Stir materials before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material: remove surface film and strain material before using.

4. Use only thinners approved by the paint manufacturer and only within recommended limits.

3.3 APPLICATION

A. General:

1. Apply paint in accordance with manufacturer's directions. Use applicators and techniques best suited for substrate and type of material being applied.

2. Paint colors, surface treatments, and finishes are indicated in the "Finish and Color Schedules".

3. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.

4. Omit field prime painting on items that are factory prime painted, unless otherwise shown. Touch-up damaged factory prime painted finish acceptable to receive subsequent field finishing.

5. Provide finish coats that are compatible with primers used.

6. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, 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.

7. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.

8. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.

9. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.

10. Labeling of Rated and Non-Rated Walls: Wall rating designations shall be painted on fire-rated, smoke-tight and sound attenuating walls above the finished ceiling. Size and spacing shall be as indicated below. Coordinate with Architect.

   a. All partitions, that extend to the structure above, are to receive labeling 6” above the ceiling line or at 8’-6” above the floor where no ceilings are scheduled.

   b. Labeling is to occur at all rooms, corridors, etc., and in all accessible spaces, including elevator hoistways.

   c. At shafts, every wall shall be labeled at 8’-6” above each floor line.

   d. Labeling is to occur at a maximum of 15’-0” on center and not less than one location per run of wall, between corners and changes in direction and/or type.

   e. Where multiple construction types occur in a single run of wall such as the corridor side of a corridor wall, a 2” wide full height painted vertical line shall be provided to note changes in wall.
f. Labeling shall be in 2” high, stenciled characters in orange fluorescent paint. Manufactured labels are an acceptable alternative. The text for various type of construction shall be as listed below.

1) TWO-HOUR FIRE
2) ONE-HOUR FIRE
3) SMOKE BARRIER
4) SMOKE TIGHT – NON-RATED
5) SOUND – NON-RATED
6) NON-RATED
7) LEAD-LINED TO 7’-0” AFF (above finished floor).
8) LEAD-LINED TO DECK ABOVE

B. Scheduling Painting:

1. Surface preparation, priming and finish coats specified in this Section are in addition to surface preparation and shop priming specified in other sections, when such shop work for surface preparation is inadequate, when primer is incompatible with field finish, when touch-up is not provided, and for other similar conditions when surface finish is not acceptable to the painter.
2. Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
3. The number of coats and the film thickness required are the same regardless of application method. Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
4. Omit primer on metal surfaces that have been shop primed and touchup painted with primer compatible with Work of this Section.
5. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
6. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure, and where application of another coat of paint does not cause the undercoat to lift or lose adhesion.

C. Application Procedures:

1. Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.
2. Brushes:
   a. Use brushes best suited for the type of material applied. Use brush of appropriate size for the surface or item being painted.
3. Rollers:
   a. Use rollers of carpet, velvet back, or high-pile sheep's wool as recommended by
      the manufacturer for the material and texture required.

4. Spray Equipment:
   a. Use airless spray equipment with orifice size as recommended by the manufacturer
      for the material and texture required.
   b. Where the metallic finish occurs, products must be sprayed using HVLP or
      conventional equipment.

D. Minimum Coating Thickness:
   1. Apply paint materials no thinner than manufacturer's recommended spreading rate.
      Provide the total dry film thickness of the entire system as recommended by the
      manufacturer.

E. Mechanical and Electrical Work:
   1. General:
      a. Painting of mechanical and electrical work is limited to those items exposed in
         mechanical equipment rooms and in finished spaces.
   2. Mechanical items to be painted include, but are not limited to, the following:
      a. Units as designated on the drawings.
      b. Piping, pipe hangers, and supports.
      c. Heat exchangers.
      d. Tanks.
      e. Ductwork.
      f. Insulation.
      g. Supports.
      h. Motors and mechanical equipment.
      i. Accessory items.
      j. Grilles, diffusers, convector covers, fin tube covers, unit ventilators, and similar
         items.
   3. Electrical items to be painted include, but are not limited to, the following:
      a. Conduit and fittings.
      b. Lighting and power panels.

F. Block Fillers:
1. Apply block fillers to concrete and concrete masonry units at a rate to ensure complete coverage with pores filled. Do not apply block filler to decorative concrete masonry units.

G. Prime Coats:

1. 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 prime coated by others.

2. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to assure a finish coat with no burn through or other defects due to insufficient sealing.
H. Pigmented (Opaque) Finishes:

1. Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness or other surface imperfections will not be acceptable.

I. Completed Work:

1. Match approved samples for color, sheen and coverage. Remove, refinish or repaint work not complying with requirements.

3.4 FIELD QUALITY CONTROL

A. The Owner reserves the right to invoke the following test procedures at any time, and as often as the Owner deems necessary during period when paint is being applied.

B. The Owner may engage the services of an independent testing laboratory to sample the paint material being used. Samples of materials delivered to Project will be taken, identified, sealed, and certified in presence of Contractor.

C. Testing laboratory may perform appropriate tests for any or all of following characteristics:

1. Quantitive materials analysis.
2. Abrasion resistance.
3. Apparent reflectivity.
4. Flexibility.
5. Washability.
6. Absorption.
7. Accelerated weathering.
8. Dry opacity.
10. Recoating.
11. Skinning.
12. Color retention.
13. Alkali resistance.

D. The Owner may direct the Contractor to stop painting if test results show material being used does not comply with specified requirements. The Contractor shall remove noncomplying paint from the site, pay for testing, and repaint surfaces previously coated with the rejected paint. If necessary, the Contractor may be required to remove rejected paint from previously painted surfaces if, on repainting with specified paint, the 2 coatings are incompatible.
3.5 INSTALLATION OF WARNING SIGNS

A. Locate warning signs every twenty feet horizontally within the ceiling space on each side of smoke barriers, horizontal exit enclosures and fire rated partitions. Apply signs by peel and stick methods, level and fully adhered to wall surfaces.

3.6 CLEANING

A. At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the site.

B. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping, using care not to scratch or otherwise damage finished surfaces.

3.7 PROTECTION

A. Protect work of other trades, whether being painted or not, against damage by painting. Correct damage by cleaning, repairing or replacing, and repainting as acceptable by the Architect.

B. Provide "Wet Paint" signs to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.

1. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces. Comply with procedures specified in PDCA P1.

3.8 INTERIOR PAINT SYSTEMS

A. General: Provide the following paint systems for the various substrates, as indicated.

B. Concrete and Masonry: (Other than concrete masonry units).

1. Low-Luster, Acrylic-Enamel Finish: 2 finish coats over a primer.

   a. Primer: Alkali-resistant, acrylic-latex, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.0 mil (0.025 mm).

      Glidden Pro:       High Hide Interior Primer Sealer 1000-1200.
      Moore:            253-00 Super Spec Latex Enamel Undercoater Primer
                        Sealer.
      PPG:              4-603 Series Perma-Crete Interior/Exterior Acrylic
                        Latex Alkali Resistant Primer.
      S-W:              PrepRite Masonry Primer B28W300.
b. First and Second Coats: Low-luster (eggshell or satin), acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.8 mils (0.071 mm).

Moore: 274 Super Spec Latex Eggshell.
PPG: 6-411 Series Speedhide Eggshell Latex Wall and Trim Enamel.
S-W: ProGreen 200 Interior Latex Eg-Shel B20-600 Series.

2. Semigloss, Acrylic-Enamel Finish: 2 finish coats over a primer.

a. Primer: Alkali-resistant, acrylic-latex, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.0 mil (0.025 mm).

Glidden Pro: High Hide Interior Primer Sealer 1000-1200.
Moore: 253-00 Super Spec Latex Enamel Undercoater Primer Sealer.
PPG: 4-603 Series Perma-Crete Interior/Exterior Acrylic Latex Alkali Resistant Primer on Highly Alkaline Surfaces.
S-W: PrepRite Masonry Primer B28W300.

b. First and Second Coats: Semigloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.6 mils (0.066 mm).


C. Concrete Masonry Units:

1. Low-Luster, Acrylic-Enamel Finish: 2 finish coats over a block filler.

a. Block Filler: High-performance, latex-based, block filler applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 5.0 mils (0.13 mm).
b. First and Second Coats: Low-luster (eggshell or satin), acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.8 mils (0.071 mm).

Moore: 274 Super Spec Latex Eggshell.
PPG: 6-411 Series Speedhide Eggshell Latex Wall and Trim Enamel.
S-W: ProGreen 200 Interior Latex Eg-Shel B20-600 Series

2. Semigloss, Acrylic-Enamel Finish: 2 finish coats over a block filler.

a. Block Filler: High-performance, latex-based, block filler applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 5.0 mils (0.13 mm).

Glidden Pro: Concrete Coatings Block Filler Interior/Exterior Primer 3010-1200.
Moore: 160 Super Spec Latex Block Filler.
PPG: 6-7 Speedhide Interior/Exterior Masonry Latex Block Filler.
S-W: Heavy Duty Block Filler B42W46.

b. First and Second Coats: Semigloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.6 mils (0.066 mm).

S-W: ProGreen 200 Interior Latex Semi-Gloss B31-600 Series
D. Gypsum Drywall Systems:

1. Low-Luster, Acrylic-Enamel Finish: 2 finish coats over a primer.
   
a. Primer: Latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils (0.031 mm).
   
   Glidden Pro: High Hide Interior Primer Sealer 1000-1200.
   Moore: 253-00 Super Spec Latex Enamel Undercoater Primer Sealer.
   PPG: 6-2 Series Speedhide Interior Latex Primer-Sealer.
   S-W: ProGreen 200 Interior Latex Primer B28W600

b. First and Second Coats: Low-luster (eggshell or satin), acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.8 mils (0.071 mm).
   
   Moore: 274 Super Spec Latex Eggshell.
   PPG: 6-411 Series Speedhide Eggshell Latex Wall and Trim Enamel.
   S-W: ProGreen 200 Interior Latex Eg-Shel B20-600 Series

2. Semigloss, Acrylic-Enamel Finish: 2 finish coats over a primer.
   
a. Primer: Latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils (0.031 mm).
   
   Glidden Pro: High Hide Interior Primer Sealer 1000-1200.
   Moore: 253-00 Super Spec Latex Enamel Undercoater Primer Sealer.
   PPG: 6-2 Series Speedhide Interior Latex Primer-Sealer.
   S-W: ProGreen 200 Interior Latex Primer B28W600
b. First and Second Coats: Semigloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.6 mils (0.066 mm).

S-W: ProGreen 200 Interior Latex Semi-Gloss B31-600 Series

3. Full-Gloss, Acrylic-Enamel Finish: 2 finish coats over a primer.

a. Primer: Latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils (0.031 mm).

Glidden Pro: High Hide Interior Primer Sealer 1000-1200.
Moore: 253-00 Super Spec Latex Enamel Undercoater Primer Sealer.
PPG: 6-2 Series Speedhide Interior Latex Primer-Sealer.
S-W: ProGreen 200 Interior Latex Primer B28W600

b. First and Second Coats: Full-gloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.5 mils (0.064 mm).

Glidden Pro: Ultra-Hide 250 Interior/Exterior Acrylic Gloss 3028-XXXXN.
PPG: 6-8534 Series Speedhide Interior 100% Acrylic Latex Gloss Enamel.
S-W: ProMar 200 Interior Latex Gloss B21W200

E. Ferrous Metal:

1. Low-Luster, Acrylic-Enamel Finish: 2 finish coats over a primer.

a. Primer: Quick-drying, rust-inhibitive, alkyd-based or epoxy-metal primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.5 mils (0.038 mm).
Glidden Pro: Devoe Coatings Devguard 4360 Loxw VOC Universal Metal Primer 4360-XXXX.
Moore: P06 Super Spec HP Alkyd Metal Primer.
PPG: 6-208 Speedhide Interior/Exterior Rust Inhibitive Steel Primer.
S-W: Pro-Cryl Universal Primer B66-310 Series.

b. First and Second Coats: Low-luster (eggshell or satin), acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.8 mils (0.071 mm).

Moore: 274 Super Spec Latex Eggshell.
PPG: 6-411 Series Speedhide Eggshell Latex Wall and Trim Paint.
S-W: ProGreen 200 Interior Latex Egg-Shel B20-600 Series

2. Semigloss, Acrylic-Enamel Finish: Two finish coats over a primer.

a. Primer: Quick-drying, rust-inhibitive, alkyd-based or epoxy-metal primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.5 mils (0.038 mm).

Glidden Pro: Devoe Coatings Devguard 4360 Loxw VOC Universal Metal Primer 4360-XXXX.
Moore: P064 Super Spec HP Acrylic Metal Primer.
PPG: 6-208 Speedhide Interior/Exterior Rust Inhibitive Steel Primer.
S-W: Pro-Cryl Universal Primer B66-310 Series.

b. First and Second Coats: Semigloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.3 mils (0.033 mm).

S-W: ProClassic Waterborne Acrylic Semi-Gloss B31 Series

3. Full-Gloss, Acrylic-Enamel Finish: 2 finish coats over a primer.
a. **Primer:** Quick-drying, rust-inhibitive, alkyd-based or epoxy-metal primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.5 mils (0.038 mm).

- **Glidden Pro:** Devoe Coatings Devguard 4360 Loxw VOC Universal Metal Primer 4360-XXXX.
- **Moore:** P064 Super Spec HP Acrylic Metal Primer.
- **PPG:** 6-208 Speedhide Interior/Exterior Rust Inhibitive Steel Primer.
- **S-W:** Pro-Cryl Universal Primer B66-310 Series.

b. **First and Second Coats:** Full-gloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.5 mils (0.064 mm).

- **Glidden Pro:** Ultra-Hide 250 Interior/Exterior Acrylic Gloss 3028-XXXXN.
- **Moore:** P28 Super Spec HP DTM Acrylic Gloss Enamel.
- **PPG:** 6-8534 Series Speedhide Interior 100% Acrylic Latex Gloss.
- **S-W:** ProMar 200 Interior Latex Gloss B21W200

F. **Zinc-Coated Metal:** Provide the following finish systems over zinc-coated metal:

1. **Low-Luster, Acrylic-Enamel Finish:** 2 finish coats over a primer.

   a. **Primer:** Galvanized metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils (0.031 mm).

   - **Glidden Pro:** Devoe Coatings Devflex 4020PF Direct to Metal Primer & Flat Finish 4020-XXXX.
   - **Moore:** P04 Super Spec HP Acrylic Metal Primer.
   - **PPG:** 90-709 Pitt-Tech One Pack Interior/Exterior Primer/Finish DTM Industrial Enamel.
   - **S-W:** DTM Primer/Finish B66W1.
b. First and Second Coats: Low-luster (eggshell or satin), acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.8 mils (0.071 mm).

Moore: 274 Super Spec Latex Eggshell.
PPG: 89 Line Manor Hall Eggshell Latex Wall and Trim Enamel.

2. Semigloss, Acrylic-Enamel Finish: 2 finish coats over a primer.

a. Primer: Galvanized metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils (0.031 mm).

Glidden Pro: Devoe Coatings Devflex 4020PF Direct to Metal Primer & Flat Finish 4020-XXXX.
Moore: P04 Super Spec HP Acrylic Metal Primer.
S-W: Pro-Cryl Universal Primer B66-310 Series.

b. First and Second Coats: Semigloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.6 mils (0.066 mm).


   a. Primer: Galvanized metal primer applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 1.2 mils (0.031 mm).

      Glidden Pro:    Devoe Coatings Devflex 4020PF Direct to Metal Primer & Flat Finish 4020-XXXX.
      Moore:         P04 Super Spec HP Acrylic Metal Primer.
      S-W:           Pro-Cryl Universal Primer B66-310 Series.

   b. First and Second Coats: Full-gloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than 2.5 mils (0.064 mm).

      Glidden Pro:    Ultra-Hide 250 Interior/Exterior Acrylic Gloss 3028-XXXXN.
      PPG:            6-8534 Series Speedhide Interior 100% Acrylic Latex Gloss Enamel.
      S-W:            ProMar 200 Interior Latex Gloss B21W200
SECTION 099600 - HIGH-PERFORMANCE COATINGS

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 surface preparation and application of high-performance coating systems on the following substrates:

1. Interior Substrates:
   a. Gypsum board.

B. Related Requirements:

1. Division 8 Section "Steel Doors and Frames" for shop priming of steel doors and frames.
2. Division 9 Section "Painting" for general field painting.

1.3 DEFINITIONS

A. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

B. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include preparation requirements and application instructions.

B. LEED Submittals:

1. Product Data for Credit EQ 4.2: For interior coatings, documentation including printed statement of VOC content.

C. Samples for Initial Selection: For each type of topcoat product indicated.

D. Samples for Verification: For each type of coating system and in each color and gloss of topcoat indicated.
1. Submit Samples on rigid backing, 8 inches (200 mm) 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.

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.
2. VOC content.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to the requirements, provide one of the following products:

1. Sherwin Williams Pro Industrial Waterborne Catalyzed Epoxy – Zero VOC with gloss level as indicated in the “Finish Material List”.
3. PPG Architectural Finishes, Inc.; Aquapon WB Polyamide Epoxy with gloss level as indicated in the “Finish Material List”.
4. Glidden Pro: Comparable product to the above listed.

2.2 HIGH-PERFORMANCE COATINGS, GENERAL

A. Material Compatibility:
1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

2. For each coat in a coating system, provide products recommended in writing by manufacturers of topcoat for use in coating system and on substrate indicated.

3. Provide products of same manufacturer for each coat in a coating system.

B. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior coatings applied at project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Primers, Sealers, and Undercoaters: 200 g/L.

C. Colors: As indicated in “Finish Material List” on the Drawings.

2.3 INTERIOR PRIMERS/SEALERS

A. Primer Sealer, Latex, Interior:

1. As recommended by epoxy finish coat manufacturer.

2.4 METAL PRIMERS

A. Primer, Rust-Inhibitive, Water Based:

1. As recommended by epoxy coating manufacturer.

2.5 EPOXY COATING SHEEN

A. Epoxy, Gloss or Semi-Gloss: Sheen as indicated on “Finish Materials List” or if not indicated, as selected by Architect.

2.6 SOURCE QUALITY CONTROL

A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure:

1. Owner may engage the services of a qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.

2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

   a. Gypsum Board, Concrete and Masonry (CMU): 12 percent.

B. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Proceed with coating application only after unsatisfactory conditions have been corrected.

   1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions applicable to substrates indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

   1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

   1. Remove incompatible primers and re-prime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.
D. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer.

E. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

3.3 APPLICATION

A. Apply high-performance coatings according to manufacturer's written instructions.
   1. Use applicators and techniques suited for coating and substrate indicated.
   2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
   3. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
   4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.

D. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.
   1. Contractor shall touch up and restore coated surfaces damaged by testing.
   2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written recommendations.
3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.6 INTERIOR HIGH-PERFORMANCE COATING SCHEDULE

A. Metal Substrates:
   1. Epoxy System:
      a. Prime Coat: Primer, anti-corrosive, for metal as recommended by epoxy coating manufacturer.
      c. Topcoat: Epoxy.

B. Gypsum Board Substrates:
   1. Epoxy System:
      a. Prime Coat: Primer sealer, latex, interior as recommended by epoxy finish coat manufacturer.
      c. Topcoat: Epoxy.

END OF SECTION 099600
DWH/BRP
SECTION 102800 - TOILET AND BATH ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division -1 Specification Sections, apply to this Section.

B. Requirements of this Section apply to work specified in Sections "Toilet and Bath Accessories, Legend/Representative Products", Appendix A.

1.2 SUMMARY

A. Extent of each type of toilet and bath accessory is shown on Drawings.

B. Refer to Sections "Toilet and Bath Accessories, Legend/Representative Products", Appendix A for specific items to be provided.

C. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 9 Section "Gypsum Board Assemblies" for sheet metal backing in walls for anchoring.

1.3 SUBMITTALS

A. General:

1. Submit each item in this Article according to the Conditions of the Contract and Division I Specification Sections.

B. Product Data:

1. For each type of product indicated. Include the following:

   a. Construction details and dimensions.
   b. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
   c. Material and finish descriptions.
   d. Features that will be included for Project.
   e. Manufacturer's warranty.
   f. Electrical requirements.
Construction

C. Shop Drawings:
   1. None required.

D. Samples:
   1. Provide samples of units when requested by the Architect. Acceptable samples will be returned and may be used in the work.

E. Setting Drawings:
   1. Provide setting drawings, templates, instructions, and directions for installation of anchorage devices and cut-out requirements in other work.

F. Product Schedule:
   1. Submit Product Schedule indicating types, quantities, sizes, and installation locations by room of each accessory required. Use designations indicated in the Toilet and Bath Accessory Schedule and room designations indicated on Drawings in product schedule.

G. Maintenance Data:
   1. Submit Maintenance Data for accessories to include in maintenance manuals specified in Division 1. Provide lists of replacement parts and service recommendations.

1.4 QUALITY ASSURANCE

A. Source Limitations:
   1. Provide products of same manufacturer for each type of accessory unit and for units exposed to view in same areas, unless specified otherwise or acceptable to the Architect.

B. Inserts and Anchorages:
   1. Furnish inserts and anchoring devices to Contractor which must be set in concrete or built into masonry; coordinate delivery with other work to avoid delay.

C. Product Options:
   1. Accessory requirements, including those for materials, finishes, dimensions, capacities, and performance, and model numbers are established by specific products indicated in Section "Toilet and Bath Accessories Legend/Representative Products", Appendix A.
   2. Products of the other listed acceptable manufacturers in Part 2 may be acceptable, if, in the judgement of the Architect, they meet the intent of the Specification in terms of design, function, materials, and quality of workmanship.
a. Do not modify aesthetic effects, as judged solely by Architect, except with Architect's approval. Where modifications are proposed, submit comprehensive explanatory data to Architect for review.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.5 COORDINATION

A. Coordinate accessory locations with other work, sequencing of operations to prevent interference with clearances required for access by disabled persons, proper installation, adjustment, operation, cleaning, and servicing of accessory units.

B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. General:

1. Deliver items in manufacturer's original unopened protective package.
2. Store materials in original protective packaging to prevent soiling, physical damage, or wetting. Handle so as to prevent damage to finished surfaces.

B. Protection:

1. Maintain protective covers on all units until installation is complete. Remove protective covers at final clean-up of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide accessories by one of the manufacturers listed for specific products in Appendix A.

2.2 MATERIALS, GENERAL

A. Stainless Steel:

1. ASTM A 666, Type 304, with No. 4 finish (satin), in 0.0312-inch (0.8-mm) minimum nominal thickness, unless otherwise indicated.
B. Brass:
   1. ASTM B 19, leaded and unleaded flat products; ASTM B 16 (ASTM B 16M), rods, shapes, forgings, and flat products with finished edges; ASTM B 30, castings.

C. Sheet Steel:
   1. ASTM A 366/A 366M, cold rolled, commercial quality, 0.0359-inch (0.9-mm) minimum nominal thickness; surface preparation and metal pretreatment as required for applied finish.

D. Galvanized Steel Sheet:
   1. ASTM A 653/A 653M, G60 (Z180).

E. Chromium Plating:
   1. ASTM B 456, Service Condition Number SC 2 (moderate service), nickel plus chromium electrodeposited on base metal.

F. Baked Enamel Finish:
   1. Factory-applied, gloss white, baked acrylic enamel coating.

G. Galvanized Steel Mounting Devices:

H. Fasteners:
   1. Screws, bolts, and other devices of same material as accessory unit, tamper and theft resistant when exposed, and of galvanized steel where concealed.

I. Keys:
   1. Provide universal keys for internal access to accessories for servicing and resupplying.
      a. Provide minimum of six (6) keys to Owner's Representative.

2.3 FABRICATION

A. General:
   1. Accessories shall be fabricated in accordance with good commercial practice, with welds ground smooth. Bending, flanging, drawing, forming, and similar operations shall be performed in a manner to insure that there are no ruptures, cracks, wrinkles, sharp exposed edges or other defects. Flanges of recessed accessories shall be designed to
return to walls to provide a continuous, tight-against-the-wall installation. Doors shall be warp free and shall have double pan construction.

2. Names or labels are not permitted on exposed faces of accessories. On interior surface not exposed to view or on back surface, provide printed, waterproof label or stamped nameplate indicating manufacturer's name and product model number.

B. Surface-Mounted Accessories, General:

1. Unless otherwise indicated, fabricate units with tight seams and joints, exposed edges rolled. Hang doors or access panels with continuous stainless steel hinge. Provide concealed anchorage where possible.

C. Recessed Accessories, General:

1. Unless otherwise indicated, fabricate units of all welded construction, without mitered corners. Hang doors or access panels with full-length stainless steel hinge. Provide anchorage that is fully concealed when unit is closed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer.

1. Install units level, plumb, and firmly anchored in locations and at heights indicated.
2. Install grab bars to withstand a downward load of at least 250 lbf (1112 N), when tested according to method in ASTM F 446.

B. Fasteners shall be concealed, except as otherwise permitted, and be secured to back plates or framing members in accordance with manufacturer's design and instructions and Codes or requirements of agencies having jurisdiction.

1. Where fasteners are exposed, fasteners shall be tamper-proof and provided with finish to match units secured.

C. Brackets, plates, anchoring devices and similar items used for mounting accessories in showers and bathtub areas shall be bedded in mildew resistant silicone, to provide a watertight installation.

1. Sealant shall comply with applicable requirements of Section "Joint Sealants".
3.2 ADJUSTING AND CLEANING

A. Adjust accessories for unencumbered, smooth operation and verify that mechanisms function properly.

1. Replace damaged or defective items.

B. Remove temporary labels and protective coatings.

C. Clean and polish all exposed surfaces in strict accordance with the accessory manufacturer's recommendations.

END OF SECTION
DWH/BRP
## SECTION 102800-A - TOILET AND BATH ACCESSORIES - LEGEND/REPRESENTATIVE PRODUCTS APPENDIX A

<table>
<thead>
<tr>
<th>Legend Number</th>
<th>Product Description</th>
<th>Manufacturer</th>
<th>Model Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Hook Strip</td>
<td>Bobrick</td>
<td>B-985</td>
</tr>
<tr>
<td>25</td>
<td>Soap Dispenser</td>
<td>Dial Complete</td>
<td>Foam Dispenser 1 Litre Smoke Part # CM-K-00396</td>
</tr>
</tbody>
</table>

END OF APPENDIX
DWH/BRP
SECTION 104416 - FIRE EXTINGUISHERS

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 portable, hand-carried fire extinguishers.

1.3 PREINSTALLATION MEETINGS
   A. Preinstallation Conference: Conduct conference at Project site.
      1. Review methods and procedures related to fire extinguishers including, but not limited to, the following:
         a. Schedules and coordination requirements.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher.
   B. Product Schedule: For fire extinguishers. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function.

1.5 INFORMATIONAL SUBMITTALS
   A. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.7 COORDINATION
A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Failure of hydrostatic test according to NFPA 10.
   b. Faulty operation of valves or release levers.

2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each type indicated with manufacturers standard wall mount bracket.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Larsens Manufacturing Company; MP10 or comparable product by one of the following:
   a. JL Industries, Inc.; a division of the Activar Construction Products Group.
   b. Nystrom Building Products.
   c. Potter Roemer LLC.

2. Valves: Manufacturer's standard.
3. Handles and Levers: Manufacturer's standard.
4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.
B. Multipurpose Dry-Chemical Type: UL-rated 4A:80B:C, 10 lb. nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

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

3.2 INSTALLATION

A. General: Install fire extinguishers in locations indicated and in compliance with requirements of authorities having jurisdiction.

END OF SECTION 104416
DWH/BRP
SECTION 110001 - MISCELLANEOUS EQUIPMENT

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.
   B. Keynote Matrix on drawings A5-81.
   C. Refer to the Drawings for equipment locations and mounting heights.

1.2 SUMMARY
   A. Work includes providing the following:
      1. PTD-01  Paper Towel Dispenser
      2. GCX-0X3  Accessory Mounting Solutions

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

1.4 COORDINATION
   A. Coordinate installation with mechanical, plumbing, electrical and other trades.

1.5 WARRANTY
   A. Provide manufacturers standard warranty for each item to ensure they are free from defective materials, poor performance, and workmanship.

PART 2 - MATERIALS

2.1 PAPER TOWEL DISPENSER (PTD-01)
   A. MANUFACTURERS: San Jamar.
   B. Basis of Design: San Jamar, Model T1900SS.
C. Requirements: Stainless steel with C-fold/Multi-fold.

2.2 ACCESSORY MOUNTING SOLUTION (GCX-0X)

A. MANUFACTURERS: GCX.

B. Basis of Design: As indicated in Keynote Matrix on Drawing A5-81.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install all equipment according to Shop Drawings and manufacturer’s written instructions. Install plumb, level, and aligned.

B. Comply with requirements of Divisions 11, 22, 23, and 26 Section for all factory installation of fittings, piping, electrical devices, and wiring. Install according to Shop Drawings and manufacturer’s written instructions.

C. Provide all services with appropriate disconnects and shut-offs at equipment site, for proper equipment function. Contractor shall receive, inspect, store, protect, uncrate, mount and complete final connections of services to equipment.

3.2 DEMONSTRATION

A. General: Install all equipment according to Shop Drawings and manufacturer’s written instructions. Install plumb, level, and aligned. Manufacturer’s field representatives and authorized service agencies shall provide initial startup of equipment and demonstration to operating and maintenance personnel.

END OF SECTION
MH/BRP
SECTION 116210 - LABORATORY SERVICE FIXTURES AND SAFETY EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
   A. Fixtures and Equipment codes scheduled Keynote Schedule on Sheet A5-87.

1.2 SUMMARY
   A. This Section includes the following:
      1. Laboratory service fixtures. (PRU-xx).
      2. Laboratory safety equipment. (EW-01).
   B. Extent and types of laboratory service fixtures and safety equipment as indicated on drawings.
   C. Provide service fixtures and safety equipment as specified herein and as indicated on drawings.
   D. Related Sections include the following:
      1. Division 11, Section "Laboratory Accessories"
      2. Division 12, Section " Laboratory Casework"
      3. Division 26, Section “Wiring Devices”.

1.3 PERFORMANCE REQUIREMENTS
   A. Chemical Resistance: All coating materials shall meet the following tests for chemical resistance:
      1. Fume Test: Suspend coated samples in a container at least 6 cubic foot capacity, approximately 12" above open beakers, each containing 100 cc of 70% nitric acid, 94% sulfuric acid and 35% hydrochloric acid, respectively. After exposure to these fumes for 150 hours, the finish on the samples shall show no discoloration, disintegration or other defects.
      2. Direct Application Test: Subject coated samples to the direct action of the reagents and solvents listed below at a temperature of 25 degrees C dropping from a burette at the rate of 60 drops per minutes for ten minutes. Finish on the samples shall not rupture, through slight discoloration or temporary softening is permissible.
3. Mar and Abrasion Resistance: Coating material shall have a pencil hardness of 2H-4H with adhesion substantial enough to withstand both direct and reverse impacts of 160 inch pounds. Coating shall have excellent mar resistance and be capable of withstanding scuffing, marring and other ordinary wear.

4. Coating Repairability: Coating material shall be capable of surface repair in the event that a fixture is scratched or a surface rupture occurs. The service fixture manufacturer shall have available an air-drying aerosol coating, specially formulated to match the existing epoxy coating color, which may be applied in the field to repair coated surfaces.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's data and installation instructions for each type of service fixture.
1. Include independent laboratory certification that applied finish complex with specified chemical and physical resistance requirements.

2. Submit samples of mechanical and electrical service fixtures when requested by Architect, complete with fittings and accessories with specified finish.

B. Service Color Code: Submit samples of index disc with letter code in colors used to identify lab gas, water and air services listed.

1.5 EXTRA MATERIALS

A. Provide to Owner a complete touch-up kit for surface repair of service fixtures. Provide an air drying aerosol or liquid coating specially formulated to match the coating color which can be applied in the field to repair coated surfaces.

1.6 QUALITY ASSURANCE

A. Single Source Responsibility: All laboratory service fixtures and safety equipment, including those provided as an integral part of other laboratory equipment such as fume hoods, shall be the product of one service fixture manufacturer, unless specified otherwise.

B. All fixtures shall be in accordance with IBC, IMC, IPC, NFPA, OSHA, the State of Illinois Plumbing Code, for the intended use.

C. All fixtures for water service shall meet the requirements of ANSI/ASME A112.18.1M-1989 and be certified by the Canadian Standards Association (CSA) under Standard CAN/CSA B.125.M89.

D. All emergency eye wash and shower equipment shall be certified to comply with ANSI Z358.1-2009.

E. Vacuum breakers shall be certified by the American Society of Sanitary Engineers (ASSE) under Standard 1001.

F. Natural gas service, ball valves shall be certified by the American Gas Association (AGA) and the Canadian Gas Association (CGA) to ½ PSI working pressure.

G. The entire installation shall be in accordance with the governing rules and regulations of the National Electric Code, and all local governing boards having jurisdiction and shall meet all the standards and requirements of the Owner.
PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. All mechanical laboratory service fixtures shall be the product of one of the following, except for EW-01:

1. Water Saver Faucet Co.
2. Chicago Faucet
3. Broen Boss

B. Vendor for combination emergency eye wash and faucet (EW-01) shall be Speakman.

2.2 FABRICATION; GENERAL

A. All laboratory service fixtures shall have the construction and shall meet the performance requirements set forth in this specification. Fixture types shall be as indicated in the fixture schedule and fixture details on the drawings.

B. Service Fixtures: Provide fixtures complete with washers, locknuts, unions, nipples and other accessories for positive mounting to supporting laboratory units. Include wall and deck turrets and flanges, escutcheons, and similar items required. Factory assembly all fixtures and individually factory test each fixture.

C. Material and Finish: Fabricate service fixtures from cast brass containing a minimum of 85% copper or forged brass containing a minimum of 60% copper.

1. Finish service fixtures and safety equipment as follows:
   a. Exposed surfaces shall be satin chrome plated with a clear epoxy coating.
2. For fittings inside fume hoods, exposed surfaces shall be epoxy powder coated in color to match the fixture service index color.

D. Handles: Except as otherwise noted, provide forged brass four-arm style handles on all fixtures. Handles shall have a screw-on index disc which is color-coded to match the fixture service index color.

1. Benchtop service fixtures at accessible locations shall be fitted with 4-inch (101.6 mm) wrist blade handles, color coded.
2. Benchtop water faucets shall be fitted with 4-inch (101.6 mm) wrist blades.

E. Water Faucets and Valves:

1. All faucets and valves for water service shall have a renewable unit containing all working components subject to wear, including a stainless steel replaceable seat and an
integral adjustable volume control. The renewable unit shall be interchangeable among all faucets and valves for water service. The renewable unit shall be broached for position locking in the valve body. The unit shall have a high durometer thermoplastic valve disc and a molded TFE stem packing. The unit shall be capable of being readily converted from compression to self-closing, and vice versa, without disturbing the faucet body.

a. Water faucets and valves shall be fully assembled and individually factory tested at 80 PSI water pressure.

b. Pre-rinse Unit: Deck-mounted for hot and cold water, self-contained compression valve units with replaceable stainless steel seats and integral check valves; self-closing squeeze valve and rubber-bound head and 39-inch (99 cm) stainless steel hose; forged brass ON-OFF handles.

2. Goosenecks shall have a separate outlet coupling with a 3/8" IPS female thread securely brazed to the gooseneck for attachment of serrated hose ends, aspirators and other outlet fittings. Rigid goosenecks shall have a 3/8" IPS male inlet thread and be threaded directly into the faucet body so as to be absolutely rigid. Swing goosenecks shall utilize a TFE packing with an externally adjustable packing nut.

a. Gooseneck faucets at cupsinks shall have a rigid gooseneck.

b. Hot and cold water gooseneck faucets at lab sinks shall have a swivel gooseneck unless noted otherwise on drawings.

3. Vacuum breakers, where required and indicated by the fixture number, shall be integral with the gooseneck. Vacuum breakers shall have a forged brass body, a renewable seat and an ultralight float cup with a silicone gasket for fine flow control. Vacuum breakers shall not spill over at low water volume.

4. Purified Water Faucets and Valves:

a. Faucets and valves for distilled, deionized and pure water service shall be fabricated with a brass exterior and an interior lining. The interior lining and all components in contact with pure water shall be:

  1) Inert Schedule 80 polypropylene.
  2) Valves shall be self-closing type (as indicated by the fixture number), and shall have a round molded nylon handle, screw-on index disc and a removable serrated hose end. Valves shall have a brass valve body, brass bonnet and brass stem with a floating tip.

F. Laboratory Ball Valves:

G. Laboratory ball valves shall have a forged brass valve body, a removable straight ten serration hose end and a forged brass lever-type handle with a full view color-coded index disc. Valves shall have a chrome plated ball and molded TFE seals with self-closing retainers.
H. Ball valves shall be individually tested at 125 PSI air pressure under water. The maximum working pressure for ball valves shall be 75 PSI air pressure. Where used for gas service, valves are AGA-and CGA-certified to ½ PSI.

I. Laboratory ball valves shall visually indicate the position of the valve.

J. Service Outlet Identification. Provide a colored plastic index disc with embossed identification letters at each service fixture handle. Color code index discs as follows:

<table>
<thead>
<tr>
<th>Service</th>
<th>Index</th>
<th>Letter</th>
<th>Color</th>
<th>Color</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
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<td>Cold Water</td>
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K. Combination Emergency Shower and Eyewash (ES-01):

1. Recessed in wall emergency shower and eyewash units shall have the following:
   a. Suspended 10-inch (254 mm) diameter stainless steel shower head with ceiling trim flange.
   b. Pull down s/s tray activates eyewash.
   c. Stainless steel activating arm.
   d. 1-inch (25.4 mm) IPS brass stay open ball valve.
   e. 30 GPM flow and 20-inch (508 mm) spray pattern at 60-inch (152.4 mm) above floor.
   f. Provide stainless steel piping for exposed piping.

L. Emergency Eyewash (EW-01).

1. Deck mounted unit at back of sink activates as unit is pulled down horizontal.

2.3 ELECTRICAL SERVICE FITTINGS

A. Service Fittings, General: Provide UL-labeled units complying with Division 26 Sections, complete with metal housings, receptacles, terminals, switches, pilot lights, device plates, and accessories and gaskets required for mounting on casework.
1. Cover Plates: Provide stainless steel Type 302 cover plates with formed and beveled edges for outlets and devices.

2. Finishes for Service Fixture Components: Finish fixtures and face plates as follows:
   a. Exposed surfaces of electrical boxes:
      1) Satin (brushed) aluminum finish.
      2) Face plates shall be satin (brushed) finish stainless steel.

3. Receptacles: 20 Ampere Grounding Type Duplex Receptacles for 120 Volt, Single Phase Service: Straight blade, 2 pole, 3 wire, NEMA configuration 5-20R, rated 20 amperes, 125 volts, NEMA performance standard grade, for back and side wiring, color to match electrical devices in room.
   a. Arrow-Hart 5352
   b. Bryant 5352
   c. Hubbell 5352
   d. General Electric 5352

4. Ground Fault Interrupter Duplex Receptacle: 2 pole, 3 wire, grounding type, rated 20 ampere, 125 volt, NEMA configuration 5-20R, 5362 Series, color to match electrical devices in room.
   a. Arrow Hart
   b. Bryant
   c. Hubbell
   d. General Electric

B. Lighting Switches:

1. Switches for Controlling Lighting Directly on AC Systems in General: Toggle operated, specification grade, composition based, heavy duty, flush, quiet type, motor rated, with provision for back and side wiring, and rated 20 amperes, 120 volts A.C., color to match electrical devices in room.
   b. Bryant, Hubbell, General Electric

C. Electrical Metallic Tubing: Zinc-coated steel per ANSI C80.3-1977 "Specification for Electrical Tubing, Zinc-Coated".

D. Flexible Steel Conduit: Per UL-1, "Flexible Steel Conduit".

E. Couplings and Connectors for EMT: Zinc-plated steel, compression type.
F. Fittings for Flexible Steel Conduit: Malleable iron or steel, zinc or cadmium plated, with insulated throats, securing the conduit by clamping action around the periphery of the conduit. Do not furnish fittings that anchor the conduit by means of set screws.

G. Junction Boxes:

1. Sheet Metal Boxes: Code gage, full seam welded with bent-in flanges seam welded at corner joints, screw fastened cover of same gage as box. Fasten cover with brass machine screws. Galvanize box and cover after fabrication. Provide sizes conforming to NEC requirements for wiring space. Furnish gaskets when located in areas requiring gaskets.

2.4 WIRES AND CABLES

A. Furnish wire and cable for standard specifications established for such material and construction by ASTM, ANSI, IPCEA and NEMA, where applicable. Furnish annealed copper conductors of 98% conductivity, not less than NO. 12 AWG. Furnish stranded conductors No. 12 AWG. NEC Type THW rated 75 deg C, 600 volts.

B. Fume Hood Wiring: Electrical devices shall be wired with 2 #12 and 1 #12 ground wire in flexible ½" conduit to a junction box on top of fume hoods. Furnish 18" of coiled slack wire pigtail in junction box for extension by Building Trades Contractor. Wire receptacles together to one circuit. Wire lights and alarm/control devices to a separate, dedicated circuit for fume hoods having a vacuum pump, wire vacuum pump to a separate, dedicated circuit. Terminate each circuit within a common junction box atop the fume hood, in an easily accessible location.

PART 3 - EXECUTION

3.1 INSTALLATION OF SERVICE FIXTURES

A. Install in a precise manner in accordance with manufacturer's directions. Adjust moving parts to operate freely without excessive bind.

B. Provide all interconnecting conduit, wiring, and devices to junction box for final connection to building systems by Electrical Trades Contractor.

3.2 REPAIRING, CLEANING, AND PROTECTION

A. Repairing: Repair or remove and replace defective work as directed upon completion of installation.

B. Cleaning: Clean shop-finished surfaces, touch-up as required, and remove or refinish damaged or soiled areas, as acceptable to Architect.
C. Protection: Advise Contractor of procedures and precautions for protection of installed laboratory service fixtures from damage by work of other trades.

END OF SECTION 116210
MH/BRP
SECTION 116220 - LABORATORY ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division -1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:

1. Drying racks (DR-xx)
2. Service drops (SD-xx)
3. Gas cylinder restraint straps and racks (GCR-xx)
4. Unistrut Framing (UVF-xx and as noted)

B. Related Sections include the following:

1. Division 9, Section "Gypsum Board Assemblies" for sheet metal fastening grounds in gypsum board partitions for anchoring laboratory casework and accessories.
2. Division 11, Section 116210, "Laboratory Service Fixtures and Safety Equipment".
3. Division 12, Section 123553 "Laboratory Casework"

1.3 SUBMITTALS

A. Product Data: Submit product data for manufactured items.

B. LEED Submittals:

1. LEED Credits MR 4: Submit product data for products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. LEED Credits MR 5 and ID 1.2: Submit product data for products that have extracted, harvested, or recovered, as well as manufactured within 500 miles or the Project site.
   a. Include a statement indicating the percentage by weight which was extracted, harvested, or recovered within 500 miles of the Project site.
3. LEED Credit MR 7: Submit certificates of chain-of-custody signed by manufacturers certifying that products specified to be made from certified wood were made from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC 1.2, "Principles and Criteria." Include evidence that mill is certified for chain-of-custody by an FSC-accredited certification body.
   a. LEED Credit MR 7 requires that 50% of wood-based materials and products used in the project are certified.
   b. The following equation is to be used to determine Certified Wood Material Percentage: Certified Wood Material Percentage = FSC-certified Wood Material Value ($) / Total New Wood Material Value ($).
   c. Laboratory Casework is one opportunity to begin to fulfill this overall project requirement.

4. LEED Credits EQ 4.1, EQ 4.2 and 4.4: Submit Certification stating that all products installed within the building enclosure meets the testing and product requirements of the South Coast Air Quality Management District (SCAQMD), Green Seal, and/or do not contain added urea-formaldehyde resins.

C. Shop Drawings: Submit shop drawings for laboratory accessory assemblies that are factory and/or field assembled from manufactured components. Submit shop drawings showing locations, materials, connections and all details of construction and installation.

   1. Service drops. (SD-xx)
   2. Unistrut framing.
   3. Gas cylinder restraint straps and racks. (GCR-xx)
   4. Glass drying racks. (DR-xx)

D. Product Test Reports: Based on tests performed by a qualified independent testing agency, indicate compliance of laboratory casework finishes and countertops with requirements specified for chemical and physical resistance.

E. Qualification Data: Firms and/or persons specified shall demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Architects and Owners, and other information specified.

1.4 QUALITY ASSURANCE

A. Coordinate the interface of the laboratory accessories with the laboratory casework. Verify and coordinate all requirements for cutouts, attachments, reinforcing, piping, electrical devices, sizes and locations with laboratory casework and other laboratory items.

B. Manufacturer shall identify and designate a full time factory representative for on-site supervision and coordination during the installation of laboratory casework and laboratory accessories.
C. **Single Source Responsibility:** Laboratory casework manufacturer shall provide and install all laboratory accessories in order to maintain single source responsibility for laboratory fit-up items.

1.5 **DELIVERY, STORAGE, AND HANDLING**

A. Do not deliver laboratory accessories until painting, utility roughing-in, and similar operations that could damage, soil, or deteriorate materials or assemblies have been completed in installation areas. If items must be stored in other than installation areas, store only in areas whose environmental conditions meet requirements specified in "Project Conditions" Article below.

B. Protect finished surfaces from soiling and damage during handling and installation until substantial completion. Keep covered with polyethylene film or other protective covering.

1.6 **PROJECT CONDITIONS**

A. Environmental Limitations: Do not deliver or install laboratory casework until building is enclosed, wet-work is completed, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels through remainder of construction period.

1.7 **COORDINATION**

A. Coordinate layout and installation of metal framing and reinforcement in gypsum board assemblies for support of laboratory accessories.

1.8 **EXTRA MATERIALS**

A. Furnish complete touchup kit for each type and color of laboratory accessory provided. Include fillers, primers, paints, fabric patches, and other materials necessary to perform permanent repairs to damaged items.

**PART 2 - PRODUCTS**

2.1 **MANUFACTURERS**

A. Available Manufacturers: Subject to compliance with requirements, other manufacturers offering products may be incorporated into the Work subject to approval by Architect.
2.2 MATERIALS

A. Unless specified otherwise under an individual laboratory accessory, provide the following materials.

1. Metal: Commercial-quality, cold-rolled, carbon-steel sheet, complying with ASTM A 366 (ASTM A 366M); matte finish; suitable for exposed applications; and stretcher leveled or roller leveled to stretcher-leveled flatness. Minimum 18 ga.
2. Stainless Steel: AISI Type 304 with No. 4 satin finish unless otherwise indicated.
3. Chemical-Resistant Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard 2-coat, chemical-resistant, baked-enamel finish consisting of prime coat and thermosetting topcoat with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat and 2 mils (0.05 mm) for system.

2.3 DRYING RACKS (DR-01)

A. Provide and install Glass Drying Racks as described here and as indicated on drawings. Unless otherwise indicated on drawings the size shall be:

1. 24" W x 30" H.

B. Drying rack assemblies shall include the following components:

1. Front Panel: 1-inch (25.4 mm) stainless steel with No. 4 finish.
2. Glassware Pegs: Replaceable solid white polypropylene with glassware protector bases, 50 pegs.
3. Drip Trough: Stainless steel drip trough with PVC drainage hose.
4. Finished Back Panels: Matching finish and material at front panel.
5. Provide all fittings, fasteners, bracing, brackets, etc., for installation illustrated on drawings. Coordinate all reinforcing requirements for wall, frame or service drop mounting.

2.4 SERVICE DROPS (SD-xx)

A. Fabricate and install plastic laminate service drops in configurations as detailed on drawings consisting of removable and fixed panels.

1. Removable and fixed service drop panels are to fit together flush showing a minimum joint where they join.
2. Removable access panels for all service drops are to have concealed-to-view pins, catches, clips, strikes, etc., that allow removal of panel with an upward motion. Provide exposed countersunk washers and oval head Stainless Steel screws.
3. Fabricate and install service drops 1-inch (25.4 mm) lower than the bottom of light fixture line or ceiling if applicable to facilitate removal of access panel in an upward motion.
4. All panels are to interlock with benchtop backsplashes so as the face of the backsplash and service drop panel are flush, unless otherwise detailed on drawings.

5. Fixed service drop panels of boards shall be fastened to the wall or support unistrut -- whichever is applicable. Fixed panels shall be fitted with internal horizontal unistrut spaced vertically at 24" O/C to facilitate the internal fastening and support of mechanical piping and ductwork.

B. Install service drops plumb, level and true.

2.5 GAS CYLINDER RESTRAINT RACKS AND STRAPS (GCR-xx)

A. Fabricate and install with Unistrut components complete with all nuts, bolts, fittings, and accessories indicated and required.

B. Racks shall be shop prime painted with corrosion resisting primer and receive shop applied finish coatings. Provide color as listed in the Laboratory Component Finish Schedule.

C. The design standard for cylinder restraint straps and buckles are:

1. Straps - McMaster Carr #9499 R11.
2. Quick Disconnect Buckles - McMaster Carr #9499 R14.

D. Install cylinder restraint racks plumb, level and square to walls unless otherwise indicated on drawings. Brace rack assemblies to walls to prevent sway.

2.6 UNISTRUT FRAMING (UVF-xx and As Noted)

A. Provide, fabricate and install metal, FRP and stainless steel Unistrut framing as detailed and indicated on drawings.

B. The following lists Unistrut framing integral with the installation of laboratory casework, fume hoods, service fittings and accessories.

1. Pipe and service drop supports.
2. Gas cylinder storage racks.
3. Suspended equipment supports.
4. Miscellaneous structures and supports as detailed on drawings.

C. Provide unistrut framing as indicated, complete with all nuts, bolts, fittings, and accessories as required.

D. Metal unistrut framing shall be shop prime painted with corrosion resisting primer and receive a shop finish coating. Provide color as listed in the Laboratory Component Finish Schedule on the drawings.
E. Provide Owner with 12 copies of current parts catalog and price guide.

F. Install unistrut framing plumb, level and true. Secure framing to structure and walls with fasteners, appropriate for the intended use. Provide engineering data and locations of all fasteners used.

PART 3 - EXECUTION

3.1 INSTALLATION AND CLEANING

A. Install accessories according to approved Shop Drawings and manufacturer's written instructions.

B. General: Install all items plumb, level, properly aligned, rigid, and securely anchored to building and casework components.

C. Repair, remove or replace defective work as directed on completion of installation.

D. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

END OF SECTION 116220

BRP
SECTION 123553 - LABORATORY CASEWORK

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 laboratory casework, with wood doors and drawer fronts. (Fxxxx-xxx, WGxx-xx).
2. Base cabinets below fume hoods.
3. Utility-space framing at backs of base cabinets and between backs of base cabinets.
4. Filler and closure panels.
5. Laboratory countertops.

B. Related Sections:

1. Section 061000 "Rough Carpentry" for wood blocking for anchoring laboratory casework.
2. Section 092216 "Non-Structural Metal Framing" for reinforcements in metal-framed partitions for anchoring laboratory casework.
3. Section 096513 "Resilient Base and Accessories" for resilient base applied to metal laboratory casework.
4. Section 116210 “Laboratory Service Fixtures and Safety Equipment”.

1.3 DEFINITIONS

A. Exposed Surfaces of Casework: Surfaces visible when doors and drawers are closed, including bottoms of cabinets more than 48 inches (1200 mm) above floor, and visible surfaces in open cabinets or behind glass doors.

1. Ends of cabinets, including those installed directly against walls or other cabinets, are defined as "exposed."

B. Semiexposed Surfaces of Casework: Surfaces behind opaque doors, such as cabinet interiors, shelves, and dividers; interiors and sides of drawers; and interior faces of doors. Tops of cabinets 78 inches (1980 mm) or more above floor are defined as "semiexposed."
C. Concealed Surfaces of Casework: Include sleepers, web frames, dust panels, and other surfaces not usually visible after installation.

D. Hardwood Plywood: A panel product composed of layers or plies of veneer, or of veneers in combination with lumber core, hardboard core, MDF core, or particleboard core, joined with adhesive and faced both front and back with hardwood veneers.

1.4 PERFORMANCE REQUIREMENTS

A. System Structural Performance: Laboratory casework and support framing system shall withstand the effects of the following gravity loads and stresses without permanent deformation, excessive deflection, or binding of drawers and doors:

1. Support Framing System: 600 lb/ft. (900 kg/m).
2. Suspended Base Cabinets (Internal Load): 160 lb/ft. (240 kg/m).
5. Shelves: 60 lb/sq. ft. (200 kg/sq. m).

1.5 ACTION SUBMITTALS

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

B. LEED Submittals: Refer to Section 01 35 16 for Reporting Forms to be submitted.

1. LEED Credits MR 4 and ID 1.1: Submit product data for products having recycled content, documentation indicating percentages by weight of post-consumer and pre-consumer recycled content.
   a. Include statement indicating costs for each product having recycled content.

2. LEED Credits MR 5 and ID 1.2: Submit product data for products that have extracted, harvested, or recovered, as well as manufactured within 500 miles or the Project site.
   a. Include a statement indicating the percentage by weight which was extracted, harvested, or recovered within 500 miles of the Project site.

3. LEED Credit MR 6: Submit certificates stating the material meets the Rapidly Renewable Criteria, and the results from the following equation.
   a. Percent of Rapidly Renewable Materials = Total Cost of Rapidly Renewable Mat'l ($) / Total Project Materials Cost ($) .

4. LEED Credit MR 7: Submit certificates of chain-of-custody signed by manufacturers certifying that products specified to be made from certified wood were made from wood obtained from forests certified by an FSC-accredited certification body to comply with
FSC 1.2, "Principles and Criteria." Include evidence that mill is certified for chain-of-custody by an FSC-accredited certification body.

a. LEED Credit MR 7 requires that 50% of wood-based materials and products used in the project are certified.
b. The following equation is to be used to determine Certified Wood Material Percentage: Certified Wood Material Percentage = FSC-certified Wood Material Value ($) / Total New Wood Material Value ($).
c. Laboratory Casework is one opportunity to begin to fulfill this overall project requirement.

5. LEED Credits EQ 4.1, EQ 4.2 and 4.4: Submit Certification stating that all products installed within the building enclosure meets the testing and product requirements of the South Coast Air Quality Management District (SCAQMD), Green Seal, and/or do not contain added urea-formaldehyde resins.

C. Shop Drawings: For laboratory casework. Include plans, elevations, sections, details, and attachments to other work.

1. Indicate locations of hardware and keying of locks.
2. Indicate locations and types of service fittings.
3. Indicate locations of blocking and reinforcements required for installing laboratory casework.
4. Include details of utility spaces showing supports for conduits and piping.
5. Include details of support framing system.
6. Include details of exposed conduits, if required, for service fittings.
7. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and other laboratory equipment.
8. Include coordinated dimensions for laboratory equipment specified in other Sections.

D. Samples for Initial Selection: For factory-applied finishes and other materials requiring color selection.

E. Samples for Verification: For each type of cabinet finish and each type of countertop material indicated, in manufacturer's standard sizes.

1.6 MOCKUPS

A. Mockups for Verification: Provide full-size mockups for on-site review. Do not proceed with fabrication of other casework items until mockups and samples are approved. Unless otherwise directed, approved full-size mockups and samples may become part of the completed Work, if in an undisturbed condition at time of Substantial Completion. Notify Architect of their exact locations. If not incorporated into the Work, retain acceptable full-size Samples at Project site and remove when directed by Architect.

1. One Sample each of hinged and sliding doors.
2. 6-inch- (150-mm-) square Samples for each type of countertop material.
3. One of each type of sink and accessory item specified.
4. One of each type of hardware item specified.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified manufacturer.

B. Product Test Reports for Casework: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory casework with requirements of specified product standard and system structural performance specified in "Performance Requirements" Article.

C. Product Test Reports for Countertop Surface Material: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of laboratory countertop surface materials with requirements specified for chemical and physical resistance.

1.8 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish complete touchup kit for each type and color of metal laboratory casework provided. Include fillers, primers, paints, and other materials necessary to perform permanent repairs to damaged laboratory casework finish.

B. Furnish complete touchup kit for each type and color of wood laboratory casework provided. Include scratch fillers, stains, finishes, and other materials necessary to perform permanent repairs to damaged laboratory casework finish.

C. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.9 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer that produces casework of types indicated for this Project that has been tested for compliance with SEFA 8.

B. Source Limitations: Obtain laboratory casework from single source from single manufacturer.

1. Obtain countertops, sinks, accessories and service fittings from casework manufacturer.

C. Casework Product Standard: Comply with SEFA 8, "Laboratory Furniture - Casework, Shelving and Tables - Recommended Practices."

D. Flammable Liquid Storage: Where cabinets are indicated for solvent or flammable liquid storage, provide units that are listed and labeled as complying with requirements in NFPA 30 by a testing and inspecting agency acceptable to authorities having jurisdiction.
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. Keying Conference: Conduct conference at Project site. Incorporate keying conference decisions into final keying requirements.

G. Preinstallation Conference: Conduct conference at Project site.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.

1.11 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install laboratory casework until building is enclosed, utility roughing-in and wet work are complete and dry, and temporary HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

1.12 COORDINATION

A. Coordinate layout and installation of framing and reinforcements for support of laboratory casework.

B. Coordinate installation of laboratory casework with installation of fume hoods and other laboratory equipment.

PART 2 - PRODUCTS

2.1 METAL CABINET AND TABLE MATERIALS

A. Metal: Cold-rolled, commercial steel (CS) sheet, complying with ASTM A 1008/A 1008M; matte finish; suitable for exposed applications.

B. Nominal Metal Thickness:

1. Sides, Ends, Fixed Backs, Bottoms, Tops, Soffits, and Items Not Otherwise Indicated: 0.048 inch (1.21 mm). Except for flammable liquid storage cabinets, bottoms may be 0.036 inch (0.91 mm) if reinforced.

2. Back Panels, Doors, Drawer Fronts and Bodies, and Shelves: 0.036 inch (0.91 mm) except 0.048 inch (1.21 mm) for back panels and doors of flammable liquid storage cabinets and for unreinforced shelves more than 36 inches (900 mm) long.
3. Intermediate Horizontal Rails, Table Aprons and Cross Rails, Center Posts, and Top Gussets: 0.060 inch (1.52 mm).
4. Drawer Runners, Sink Supports, and Hinge Reinforcements: 0.075 inch (1.90 mm).
5. Leveling and Corner Gussets: 0.105 inch (2.66 mm).

C. Wood Door and Drawer Front Materials:

1. General: Provide materials that are selected and arranged for compatible grain and color. Do not use materials adjacent to one another that are noticeably dissimilar in color, grain, figure, or natural character markings.
2. Wood Species: Maple, match Architect’s sample.
3. Certified Wood Materials: Provide wood door and drawer fronts obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
4. Adhesives: Adhesives shall not contain urea formaldehyde.
5. Adhesives: Adhesives shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
6. Composite Wood and Agrifiber Products: Products shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
7. Hardwood Plywood: HPVA HP-1, either veneer core or particleboard core, unless otherwise indicated, made without urea formaldehyde with face veneer of species indicated, selected for compatible color and grain. Grade A exposed faces at least 1/50 inch (0.5 mm) thick, and Grade J crossbands. Provide backs of same species as faces.
   a. Face Veneer Cut: Plain sliced.
8. Solid Wood: Clear hardwood lumber of species indicated and selected for grain and color compatible with exposed hardwood plywood, with moisture content not more than 7 percent.
9. Edgebanding for Wood-Veneered Construction: Minimum 1/8-inch- (3-mm-) thick, solid wood of same species as face veneer.

2.2 AUXILIARY CABINET MATERIALS

A. Acid Storage-Cabinet Lining: 1/4-inch- (6-mm-) thick, polyethylene or polypropylene.

B. Glass for Glazed Doors: Clear tempered glass complying with ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality-Q3; not less than 5.0 mm thick.

2.3 COUNTERTOP, TABLE TOP AND SINK MATERIALS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Durcon Company (The).
   b. Epoxyn Products.
   c. Laboratory Tops, Inc.
   d. Prime industries, Inc.

2. Physical Properties:
   a. Flexural Strength: Not less than 10,000 psi (70 MPa).
   b. Modulus of Elasticity: Not less than 2,000,000 psi (1400 MPa).
   c. Hardness (Rockwell M): Not less than 100.
   d. Water Absorption (24 Hours): Not more than 0.02 percent.
   e. Heat Distortion Point: Not less than 260 deg F (127 deg C).

3. Chemical Resistant: Epoxy-resin material has the following ratings when tested with indicated reagents according to NEMA LD 3, Test Procedure 3.4.5:
   a. No Effect: Acetic acid (98 percent), acetone, ammonium hydroxide (28 percent), benzene, carbon tetrachloride, dimethyl formamide, ethyl acetate, ethyl alcohol, ethyl ether, methyl alcohol, nitric acid (70 percent), phenol, sulfuric acid (60 percent), and toluene.
   b. Slight Effect: Chromic acid (60 percent) and sodium hydroxide (50 percent).

4. Color: Light Gray, Tier I or II as selected by the Architect.

2.4 METAL CABINETS

A. Manufacturers: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
   1. Kewaunee Scientific Corporation; Laboratory Products Group.
   2. Mott Manufacturing Ltd.
   3. Hamilton Scientific.

B. Fabrication: Assemble and finish units at point of manufacture. Use precision dies for interchangeability of like-size drawers, doors, and similar parts. Perform assembly on precision jigs to provide units that are square. Reinforce units with angles, gussets, and channels. Except where otherwise specified, integrally frame and weld cabinet bodies to form dirt and vermin-resistant enclosures. Where applicable, reinforce base cabinets for sink support. Maintain uniform clearance around door and drawer fronts of 1/16 to 3/32 inch (1.5 to 2.4 mm).

C. Flush Doors: Outer and inner pans that nest into box formation, with full-height channel reinforcements at center of door. Fill doors with noncombustible, sound-deadening material.
D. Glazed Doors: Hollow-metal stiles and rails of similar construction as flush doors, with glass held in resilient channels or gasket material.

E. Hinged Doors: Mortise for hinges and reinforce with angles welded inside inner pans at hinge edge.

F. Drawers: Fronts made from outer and inner pans that nest into box formation, with no raw metal edges at top. Sides, back, and bottom fabricated in one piece with rolled or formed top of sides for stiffening and comfortable grasp for drawer removal. Provide drawers with rubber bumpers, polymer roller slides, and positive stops to prevent metal-to-metal contact or accidental removal.

G. Wood Doors: 3/4 inch (19 mm) thick, with particleboard or MDF cores, solid hardwood stiles and rails, and hardwood face veneers and crossbands.

H. Drawers with Wood Fronts: Fronts made from 3/4-inch- (19-mm-) thick, hardwood plywood or solid hardwood. Subfronts, sides, back, and bottom fabricated in one piece with rolled or formed top of sides for stiffening and comfortable grasp for drawer removal. Provide drawers with rubber bumpers, polymer roller slides, and positive stops to prevent metal-to-metal contact or accidental removal.

I. Design of Wood Doors and Drawer Fronts: Reveal overlay with square edges.

1. Provide 1/8-inch (3.2-mm) reveals between adjacent doors and adjacent drawers and between adjacent cabinets.

J. Grain Direction for Wood Doors and Drawer Fronts: Vertical on both doors and drawer fronts, with continuous vertical matching.

K. Veneer Matching for Wood Doors and Drawer Fronts:

1. Provide veneers for each cabinet from a single flitch, book and running matched.

L. Adjustable Shelves: Front, back, and ends formed down, with edges returned horizontally at front and back to form reinforcing channels.

M. Toe Space: Fully enclosed, 4 inches (100 mm) high by 3 inches (75 mm) deep, with no open gaps or pockets.

N. Utilities: Provide space, cutouts, and holes for pipes, conduits, and fittings in cabinet bodies to accommodate utility services and their support-strut assemblies.

1. Provide base cabinets with removable backs for access to utility space.

O. Utility-Space Framing: Laboratory casework manufacturer's standard steel framing units consisting of 2 steel slotted channels complying with MFMA-4, not less than 1-5/8 inches (41 mm) square by 0.105-inch (2.66-mm) nominal thickness, and connected at top and bottom by U-shaped brackets made from 1-1/4-by-1/4-inch (32-by-6-mm) steel flat bars. Framing units
P. Filler and Closure Panels: Provide where indicated and as needed to close spaces between cabinets and walls, ceilings, and indicated equipment. Fabricate from same material and with same finish as cabinets and with hemmed or flanged edges unless otherwise indicated.

1. Provide utility-space closure panels at spaces between base cabinets where utility space would otherwise be exposed, including spaces below countertops.
2. Provide closure panels at ends of utility spaces where utility space would otherwise be exposed.
3. Provide knee-space panels (modesty panels) at spaces between base cabinets, where cabinets are not installed against a wall or where space is not otherwise closed. Fabricate from back-to-back panels or of hollow construction to eliminate exposed hemmed or flanged edges.

2.5 WOOD FINISH

A. Preparation: Sand lumber and plywood before assembling. Sand edges of doors, drawer fronts, and molded shapes with profile-edge sander. Sand after assembling for uniform smoothness at least equivalent to that produced by 220-grit sanding and without machine marks, cross sanding, or other surface blemishes.

B. Staining: Remove fibers and dust and apply stain to exposed and semiexposed surfaces as necessary to match approved Samples. Apply stain in a manner that will produce a consistent appearance. Apply wash-coat sealer before applying stain to closed-grain wood species.


C. Chemical-Resistant Finish: Apply laboratory casework manufacturer's standard two-coat, chemical-resistant, transparent finish. Sand and wipe clean between coats. Topcoat(s) may be omitted on concealed surfaces.

1. Chemical and Physical Resistance of Finish System: Finish complies with acceptance levels of cabinet surface finish tests in SEFA 8. Acceptance level for chemical spot test shall be no more than four Level 3 conditions.

2.6 HARDWARE

A. General: Provide laboratory casework manufacturer's standard, commercial-quality, heavy-duty hardware complying with requirements indicated for each type.

B. Hinges: Stainless-steel, 5-knuckle hinges complying with BHMA A156.9, Grade 1, with antifriction bearings and rounded tips. Provide 2 for doors 48 inches (1200 mm) high or less and 3 for doors more than 48 inches (1200 mm) high.
C. Hinged Door and Drawer Pulls: Stainless steel, back-mounted pulls. Provide 2 pulls for drawers more than 24 inches (600 mm) wide.
   1. Design: Wire pulls.
   2. Overall Size: 1 by 4-1/2 inches (25 by 114 mm). As selected from manufacturer's full range.

D. Door Catches: Nylon-roller spring catches. Provide 2 catches on doors more than 48 inches (1200 mm) high.

E. Drawer Slides: Side mounted, epoxy-coated steel, self-closing; designed to prevent rebound when drawers are closed; complying with BHMA A156.9, Type B05091.
   1. Provide Grade 1HD-100; for drawers not more than 6 inches (150 mm) high and 24 inches (600 mm) wide.
   2. Provide Grade 1HD-200; for drawers more than 6 inches (150 mm) high or 24 inches (600 mm) wide.
   3. Standard Duty (Grade 1): Full-extension type, with polymer rollers.
   4. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Full-extension, ball-bearing type.

F. Label Holders: Stainless steel, aluminum, or chrome plated; sized to receive standard label cards approximately 1 by 2 inches (25 by 50 mm), attached with screws or rivets. Provide on all drawers.

G. Locks for Metal Cabinets: Cam or half-mortise type with 5-pin tumbler, brass with chrome-plated finish; complying with BHMA A156.11, Type E07261.
   1. Provide a minimum of two keys per lock and two master keys.
   2. Provide on all drawers and doors.
   3. Keying: Key locks as directed.
   4. Master Key System: Key all locks to be operable by master key.

2.7 COUNTERTOPS AND SINKS

A. Countertops, General: Provide units with smooth surfaces in uniform plane free of defects. Make exposed edges and corners straight and uniformly beveled. Provide front and end overhang of 1 inch (25 mm), with continuous drip groove on underside 1/2 inch (13 mm) from edge.

B. Sinks, General: Provide sizes indicated or laboratory casework manufacturer's closest standard size of equal or greater volume, as approved by Architect.
   1. Outlets: Provide with strainers and tailpieces, NPS 1-1/2 (DN 40), unless otherwise indicated.
   2. Overflows: Provide overflow of standard beehive or open-top design with separate strainer. Height 2 inches (50 mm) less than sink depth. Provide in same material as strainer.
C. Epoxy Countertops, Table Tops and Sinks:

1. Countertop Fabrication: Fabricate with factory cutouts for sinks, holes for service fittings and accessories, and with butt joints assembled with epoxy adhesive and concealed metal splines.
   a. Countertop Configuration: Flat, 1 inch (25 mm) thick, with beveled edge and corners, and with drip groove and applied backsplash.
   b. Countertop Construction: Uniform throughout full thickness.

2. Sink Fabrication: Molded in 1 piece with smooth surfaces, coved corners, and bottom sloped to outlet; 1/2-inch (13-mm) minimum thickness.
   a. Provide with polypropylene strainers and tailpieces.
   b. Provide integral sinks in epoxy countertops, bonded to countertops with invisible joint line.
   c. Provide manufacturer's recommended adjustable support system for table- and cabinet-type installations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of reinforcements, and other conditions affecting performance of laboratory casework.

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

3.2 INSTALLATION OF CABINETS

A. Comply with installation requirements in SEFA 2.3. Install level, plumb, and true; shim as required, using concealed shims. Where laboratory casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical. Do not exceed the following tolerances:

1. Variation of Tops of Base Cabinets from Level: 1/16 inch in 10 feet (1.5 mm in 3 m).
2. Variation of Bottoms of Upper Cabinets from Level: 1/8 inch in 10 feet (3 mm in 3 m).
3. Variation of Faces of Cabinets from a True Plane: 1/8 inch in 10 feet (3 mm in 3 m).
4. Variation of Adjacent Surfaces from a True Plane (Lippage): 1/32 inch (0.8 mm).
5. Variation in Alignment of Adjacent Door and Drawer Edges: 1/16 inch (1.5 mm).

B. Utility-Space Framing: Secure to floor with two fasteners at each frame. Fasten to partition framing, wood blocking, or metal reinforcements in partitions and to base cabinets.
C. Base Cabinets: Fasten cabinets to utility-space framing, partition framing, wood blocking, or reinforcements in partitions with fasteners spaced not more than 24 inches (600 mm) o.c. Bolt adjacent cabinets together with joints flush, tight, and uniform.

1. Where base cabinets are installed away from walls, fasten to floor at toe space at not more than 24 inches (600 mm) o.c. and at sides of cabinets with not less than 2 fasteners per side.

D. Wall Cabinets: Fasten to hanging strips, masonry, partition framing, blocking, or reinforcements in partitions. Fasten each cabinet through back, near top, at not less than 24 inches (600 mm) o.c.

E. Install hardware uniformly and precisely. Set hinges snug and flat in mortises.

F. Adjust laboratory casework and hardware so doors and drawers align and operate smoothly without warp or bind and contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.

3.3 INSTALLATION OF COUNTERTOPS

A. Comply with installation requirements in SEFA 2.3. Abut top and edge surfaces in one true plane with flush hairline joints and with internal supports placed to prevent deflection. Locate joints only where shown on Shop Drawings.

B. Field Jointing: Where possible, make in same manner as shop-made joints using dowels, splines, fasteners, adhesives, and sealants recommended by manufacturer. Prepare edges in shop for field-made joints.

1. Use concealed clamping devices for field-made joints in plastic-laminate countertops. Locate clamping devices within 6 inches (150 mm) of front and back edges and at intervals not exceeding 24 inches (600 mm). Tighten according to manufacturer's written instructions to exert a uniform heavy pressure at joints.

C. Fastening:

1. Secure countertops, except for epoxy countertops, to cabinets with Z-type fasteners or equivalent, using two or more fasteners at each cabinet front, end, and back.
2. Secure epoxy countertops to cabinets with epoxy cement, applied at each corner and along perimeter edges at not more than 48 inches (1200 mm) o.c.
3. Where necessary to penetrate countertops with fasteners, countersink heads approximately 1/8 inch (3 mm) and plug hole flush with material equal to countertop in chemical resistance, hardness, and appearance.

D. Provide required holes and cutouts for service fittings.

E. Seal unfinished edges and cutouts in plastic-laminate countertops with heavy coat of polyurethane varnish.
F. Provide scribe moldings for closures at junctures of countertop, curb, and splash with walls as recommended by manufacturer for materials involved. Match materials and finish to adjacent laboratory casework. Use chemical-resistant, permanently elastic sealing compound where recommended by manufacturer.

G. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

3.4 INSTALLATION OF SINKS

A. Comply with installation requirements in SEFA 2.3.

B. Underside Installation of Epoxy Sinks: Use laboratory casework manufacturer's recommended adjustable support system for table- and cabinet-type installations. Set top edge of sink unit in sink and countertop manufacturers' recommended chemical-resistant sealing compound or adhesive and firmly secure to produce a tight and fully leakproof joint. Adjust sink and securely support to prevent movement. Remove excess sealant or adhesive while still wet and finish joint for neat appearance.

3.5 INSTALLATION OF LABORATORY ACCESSORIES

A. Install accessories according to Shop Drawings, installation requirements in SEFA 2.3, and manufacturer's written instructions.

B. Securely fasten adjustable shelving supports, stainless-steel shelves, and pegboards to partition framing, wood blocking, or reinforcements in partitions.

C. Install shelf standards plumb and at heights to align shelf brackets for level shelves. Install shelving level and straight, closely fitted to other work where indicated.

D. Securely fasten pegboards to partition framing, wood blocking, or reinforcements in partitions.

3.6 CLEANING AND PROTECTING

A. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

B. Protect countertop surfaces during construction with 6-mil (0.15-mm) plastic or other suitable water-resistant covering. Tape to underside of countertop at a minimum of 48 inches (1200 mm) o.c.

END OF SECTION 123553
MH/BRP
SECTION 134900 – X-RAY PROTECTION

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. Section Includes:

1. Lead sheet, strip, and plate.
2. Lead glass.
3. Lead-lined building materials and products including the following:
   a. Plywood.

B. Related Sections:

1. Division 8 Section "Door Hardware" for door hardware for lead-lined steel hollow-metal doors.
2. Division 9 Section "Gypsum Board Assemblies" for metal framing and furring for lead-lined gypsum board and for finishing materials, accessories, and trim applied to lead-lined gypsum board.
3. Division 9 Sections "Painting" for field finishing frames.

1.3 DEFINITIONS

A. Lead Equivalence: The thickness of lead that provides the same attenuation (reduction of radiation passing through) as the material in question under the specified conditions.

1. Lead equivalence specified for materials used in diagnostic x-ray rooms is as measured at 100 kV unless otherwise indicated.

1.4 PERFORMANCE REQUIREMENTS

A. Provide materials and workmanship, including joints and fasteners, that maintain continuity of radiation protection at all points and in all directions equivalent to materials specified in thicknesses and locations indicated.
Construction

1. Materials, thicknesses, and configurations indicated are based on radiation protection design prepared by Owner's radiation health physicist. This design is available to Contractor on request.

B. Lead-Lined Assemblies: Unless otherwise indicated, provide lead thickness in doors, door frames, window frames, penetration shielding, joint strips, and other items located in lead-lined assemblies not less than that indicated for assemblies in which they are installed.

1.5 ACTION SUBMITTALS

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

B. Shop Drawings: Show layout of radiation-protected areas. Indicate lead thickness or lead equivalence of components. Show components and installation conditions not fully dimensioned or detailed in product data.

1. Show ducts, pipes, conduit, and other objects that penetrate radiation protection; include details of penetrations.

C. Other Action Submittals:

1. Schedule: Provide a schedule of observation windows, doors and frames prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with door hardware schedule.

1.6 INFORMATIONAL SUBMITTALS

A. Warranty: Sample of special warranty.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Source Limitations: Obtain each type of radiation protection product from single source from single manufacturer unless otherwise indicated.

C. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to radiation protection including, but not limited to, the following:

a. Sequence and schedule of radiation protection work in relation to other work.

b. Supplementary lead shielding at duct, pipe, and conduit penetrations of radiation protection.

c. Methods of attaching other construction and equipment to lead-lined finishes.
d. Notification procedures for work that requires modifying radiation protection.

e. Requirements for field quality control.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Lead-Lined Gypsum Panels: Neatly stack panels flat to prevent deformation.

B. Lead-Lined Steel Doors and Frames: Comply with requirements in Division 8 Section "Steel Doors and Frames" for delivery, storage, and handling.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install radiation protection until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.10 WARRANTY

A. Comply with requirements in Division 8 Section “Flush Wood Doors”.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Lead Sheet, Strip, and Plate: ASTM B 749, alloy UNS No. L51121 (chemical-copper lead).

B. Lead-Lined Plywood: 3/4-inch- thick plywood complying with Division 6, of width and length required for support spacing and to prevent cracking during handling, and with a single sheet of lead laminated to the back of the board.

1. Provide lead sheet lining the full width of board and height as indicated on Drawings.

2. Provide 2-inch- (50-mm-) wide lead strips for backing joints.

3. Provide 5/8-inch (16-mm) lead disks for covering screw heads.

C. Accessories and Fasteners: Provide manufacturer's standard fasteners and accessories as required for installation, maintaining same lead equivalence as rest of system.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates in areas to receive radiation protection, with Installer present, for compliance with requirements, installation tolerances, and other conditions affecting performance of radiation protection.

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

3.2 INSTALLATION OF LEAD-LINED PLYWOOD

A. Install with long edge parallel to supports and lead lining facing supports. Provide blocking at end joints. Install using construction adhesive and supplementary fasteners.

B. Fastening to Metal Supports: Use steel drill screws spaced as recommended in writing by gypsum board manufacturer.

1. Install lead strips, 1-1/2 inches (38 mm) wide minimum and same thickness as lead lining, to face of supports and blocking where joints occur. Secure lead strips with construction adhesive. Provide shims at intermediate supports.

2. Where possible, install lead-lined plywood and lead shields at penetrating items before installing gypsum board on other side of partition.

C. Openings: Extend lead-lined plywood into frames of openings, lapping lead lining with lead frames or frame linings at least 1 inch (25 mm). Arrange shielding around openings so neither horizontal nor vertical joints occur at corners of openings.

3.3 INSTALLATION OF PENETRATING ITEMS

A. At penetrations of lead linings, provide lead shields to maintain continuity of protection.

B. Provide lead linings, sleeves, shields, and other protection in thickness not less than that required in assembly being penetrated.

C. Secure shields at penetrations using adhesive or wire ties but not penetrating fasteners unless indicated on Drawings.

D. Outlet Boxes and Conduit: Cover or line with lead sheet lapped over adjacent lead lining at least 1 inch (25 mm). Wrap conduit with lead sheet for a distance of not less than 10 inches (250 mm) from box.
3.4 INSPECTION BY OWNER’S PHYSICIST

A. X-ray protection shall be inspected by Owner’s Physicist prior to finishing of gypsum board and installing gypsum board on other side of partition. Notify the Owner’s Physicist 14 days in advance of required inspection.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections after radiology equipment has been installed and placed in operating condition.

B. Correct deficiencies in or remove and replace radiation protection that inspection reports indicate does not comply with specified requirements.

3.6 PROTECTION

A. Lock x-ray -protected rooms once doors and locks are installed and limit access to only those persons performing work in the rooms.

END OF SECTION 134900
DWH/BRP
SECTION 210010 - BASIC FIRE SUPPRESSION REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division -1 Specification Sections, apply to this Section.

B. This is a Basic Fire Suppression Requirement Section and forms a part of the following Sections:

   1. All Division 21 Sections.
   2. All Division 23 Sections referencing “Basic Fire Suppression Requirements”.

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements for plumbing installations, including but not limited to:

   1. Proposed substitutions
   2. Codes, rules, regulations, ordinances and standards
   3. Permits, inspections, tests and approvals.
   4. References
   5. Acceptable manufacturers
   6. Contract drawings
   7. Use of equipment
   8. Layout drawings
   9. Record documents
  10. Maintenance and Operating Manuals
  11. Submittals
  12. Construction punch list
  13. Delivery, storage and handling
  14. Quality Assurance
  15. Temporary protection and utilities
  16. Warranty
  17. Housekeeping
  18. Rough-ins
  19. Installation, coordination and special provisions
  20. Cutting and patching
B. Provide all labor, materials, tools, and equipment necessary to complete all work as specified herein and noted on the Drawings.

C. All work shall be installed in accordance with manufacturer's recommendations, industry standards of good practice, and as specified herein and as noted on the Drawings.

1.3 PROPOSED SUBSTITUTIONS

A. Refer to Division 1 "Substitutions".

1.4 CODES, RULES, REGULATIONS, ORDINANCES AND STANDARDS

A. In addition to the requirements shown or specified, comply with all applicable State, County, City, Township and local Codes, Rules, Regulations, Ordinances and Standards.

B. Comply with the requirements shown or specified when those requirements are in excess of that required by Codes, Rules, Regulations, Standards and Ordinances.

C. Advise the Architect of changes required to conform to State, County, and Local regulations, ordinances and codes prior to the time that contract is awarded.

1.5 PERMITS, INSPECTIONS, TESTS, AND APPROVALS

A. Secure and pay for all required permits, inspections, tests and approvals.

B. Perform all tests required under applicable codes, rules, regulations, and ordinances.

C. All parts of each system and associated equipment shall be tested and adjusted to work properly and be left in good operating condition.

D. Provide all testing instruments, gauges, pumps and other equipment required or necessary for tests.

E. Notify the Owner's Representative in advance of all tests and conduct all tests to his entire satisfaction.

F. Correct all defects disclosed in the work by tests or otherwise without additional cost to the Owner.

G. Repeat tests after any defects disclosed thereby have been corrected.

H. Arrange and pay the cost of all utilities used in any tests.

I. Blank off all equipment prior to tests which could be damaged by the test pressure.
J. Listing of Referenced Associations, Codes, Standards and abbreviations:

AGA American Gas Association
ANSI American National Standards Institute
ARI Air-Conditioning and Refrigeration Institute
ASHRAE American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc.
ASME American Society of Mechanical Engineers
ASTM American Society for Testing & Materials
AWS American Welding Society, Inc.
AWWA American Water Works Association, Inc.
CISPI Cast Iron Soil Pipe Institute
FM Factory Mutual Engineering Corp.
IBC International Building Code
IMC International Mechanical Code
IPC International Plumbing Code
IRI Industrial Risk Insurance
MDCH Michigan Department of Community Health
MMC Michigan Mechanical Code
MPC Michigan Plumbing Code
MSS Manufacturer's Standardization Society of the Valve and Fitting Industry
NCPWB National Certified Pipe Welding Bureau
NEC National Electrical Code
NEMA National Electrical Manufacturers Association
NFPA National Fire Protection Association
NSF National Sanitation Foundation
OSHA Occupational Safety and Health Act
PDI Plumbing and Drainage Institute
HYDI Standards by the Hydronics Institute
UL Underwriters' Laboratories, Inc.

K. Note: Latest edition applies unless otherwise noted on the drawings or herein.

1.6 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers shall be considered for material in accordance with the requirements of the Specification Section, subject to the approval of the Architect. Such approval concerns the manufacturer only and does not in any way act to permit any deviation from strict compliance with the requirements of these Specifications.
1.7 CONTRACT DRAWINGS

A. Contract Drawings for Plumbing Work are diagrammatic, intended to convey the scope of the work and indicate general arrangement of piping and approximate sizes and locations of equipment and outlets. Do not scale drawings for measurements.

B. Consult Civil, Architectural, Structural, Plumbing, Mechanical and Electrical Contract Drawings and Specifications to become familiar with all conditions affecting the Work, coordinate interconnecting work with other Trades affected, and verify all spaces in which the work will be installed.

C. Where job conditions require reasonable changes in order to coordinate installation with other trades, these changes shall be made without extra cost to the Owner.

D. The Contract Drawings and Specifications are to be cooperative, and whatever is called for by either shall be binding as if called for by both.

1.8 USE OF EQUIPMENT

A. The use of any equipment, or any part thereof, for any purpose including testing even with the Owner's consent, shall not be construed to:

1. Be an acceptance of the work on the part of the Owner.
2. Obligate the Owner in any way to accept improper work or defective materials.
3. Be the basis for determining the beginning of the Contractor's guarantee or manufacturer's warrantee period.

1.9 LAYOUT DRAWINGS

A. Prepare layout drawings in accordance with Division 1 Section "Project Management and Coordination", and as specified below.

B. Prepare layout drawings drawn to scale showing the intended method of installation and construction. Coordinate work with all other trades. Use the Contract Drawings and Specifications as a guide in preparing coordination drawings. Comply with the full intent of the Contract Drawings. Deviate from the Contract Drawings only as required to resolve installation requirements. Layout drawings shall show the detailed routing of all piping and shall incorporate all requirements for; building structural systems; building architectural systems; and other items as may be required.

C. The layout drawings shall not be a repetition of the Contract Drawings. Prepare coordination drawings on a reproducible medium with dimensioned equipment and piping locations, elevations and mounting details. If available, electronic drawing files can be purchased from the Architect. Drawing size shall match contract drawing size. Post changes and modifications as they occur.
D. A set of layout drawings shall be kept on site and be available to the Architect, Owner's Project Representative, and others.

E. Layout drawings shall not be submitted to the Architect.

F. Update the layout drawings, when changes are made, so that these drawings represent the currently constructed (or about to be constructed) conditions.

G. Use the final layout drawings in preparing "Record Documents" as specified below and as specified in "Project Closeout Procedures" section.

1.10 RECORD DOCUMENTS

A. Prepare record documents in accordance with Division 1 Section "Project Closeout Procedures". In addition to the requirements specified in Division 1, indicate the following installed conditions:

1. Mains and branches of piping systems, and with items requiring maintenance located (i.e., backwater valves, etc.). Indicate actual inverts and horizontal locations of underground piping.
2. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

1.11 MAINTENANCE AND OPERATING MANUALS

A. Prepare maintenance and operating manuals in accordance with Division 1 Section "Project Closeout Procedures". In addition to the requirements specified in Division 1, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating and maintenance data, parts list and procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures and schedule for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.

1.12 SUBMITTALS

A. General:
1. Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Comply with the requirements of Section "Submittal Procedures" and as specified herein. All required submittals for an item shall be submitted in a complete single package.

C. Required submittals are listed in applicable Specification Sections. Submittals not required by these Specifications will not be reviewed and will not be returned.

D. After development and acceptance of the Contractor's construction schedule, prepare a complete schedule of submittals in accordance with the requirements of Section "Submittal Procedures".

E. The following submittals are required prior to bid submission:

1. Proposed substitutions.
2. The following submittals are required prior to construction start:
   a. Required product data.
   b. Required shop drawings.

3. The following submittals are required prior to construction punch list:
   a. All required shop drawings and product data.
   b. Operating and maintenance manuals.
   c. Record documents.
   d. Guarantees and warranties.
   e. Certifications, inspection and test reports.

F. Shop Drawings:

1. Submit manufacturer's technical product data, including rated capacities of selected model with clearly indicated, weights (shipping, installed, and operation), dimensions, required clearances, and methods of assembly of components, furnished specialties and accessories; and installation and start-up instructions.
2. Submit maintenance data and parts list for all plumbing equipment; including "trouble shooting" maintenance guide; plus servicing, and preventative maintenance procedures and schedule. Include this data and product data in maintenance manual; in accordance with requirements of Division 1.
3. Submit ladder-type wiring diagrams for power and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
1.13 CONSTRUCTION PUNCH LIST

A. Inspect the work and operate all systems prior to requesting the construction punch list to insure that the work is complete and operating in accordance with the requirements of the Contract Documents.

B. Prior to requesting construction punch list:
   1. Operate the system.
   2. Verify maintenance and operating manual work is complete, reviewed and accepted by the Owner's Representative.
   3. Verify system final adjustments and cleaning work is complete.

C. The final construction punch list time shall be coordinated with the Owner's Representative, providing; minimum one (1) week notice.

D. Provide sufficient personnel and portable telephones to demonstrate the operation of each system in each of the various modes of operation.

1.14 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Receive, properly house, handle, hoist, deliver to proper location, equipment and other material required.

C. After delivery, before and after installation, protect equipment and materials against theft, injury or damage from all causes.

D. Provide factory-applied plastic end-caps on each length of pipe and tube, except for concrete, corrugated metal, hub-and-spigot, clay piping. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

E. Protect stored pipes and tubes from moisture and dirt. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.

F. Protect flanges, fittings, and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

G. Store equipment and materials in clean, dry space; store off the ground; protect from weather and physical damage.
1.15 QUALITY ASSURANCE

A. Applicable Codes and Standards.

B. Installer's qualifications: Minimum 5 years of installation experience on successful projects for the installing firm of the individual doing the installation, unless a higher minimum is otherwise specifically noted in other Specification Sections.

C. Welder's Qualifications:

1. Welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, and Brazing Qualifications.
4. Certifications: Submit welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" heading of this Section.

D. Provide the following stamps and labels:
   1. "AGA" label on all gas fired equipment.
   2. "UL" or "ETL" label on all equipment with electrical connections.
   3. ASME Code stamp/label on all water heaters, tanks and receivers.

1.16 WARRANTY
   A. All systems, components, parts, assemblies and labor furnished under this contract shall be warranted against defects in materials and workmanship in accordance with the General Conditions. Any manufacturing or component defects arising during this warranty period shall be corrected without cost to the Owner.
   B. Additional warranty requirements, included in the individual specification sections, shall be considered requirements in addition to those of the General Conditions. In all instances, the most stringent requirements shall apply.

1.17 HOUSEKEEPING
   A. Maintain the premises neat and orderly and thoroughly clean upon completion of the work.

PART 2 - PRODUCTS
   Not Applicable

PART 3 - EXECUTION

3.1 ROUGH-INS
   A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
   B. Refer to equipment specifications in other Specification Sections and the Drawings for rough-in requirements.
3.2 INSTALLATION, COORDINATION AND SPECIAL PROVISIONS

A. Sequence, coordinate, and integrate the various elements of plumbing systems, materials, and equipment.

B. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

C. Coordinate plumbing systems, equipment, and materials installation with other building components.

D. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

E. Coordinate connection of plumbing systems with exterior underground services. Provide required connection for each service.

F. Verify all dimensions by field measurements.

G. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for plumbing installations.


I. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form.

J. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.3 TESTING, START-UP, AND TRAINING PROCEDURES

A. Develop and implement a plan and schedule for the testing, start-up, and training for all new plumbing equipment and systems. This plan will be specific to the project.

B. Provide any testing equipment and re-testing necessary.

C. In addition to all required submittal data for approval of the equipment, O & M Manuals, and warrantee information, provide documentation on all testing, start-up, and training activities. This documentation will include but is not limited to:

1. Installation, Start-up, and Check-out materials shipped with the equipment
2. Factory or Field Check-out forms used by factory or field technicians
3. Pre-functional and Functional Test Procedures and Check Lists
4. Re-testing of all deficiencies or non-conformance issues

D. All testing, start-up, and training will be scheduled in the Contractor’s Master Schedule. Seasonal testing and deferred testing will also be part of this contract. Seasonal tests will be delayed until weather conditions are closest to the system’s design. Deferred tests due to the building structure, required occupancy phasing, or other deficiencies will be completed as soon as possible. Seasonal and deferred testing will follow the same procedures, be witnessed by the same personnel, and require the same documentation.

E. All pre-functional and pre-start-up activities will be documented by the plumbing contractor and submitted before arrangements are made for the functional tests and start-up. At least 7 working days shall be provided.

F. Submit at project close-out with the as-built drawings, a document certifying that:

1. Systems were tested and function per design intent
2. Systems were installed per manufacturers recommendations and to industry accepted minimum standards
3. Systems received adequate operational check-out by installing contractors
4. Proper performance of equipment and systems was documented and given to the Owner.
5. O & M Manuals and as-built drawings are complete and accurate.
6. Owner’s operating personnel are adequately trained.

END OF SECTION
CEW
SECTION 210517 - SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION 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.

B. Related Sections: The following sections contain requirements that relate to this Section:

   1. Division 21 Section “Escutcheons for Fire Suppression Piping”.
   2. Division 21 Section “Facility Fire-Suppression Water Service Piping”.
   3. Division 21 Section “Fire-Suppression Standpipes”.
   4. Division 21 Section “Wet-Pipe Sprinkler Systems”.

1.2 SUMMARY

A. Section Includes:

   1. Sleeves.
   2. Stack-sleeve fittings.
   3. Sleeve-seal systems.
   4. Sleeve-seal fittings.
   5. Grout.

1.3 SUBMITTALS

A. Product Data: None required.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel Sleeves: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
D. Galvanized-Steel-Sheet Sleeves: 10 gauge minimum thickness; round tube closed with welded longitudinal joint.

2.2 STACK-SLEEVE FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.4 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Presealed Systems.
B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT


B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.

   a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.

2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.

2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.

3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."

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IBIO RADIO CHEMISTRY FACILITY

SLEEVES AND SLEEVE SEALS FOR FIRE-SUPPRESSION PIPING

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E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07 Section "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.
3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:
   a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves or Galvanized-steel wall sleeves or Sleeve-seal fittings.
   b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves or Galvanized-steel sleeves or Galvanized-steel-pipe sleeves.

2. Exterior Concrete Walls below Grade:
   a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel sleeves with sleeve-seal system or Sleeve-seal fittings.
      1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:
   a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel sleeves with sleeve-seal system or Sleeve-seal fittings.
      1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:
   a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves or Stack-sleeve fittings or Sleeve-seal fittings.
   b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe sleeves or Stack-sleeve fittings.
5. Interior Partitions:

   b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 230517
CEW
SECTION 210518 - ESCUTCHEONS FOR FIRE-SUPPRESSION 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.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 21 Section “Sleeves and Sleeve Seals for Fire-Suppression Piping”.
2. Division 21 Section “Facility Fire-Suppression Water Service Piping”.
3. Division 21 Section “Fire-Suppression Standpipes”.
4. Division 21 Section “Wet-Pipe Sprinkler Systems”.

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

A. Product Data: None required.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, exposed-rivet hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
   c. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
   d. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
   e. Bare Piping in Equipment Rooms: One-piece, cast-brass type with polished, chrome-plated finish.

2. Escutcheons for Existing Piping:
   a. Bare Piping at Wall and Floor Penetrations: Split-casting brass type with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.
3.2 FIELD QUALITY CONTROL
  A. Replace broken and damaged escutcheons and floor plates using new materials.
SECTION 210529 - HANGERS AND SUPPORTS FOR FIRE SUPPRESSION 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.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 5 Section “Post-Installed Anchors” for selection, design, and installation of post-installed anchors.
2. Division 21 Section “Facility Fire-Suppression Water Service Piping”.
3. Division 21 Section “Wet-Pipe Sprinkler Systems”.
4. Division 21 Section “Electric-Drive Centrifugal Fire Pumps”.
5. Division 21 Section “Pressure-Maintenance Pumps”.
6. Division 21 Section “Metal Fabrications”.

1.2 DESIGN-BUILD

A. It is the intent of this Section to provide a design-build sprinkler installation contract.

B. Drawings describe general building arrangement including architectural features, structure, mechanical, and electrical features, spaces to be protected, hazard requirements, and Owner requirements.

C. Specifications describe required fire protection systems, materials, equipment, installation requirements, and Owner requirements.

D. Provide all design, engineering, installation, testing, certification, and approval in accordance with the requirements of NFPA, 2009 Michigan Building Code, State and local Fire Marshal, and Owner’s Underwriter.

E. Secure design approval of State and/or local Fire Marshal, and Owner's Underwriter prior to start of construction.

F. Provide all fire protection system installation, and documentation required by the Michigan Department of Community Health - Office of Fire Safety, and/or local Fire Marshal, and Owner's Underwriter.
G. Design Requirements:

1. Systems, material, equipment, installation, testing, and approval shall comply with all applicable codes, NFPA requirements, State and Local Fire Marshal requirements, and Owner's Underwriter requirements.
2. Refer to drawings for additional design criteria.
3. Provide design, engineering, and certification of seismic support and restraining system in accordance with Division 21 Sections and NFPA-13.

1.3 SUMMARY

A. Section Includes:

1. Supplemental framing
2. Metal pipe hangers and supports (horizontal and vertical).
4. Spring hangers and supports.
5. Fastener systems.
6. Equipment supports.
7. Miscellaneous materials.

B. Provide all supports, supplemental framing, anchors, guides, platforms, and bases for all new fire-suppression equipment, and piping as specified in this Section; and as indicated on the drawings; and/or specified in other Division-21 Sections.

C. Supports that are an integral part of factory-fabricated equipment are specified as part of equipment assembly in other Division-21 Sections.

D. Support components or systems shown on the Drawings are minimum requirements and are to be used as a guide only.

1.4 DEFINITIONS

A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

B. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).

C. Other definitions for fire protection systems are listed in NFPA Standards 13, 14, and 24.

D. Working Plans as used in this Section means those documents (including drawings and calculations) prepared pursuant to the requirements contained in NFPA 13 for obtaining approval of the authority having jurisdiction.
1.5 PERFORMANCE REQUIREMENTS

A. Structural Performance: Hangers and supports for fire-suppression 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.

1.6 SUBMITTALS

A. Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Section.

B. Shop Drawings: Provide fabrication and installation details and include calculations for each type of attachment for each piping system. Provide product data for all hanger and attachments.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis by a qualified professional structural engineer responsible for their preparation.

D. Welding certificates.

1.7 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. Code Compliance: Comply with all applicable codes, including ANSI, pertaining to product materials and installation of supports and anchors.
2. UL Compliance: Provide products, where applicable, which are UL-listed.
3. MSS Standard Compliance:

   a. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.
   b. Select and install pipe hangers and supports, complying with MSS SP-69.
   c. Fabricate and install pipe hangers and supports, complying with MSS SP-89.
   d. Terminology used in this Section is defined in MSS SP-90.


7. Pre-construction Meeting: Coordinate installation of concrete inserts and all building attachments with installers of related work, prior to the start of construction.

C. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver all materials to project site in manufacturer’s original packaging, marked with manufacturer’s name, product model names and catalog numbers, identification numbers, and other related information.

B. Store materials under cover until needed for installation.

PART 2 - PRODUCTS

2.1 GENERAL

A. All supports and parts shall conform to the latest requirements of applicable NFPA Standards and MSS Standard Practice SP-58, except as supplemented or modified by the requirements of this Specification.

B. Hangers shall be designed so that they cannot become disengaged by movement of the supported pipe.

C. Rigid riser supports shall be designed so that the load is always equalized, and at no time can one side of the support be completely unloaded by the riser moving out of plumb, thereby transferring the entire load to the opposite side. Wherever practical, support riser piping independently of the connected horizontal piping.

D. Hangers, supports, hanger rod attachments and building attachments shall be provided by the same manufacturer where possible.
E. Fire suppression piping shall be supported independently.

2.2 SUPPLEMENTAL FRAMING

A. Provide supplemental framing for the following conditions:
   1. Where the anchor locations do not align with the structural framing.
   2. Where the intended loads exceed the structural framing maximum load carrying capacity.
   3. Floor mounted supplemental supports may only be used where indicated or with specific approval of the Owner's Representative.

2.3 METAL PIPE HANGERS AND SUPPORTS

A. The following are acceptable manufacturers subject to compliance with specified requirements.
   1. Michigan Hanger Co.
   2. Carpenter and Patterson, Inc.
   3. Anvil International.

B. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-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.

2.4 PIPING HANGERS AND SUPPORTS DESCRIPTION

A. General:
   1. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping.

B. Adjustable Steel Clevis Hangers: MSS Type 1.
2.5 VERTICAL-PIPING CLAMPS

A. General:

1. Select size of vertical piping clamps to exactly fit pipe size of bare pipe.

B. Two-Bolt Riser Clamps: MSS Type 8.

C. Four-Bolt Riser Clamps: MSS Type 42.

2.6 HANGER-ROD ATTACHMENTS

A. General:

1. Hanger rods and attachments to the structure shall be subjected to tensile loading only and shall be designed with a minimum safety factor of five (5). Hanger rod diameters shall be compatible with the other component parts of the hanger assembly.

2. Select size of hanger-rod attachments to suit hanger rods.

B. Steel Turnbuckles: MSS Type 13.

C. Steel Clevises: MSS Type 14.

D. Swivel Turnbuckles: MSS Type 15.
2.7 BUILDING ATTACHMENTS

A. General:
   1. Select attachments to suit building substrate conditions.
   2. Select size of building attachments to suit hanger rods, load restrictions and building material.
   3. Provide supplemental framing wherever hanger locations are not directly below building attachment locations.
   4. Do not attach supports to metal floor decking (or roof decking) panels.

B. Concrete Inserts: MSS Type 18.

C. Center Beam Clamps: MSS Type 21.

D. Linked Steel Clamps w/ Eye Nut: MSS Type 29.

E. Steel Beam Clamp wit Eye Nut: MSS Type 28.
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F. Malleable Beam Clamp with Extension Piece: MSS Type 30.

G. Steel Brackets: One of the following for indicated loading:

1. Loading up to 3000 lbs.: MSS Type 33.

2.8 FASTENER SYSTEMS
A. Refer to Division 05 Section “Post-Installed Anchors”.

2.9 EQUIPMENT SUPPORTS
A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.10 MISCELLANEOUS MATERIALS
A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Metal Framing: NEMA STD ML 1.

C. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Heavy Duty Steel Trapezes: Fabricated steel shapes for loads required. Weld steel in accordance with AWS Standards.
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. Unless otherwise noted on Drawings or specified herein, comply with the requirements of Division 21 Sections, NFPA-13, and the 2009 Michigan Building Code. Where hanger spacing differs, follow the most restrictive standard (the standard requiring the closest hanger spacing).

   1. Hanger and support spacing for piping joined with grooved mechanical couplings shall be in accordance with the grooved mechanical coupling system manufacturers published instructions for "rigid" systems.

C. Fastener System Installation:

   1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Locate steel reinforcing members with PACOMETER or other approved means to avoid resteel during anchor installation.

D. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.


F. Install hangers and supports to allow controlled 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.

G. Install bracing with pipe hangers and supports to prevent swaying.

H. Install building attachments within concrete slabs or attach to supplemental 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.

I. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
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 bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve uniform slope of pipe to assure complete drainage and compensate for pipe deflection between hangers.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm) past the end of the nut.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).
B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 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 copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

E. 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, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).

F. 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.

G. 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. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.
H. 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. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
3. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
4. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
5. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
6. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Heavy (MSS Type 33): 3000 lb (1360 kg).

I. Install anchors in accordance with Division 05 Section “Post-Installed Anchors”
SECTION 210553 - IDENTIFICATION FOR FIRE SUPPRESSION 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.

B. Related Sections: The following sections contain requirements that relate to this Section:

1. Division 21 Section “Wet-Pipe Sprinkler Systems”.
2. Division 21 Section “Electric-Drive Centrifugal Fire Pumps”.
3. Division 21 Section “Pressure-Maintenance Pumps”.

1.2 SUMMARY

A. Extent of mechanical identification work required by this Section is indicated on Drawings and/or specified in other Division Sections containing mechanical work.

B. Types of identification devices specified in this Section include the following:

1. Pipe identification labels.
2. Underground-type plastic line markers.
3. Equipment labels.
4. Warning signs and labels.
5. Valve tags.
6. Valve schedule frames.
7. Engraved plastic-laminate signs.
8. Plasticized tags.
9. Warning tags.

1.3 SUBMITTALS

A. General:

1. Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Product Data:

1. None required.
C. Shop Drawings:
   1. None required.

D. Samples:
   1. None required.

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.

D. Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.

E. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:
   1. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide mechanical identification materials of one of the following:
2.2 PIPE IDENTIFICATION LABELS

A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid, snap-on, color-coded pipe identification labels, complying with ANSI A13.1.

B. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 deg. F or greater. Cut length to extend 2" beyond each end of plastic pipe marker.

C. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:

1. Snap-on application of pre-tensioned semi-rigid plastic pipe identification label.
2. Laminated or bonded application of pipe identification label to pipe (or insulation).

D. Large Pipes: For external diameters of 6" and larger (including insulation, if any), provide either full-band or strip-type pipe identification labels, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:

1. Laminated or bonded application of pipe identification label to pipe (or insulation).
2. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

E. Lettering: Comply with piping system nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application length.

1. Arrows: Print each pipe identification label with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

2.3 UNDERGROUND-TYPE PLASTIC LINE MARKERS

A. Manufacturer's standard permanent, bright-colored continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe.

1. Provide multi-ply tape consisting of solid aluminum foil core between 2-layers of plastic tape.
2.4 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. General: Provide manufacturer's standard laminated plastic, color coded equipment identification labels. Conform to the following color code, for background color.
   a. Green: Cooling equipment and components.
   b. Yellow: Heating equipment and components.
   c. Yellow/Green: Combination cooling and heating equipment and components.
   e. Blue: Equipment and components that do not meet any of the above criteria.
   f. Use colors and designs recommended by ANSI A13.1 for hazardous equipment.

2. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
   a. Name and plan number.
   b. Equipment service.
   c. Design capacity.
   d. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.

3. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.


5. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

6. 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).

7. 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.


B. 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.

2.5 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

E. 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).

F. 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.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.6 VALVE TAGS

A. Provide 1-1/2" diameter 19-gage polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.

B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

C. Access Panel Markers: Provide manufacturer's standard 1/16" thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8" center hole to allow attachment.

D. 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.

2.7 VALVE SCHEDULE FRAMES

A. For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.
2.8 ENGRAVED PLASTIC-LAMINATE SIGNS

A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

B. Thickness: 1/16" for units up to 20 sq.in. or 8" length; 1/8" for larger units.

C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.9 PLASTICIZED TAGS

A. Manufacturer's standard pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matte finish suitable for writing, approximately 3-1/4" x 5-5/8", with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples: DANGER, CAUTION, DO NOT OPERATE).

2.10 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4 by 7 inches (100 by 178 mm).
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

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.

B. Locate equipment labels where accessible and visible.
3.3 PIPE LABEL INSTALLATION

A. Install pipe identification labels of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:

1. Plastic pipe identification labels, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.

B. Locate pipe identification labels and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.

1. Near each valve and control device.
2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
3. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
4. At access doors, manholes and similar access points which permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced intermediately at maximum spacing of 50’ along each piping run, except reduce spacing to 25’ in congested areas of piping and equipment.
7. On piping above ceilings.

C. Pipe Label Color Schedule: Comply with Owner’s standards, if there are not standards then comply with ANSI A13.1.

3.4 UNDERGROUND PIPING IDENTIFICATION

A. During backfilling/topsoiling of each exterior underground piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6” to 8” below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

3.5 VALVE-TAG INSTALLATION

A. Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valve within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibbs, and shut-off valves at plumbing fixtures, HVAC terminal devices and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.

B. Mount valve schedule frames and schedules in machine rooms where indicated or, if not otherwise indicated, where directed by Architect/Engineer.
1. Where more than one major machine room is shown for project, install mounted valve schedule in each major machine room, and repeat only main valves which are to be operated in conjunction with operations of more than single machine room.

3.6 EQUIPMENT IDENTIFICATION

A. General: Install engraved plastic laminate sign or plastic equipment identification label on or near each major item of mechanical equipment and each operational device as specified herein, unless specified otherwise for each item or device. Provide signs for the following general categories of equipment and operational devices.

1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
3. Fuel-burning units.
4. Pumps.

B. Optional Sign Types: Where lettering larger than 1" height is needed for proper identification, because of distance from normal location of required identification, stenciled signs may be provided in lieu of engraved plastic, at Installer's option.

C. Lettering Size: Minimum 1/4" high lettering for name of unit where viewing distance is less than 2'-0", 1/2" high for distances up to 6'-0", and proportionately larger lettering for greater distances. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.

D. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

E. Optional use of Plasticized Tags: At Installer's option, where equipment to be identified is concealed above acoustical ceiling or similar concealment, plasticized tags may be installed within concealed space to reduce amount of text in exposed sign (outside concealment).

3.7 WARNING-TAG INSTALLATION

A. Record message on, and attach warning tags to, equipment and other items where required.

3.8 ADJUSTING AND CLEANING

A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.

B. Cleaning: Clean face of identification devices, and frames of valve charts.
3.9 EXTRA STOCK

A. Furnish minimum of 5% extra stock of each mechanical identification material required, including additional numbered valve tags (not less than 3) for each piping system, additional piping system identification markers and additional plastic laminate engraving blanks of assorted sizes.
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.

B. Related Sections: The following sections contain requirements that relate to this Section:
   1. Division 21 Section “Common Electrical Requirements for Fire Suppression Equipment”.
   2. Division 21 Section “Sleeves and Sleeve Seals for Fire-Suppression Piping”.
   3. Division 21 Section “Hangers and Supports for Fire Suppression Piping and Equipment”.
   4. Division 21 Section “Identification for Fire Suppression Piping and Equipment”.
   5. Division 21 Section “Electric-Drive Centrifugal Fire Pumps”.
   6. Division 21 Section “Pressure-Maintenance Pumps”.

1.2 DESIGN-BUILD

A. It is the intent of this Section to provide a design-build sprinkler contract.

B. Drawings describe general building arrangement including architectural features, structure, mechanical, and electrical features, spaces to be protected, hazard requirements, and Owner requirements.

C. Specifications describe required fire protection systems, materials, equipment, installation requirements, and Owner requirements.

D. Provide all design, engineering, installation, flushing, testing, certification, and approval in accordance with the requirements of NFPA, State and Local Fire Marshal, and Owner's Underwriter.

E. Secure design approval of State and/or Local Fire Marshal, and Owner's Underwriter prior to start of construction.

F. Provide all fire protection system installation, and documentation required by the Michigan Department of Consumer and Industry Services - Office of Fire Safety, and/or Local Fire Marshal, and Owner's Underwriter.
G. Design Requirements:

1. Systems, material, equipment, installation, testing, and approval shall comply with all applicable codes, NFPA requirements, State and Local Fire Marshal requirements, and Owner's Underwriter requirements.
2. Working plans shall be coordinated with reflected ceiling plans and exposed concrete beam construction. In all locations, sprinklers shall be located on a grid system.
3. Refer to drawings for additional design criteria.

1.3 SUMMARY

A. This Section specifies automatic sprinkler systems and standpipe and hose systems for buildings and structures. Materials and equipment specified in this Section include:

1. Pipe, fittings, valves, and specialties.
2. Sprinklers, fire hoses and cabinets, combination fire hose and extinguishing cabinets, and accessories.

B. Products furnished but not installed include sprinkler head cabinet with spare sprinkler heads. Furnish to the Owner's maintenance personnel.

C. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Fire-department connections.
4. Sprinklers.
5. Alarm devices.
7. Control panels.
8. Pressure gages.

1.4 DEFINITIONS

A. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).

B. Other definitions for fire protection systems are listed in NFPA Standards 13, 14, and 24.

C. Working Plans as used in this Section means those documents (including drawings and calculations) prepared pursuant to the requirements contained in NFPA 13 for obtaining approval of the authority having jurisdiction.

D. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psi (1200 kPa) maximum.
1.5 SYSTEM DESCRIPTIONS

A. Combined Wet-Pipe Sprinkler and Class I Standpipe 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. 2-1/2” fire department hose connections are included.

1.6 PERFORMANCE REQUIREMENTS

A. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.

B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.7 SUBMITTALS

A. General:

1. Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Submit product data for each type sprinkler head, valve, (hangers), piping specialty, fire protection specialty, fire department connection, hose and rack, and hose cabinet specified.

C. Shop Drawings:

1. Submit shop drawings prepared in accordance with NFPA 13 identified as "Working Plans", including hydraulic calculations where applicable, and which have been approved by the authorities having jurisdiction and the Owner's Insurance Underwriter prior to submittal to the Architect.

D. Maintenance Data:

1. Submit maintenance data for each type sprinkler head, valve, piping specialty, fire protection specialty, fire department connection, hose and rack, and hose cabinet specified, for inclusion in operating and maintenance manual specified in Division 1.

E. Test Reports and Certificates:


2. Contactor shall submit preliminary sprinkler layout for Architect’s review.
1.8 QUALITY ASSURANCE

A. Installer Qualifications: Installation and alterations of fire protection piping, equipment, specialties, and accessories, and repair and servicing of equipment shall be performed only by a qualified installer. The term qualified means experienced in such work (experienced shall mean having a minimum of 5 previous projects similar in size and scope to this project), familiar with all precautions required, and has complied with all the requirements of the authority having jurisdiction. Upon request, submit evidence of such qualifications to the Architect. Refer to Division-1 Section: "Quality Requirements" for definitions for "Installers".

B. Qualifications for Welding Processes and Operators: Comply with the requirements of AWS D10.9, "Specifications for Qualifications of Welding Procedures and Welders for Piping and Tubing, Level AR-3".

C. Regulatory Requirements: Comply with the requirements of the following codes:

2. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems.
4. UL and FM Compliance: Fire protection system materials and components shall be Underwriter's Laboratories listed and labeled, and Factory Mutual approved for the application anticipated.

1.9 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

B. Coordinate layout and installation with reinforced concrete beams for exposed construction areas.

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. 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.

2. Valve Wrenches: Furnish to Owner, (2) two valve wrenches for each type of sprinkler head installed.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide fire protection system products from one of the following:

1. Gate Valves:
   a. Fairbanks
   b. Jenkins
   c. Kennedy Valve, Div. of Grinnell Valve Co., Inc.
   d. Stockham

2. Butterfly Valves:
   a. Victaulic Company of America
   b. Fairbanks
   c. Jenkins
   d. Kennedy Valve, Div. of Grinnell Valve Co., Inc.
   e. Stockham

3. Swing Check Valves:
   a. Fairbanks
   b. Jenkins
   c. Kennedy Valve, Div. of Grinnell Valve Co., Inc.
   d. Star Sprinkle Corp.
   e. Stockham
   f. Viking Corp.
   g. Victaulic Company of America

4. Grooved Mechanical Couplings:
   a. Anvil
   b. Victaulic Company of America
   c. Grinnell Gruvlok

5. Water Flow Indicators:
   a. System Sensor
   b. Potter
6. Detector Check Valves:
   a. Ames Company, Inc.
   b. Kennedy Valve, Div. of Grinnell Valve Co., Inc.
   c. Victaulic Company of America

7. Alarm Check Valve:
   a. Reliable Automatic Sprinkler Co., Inc.
   b. Star Sprinkler Corp.
   c. Viking Corp.

8. Hose Outlet Valves:
   a. Guardian Fire Equipment, Inc.

9. Fire Department Connection Valve:
   a. Guardian Fire Equipment, Inc.

10. Sprinkler Heads:
    a. Automatic Sprinkler Corp. of America
    b. Central Sprinkler Corp.
    c. Firematic Sprinkler Devices, Inc.
    d. Guardian Automatic Sprinkler Co., Inc.
    e. Grinnell
    f. Reliable Automatic Sprinkler Co., Inc.
    g. Star Sprinkler Corp.
    h. Viking Corp.

11. Factory Mutual Research Corporation-Approved (FMAC-Approved) Flexible Sprinkler Connections:
    a. Flexhead Industries, Inc.
    b. Victaulic Company of America, Aquaflex AQB System.

12. Fire Hose, Valve, and Extinguisher Cabinets:
    a. J. L. Industries
    c. Johnson-Lee, Division of W. F. Lee Corp.
    d. Muckle Manufacturing, Division of Technico, Inc.
    e. Watrous, Inc.
2.2 PIPING MATERIALS

A. General: Refer to Part 3 Article "PIPE APPLICATIONS" for identification of systems where the below specified pipe and fitting materials are used.

2.3 STEEL PIPE AND FITTINGS

A. Standard Weight, Black-Steel Pipe: ASTM A 53/A 53M, or A-135, Schedule 40. Pipe ends may be factory or field formed to match joining method.


C. Malleable- or Ductile-Iron Unions: UL 860.

D. Cast-Iron Flanges: ASME 16.1, Class 125.

E. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.


G. Grooved-Joint, Steel-Pipe Appurtenances:
   1. Pressure Rating: 175 psig (1200 kPa) minimum.
   2. Uncoated, 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.
   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.

2.4 PIPING JOINING MATERIALS

   1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face 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.

D. Gasket Materials: Thickness, material and type suitable for fluid or gas to be handled, and design temperatures and pressures.
2.5 LISTED FIRE-PROTECTION VALVES

A. General Requirements:
   1. Valves shall be UL listed or FM approved.

B. Gate Valves - 2 Inch and Smaller: Body and bonnet of cast bronze, 175 pound cold water working pressure - non-shock, threaded ends, solid wedge, outside screw and yoke, rising stem, screw-in bonnet, and malleable iron handwheel. Valves shall be capable of being repacked under pressure, with valve wide open.

C. Gate Valves - 2-1/2 Inch and Larger: Iron body; bronze mounted, 175 pound cold water working pressure - non-shock. Valves shall have solid taper wedge; outside screw and yoke, rising stem; flanged bonnet, with body and bonnet conforming to ASTM A 126 Class B; replaceable bronze wedge facing rings; flanged ends; and a packing assembly consisting of a cast iron gland flange, brass gland, packing, bonnet, and bronze bonnet bushing. Valves shall be capable of being repacked under pressure, with valve wide open.

D. Butterfly Valves - 2-1/2 Inch and Larger: Iron body and disc. UL listed, FM approved.

E. Swing Check Valves: MSS SP-71; Class 175, cast iron body and bolted cap conforming to ASTM A 126, Class B; horizontal swing, with a bronze disc or cast iron disc with bronze disc ring, and flanged ends. Valve shall be capable of being refitted while the valve remains in the line.

2.6 SPECIALTY VALVES

A. Alarm Check Valve: 175 psig working pressure, designed for horizontal or vertical installations, and have cast iron, flanged inlet and outlet, bronze grooved seat with "O" ring seals, single hinge pin and latch design. Provide trim sets for bypass, drain, electric sprinkler alarm switch, pressure gages, precision retarding chamber, drip cup assembly piped with check valve to main drain line, and fill line attachment with strainer.

B. Detector Check Valves: Galvanized cast iron body, with a bolted cover with air bleed device for access to internal parts; 175 psig working pressure. One piece bronze disc with bronze bushings, pivot and replaceable set. Provide threaded bypass taps in the inlet and outlet for bypass meter connection. Valve shall be set to allow minimal water flow through the bypass meter; when major water flow is required, the water pressure will fully open the clapper.

C. Indicating-Type Butterfly Valves:
   1. Pressure Rating: 175 psig (1200 kPa) minimum.
   2. Valves NPS 2 (DN 50) and Smaller:
3. 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.


### 2.7 FIRE-DEPARTMENT CONNECTIONS

#### A. Exposed-Type, Fire-Department Connection:

2. Type: Exposed, projecting, for wall mounting.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
5. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
6. Caps: Brass, lugged type, with gasket and chain.
7. Escutcheon Plate: Round, brass, wall type.
8. Outlet: Back, with pipe threads.
9. Number of Inlets: Two.
10. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE FIRE DEPARTMENT CONNECTION."

### 2.8 SPRINKLER SPECIALTY PIPE FITTINGS

#### A. Branch Outlet Fittings:

2. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Type: Mechanical-T and -cross fittings.
5. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
6. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
7. Branch Outlets: Grooved, or threaded.
B. Flow Detection and Test Assemblies:

2. Pressure Rating: 175 psig (1200 kPa) minimum.
3. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

C. Branch Line Testers:

2. Pressure Rating: 175 psig (1200 kPa).
4. Size: Same as connected piping.
5. Inlet: Threaded.
6. Drain Outlet: Threaded and capped.
7. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector's Test Fittings:

2. Pressure Rating: 175 psig (1200 kPa) minimum.
3. Body Material: Cast- or ductile-iron housing with sight glass.
4. Size: Same as connected piping.
5. Inlet and Outlet: Threaded.

E. Adjustable Drop Nipples:

2. Pressure Rating: 250 psig (1725 kPa) minimum.
4. Size: Same as connected piping.
5. Length: Adjustable.
6. Inlet and Outlet: Threaded.

F. Flexible, Sprinkler Hose Fittings:

1. Flexible sprinkler system final connections in commercial suspended ceilings shall be FlexHead Model 20XX* as manufactured by FlexHead Industries, Inc. Acton, Massachusetts USA as approved by Factory Mutual research Corporation. Each system shall be manufactured in FlexHead Industries' Factory Mutual Approved and audited facility. Each FlexHead Ceiling Sprinkler System includes a Ceiling Grid Mounting Bracket and a one piece leak tested FlexHead Sprinkler Drop including adjustable flange and sprinkler head.
3. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
4. Pressure Rating: 175 psig (1200 kPa) minimum.
5. Size: Same as connected piping, for sprinkler.

2.9 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Reliable Automatic Sprinkler Co., Inc.
   3. Tyco Fire & Building Products LP.

B. General Requirements:
   2. Pressure Rating for Automatic Sprinklers: 175 psig (1200 kPa) minimum.

C. Automatic Sprinklers with Heat-Responsive Element:
   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.

D. Sprinkler Finishes:
   1. Chrome plated.
   2. Bronze.
   3. Painted.

E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
   1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
   2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

F. Sprinkler Guards:
   2. Type: Wire cage with fastening device for attaching to sprinkler.
   3. Provide guards same manufacturer as sprinkler head.
2.10 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Electrically Operated Alarm Bell:
   2. Type: Vibrating, metal alarm bell.
   3. Size: 6-inch (150-mm) minimum-diameter.

C. Water-Flow Indicators:
   3. 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.
   4. Type: Paddle operated.
   6. Design Installation: Horizontal or vertical.

D. Pressure Switches:
   2. Type: Electrically supervised water-flow switch with retard feature.
   4. Design Operation: Rising pressure signals water flow.

E. Valve Supervisory Switches:
   2. Type: Electrically supervised.
   4. Design: Signals that controlled valve is in other than fully open position.

F. Indicator-Post Supervisory Switches:
   2. Type: Electrically supervised.
   4. Design: Signals that controlled indicator-post valve is in other than fully open position.
2.11 PRESSURE GAGES

A. Standard: UL 393.

B. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.

C. Pressure Gage Range: 0 to 250 psig (0 to 1725 kPa) minimum.

D. Water System Piping Gage: Include "WATER" label on dial face.

PART 3 - EXECUTION

3.1 GENERAL

A. Provide piping materials and factory-fabricated piping products of sizes, types, pressure ratings, temperature ratings, and capacities as indicated. Where not indicated, provide proper selection as determined by Contractor to comply with installation requirements. Provide sizes and types matching piping and equipment connections; provide fittings of materials which match pipe materials used in fire protection systems. Where more than one type of materials or products are indicated, selection is Installer’s option.

B. Design, layout and install all automatic fire sprinkler systems and standpipe systems to conform to all applicable codes and requirements. The installation shall be a hydraulically designed system.

C. Complete installation shall include all piping, heads, valves, Inspector’s test connections, drains, alarms, specialties, and all required access panels for a complete operable and approved system.

D. Automatic fire sprinkling shall be provided for all areas indicated on the drawings. Piping shall be run concealed above the suspended ceilings and through sleeves in new reinforced concrete beams and shall be so located to minimize the obstructions and interferences above the ceilings. Only the heads shall be exposed in rooms with ceilings where exposed heads are permitted.

E. The location of heads is of critical importance in missing lights, diffusers, and in furnishing a coordinated ceiling pattern consistent with tile and other architectural features. Sprinkler locations shall be verified before installing, using architectural reflected ceiling plans, mechanical plans, structural plans, and electrical plans. Mains are shown in approximate location and must be coordinated with other trades. Additional heads, piping, alarms, valves, etc. which may be required for a coordinated ceiling pattern shall be furnished without additional cost even though the number of heads and related piping may exceed minimum requirements of NFPA.

F. Heads located in acoustic tile shall be centered in the tile in both directions.
G. FMRC-approved flexible sprinkler connections may be used as an alternate to hand piped systems as means to center sprinkler heads within tiles.

3.2 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.

3.3 WATER-SUPPLY CONNECTIONS

A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Section 221116 "Domestic Water Piping."

B. Install shutoff valve, detector check type backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-distribution piping. Comply with requirements for backflow preventers in Section 221119 "Domestic Water Piping Specialties."

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

3.4 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of feed main and riser 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.

B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.

C. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.

E. 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.

F. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.

G. Install sprinkler piping with drains for complete system drainage.
H. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

I. 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.

J. Install alarm devices in piping systems.

K. Hangers and Supports: Unless otherwise noted on Drawings or specified herein, comply with the requirements of Division 21 Section "Hangers and Supports for Fire Suppression Piping and Equipment", NFPA-13, and NFPA-14. Where hanger spacing differs between Division 21 Section "Hangers and Supports for Fire Suppression Piping and Equipment", NFPA-13 and NFPA-14, follow the most restrictive standard (the standard requiring the closest hanger spacing).

1. The use of "C" clamp style building attachments is allowed only for piping 2 inch and smaller when attaching to steel beams, provided point load limitations indicated in Structural Drawings is not exceeded.

2. The use of "C" clamps style building attachments is prohibited when attaching piping 2-1/2 inch and larger to steel beams.

3. The use of "C" clamp style building attachments is prohibited when attaching piping of any size to steel joists.

4. Hanger and support spacing for piping joined with grooved mechanical couplings shall be in accordance with the grooved mechanical coupling system manufacturers published instructions for "rigid" systems.

L. 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.

M. Fill sprinkler system piping with water.

N. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

O. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 210517 "Sleeves and Sleeve Seals for Fire-Suppression Piping."

P. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 210518 "Escutcheons for Fire-Suppression Piping."
3.5 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.

K. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.
3.6 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. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.

D. Specialty Valves:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.

3.7 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. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

3.8 FIRE-DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type, fire-department connections.

B. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

3.9 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 Section 260553 "Identification for Electrical Systems."
3.10 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. Coordinate with fire-alarm tests. Operate as required.
6. Coordinate with fire-pump tests. Operate as required.
7. 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.

3.11 CLEANING

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

3.12 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves, fire pumps, and pressure-maintenance pumps.

3.13 PIPING SCHEDULE

A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast-iron threaded fittings; and threaded joints.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

1. Standard-pressure, wet-pipe sprinkler system, NPS 2 (DN 50) and smaller, shall be the following: Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
C. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:

1. Standard-weight or Schedule 30, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight or Schedule 30, 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.
3. Standard-weight or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.

D. Standard-pressure, wet-pipe sprinkler system, NPS 5 (DN 125) and larger, shall be the following:

1. Standard-weight or Schedule 30, 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 or Schedule 30, black-steel pipe with plain ends; steel welding fittings; and welded joints.

3.14 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Concealed sprinklers or recessed sprinklers. Refer to Drawings for locations of concealed sprinklers.
4. Spaces Subject to Freezing: Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated.
5. Special Applications: Extended-coverage, 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. 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.

END OF SECTION 211313
CEW
SECTION 220010 - BASIC PLUMBING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division -1 Specification Sections, apply to this Section.

B. This is a Basic Plumbing Requirement Section and forms a part of the following Sections:

1. All Division 22 Sections.
2. All Division 31 Sections referencing “Basic Plumbing Requirements”.
3. All Division 33 Sections referencing “Basic Plumbing Requirements”.

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements for plumbing installations, including but not limited to:

1. Proposed substitutions
2. Codes, rules, regulations, ordinances and standards
3. Permits, inspections, tests and approvals.
4. References
5. Acceptable manufacturers
6. Contract drawings
7. Use of equipment
8. Layout drawings
9. Record documents
10. Maintenance and Operating Manuals
11. Submittals
12. Construction punch list
13. Delivery, storage and handling
14. Quality Assurance
15. Temporary protection and utilities
16. Warranty
17. Housekeeping
18. Rough-ins
19. Installation, coordination and special provisions
20. Cutting and patching
21. Maintenance of existing utility services
22. Demolition
Construction

B. Provide all labor, materials, tools, and equipment necessary to complete all work as specified herein and noted on the Drawings.

C. All work shall be installed in accordance with manufacturer's recommendations, industry standards of good practice, and as specified herein and as noted on the Drawings.

1.3 PROPOSED SUBSTITUTIONS

A. Refer to Division 1 "Substitutions".

1.4 CODES, RULES, REGULATIONS, ORDINANCES AND STANDARDS

A. In addition to the requirements shown or specified, comply with all applicable State, County, City, Township and local Codes, Rules, Regulations, Ordinances and Standards.

B. Comply with the requirements shown or specified when those requirements are in excess of that required by Codes, Rules, Regulations, Standards and Ordinances.

C. Advise the Architect of changes required to conform to State, County, and Local regulations, ordinances and codes prior to the time that contract is awarded.

1.5 PERMITS, INSPECTIONS, TESTS, AND APPROVALS

A. Secure and pay for all required permits, inspections, tests and approvals.

B. Perform all tests required under applicable codes, rules, regulations, and ordinances.

C. All parts of each system and associated equipment shall be tested and adjusted to work properly and be left in good operating condition.

D. Provide all testing instruments, gauges, pumps and other equipment required or necessary for tests.

E. Notify the Owner's Representative in advance of all tests and conduct all tests to his entire satisfaction.

F. Correct all defects disclosed in the work by tests or otherwise without additional cost to the Owner.

G. Repeat tests after any defects disclosed thereby have been corrected.

H. Arrange and pay the cost of all utilities used in any tests.

I. Blank off all equipment prior to tests which could be damaged by the test pressure.
J. Listing of Referenced Associations, Codes, Standards and abbreviations:

AGA  American Gas Association
ANSI  American National Standards Institute
ARI   Air-Conditioning and Refrigeration Institute
ASHRAE American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc.
ASME  American Society of Mechanical Engineers
ASTM  American Society for Testing & Materials
AWS   American Welding Society, Inc.
AWWA  American Water Works Association, Inc.
CISPI  Cast Iron Soil Pipe Institute
FM    Factory Mutual Engineering Corp.
IBC   International Building Code
IMC   International Mechanical Code
IPC   International Plumbing Code
IRI   Industrial Risk Insurance
MDCH  Michigan Department of Community Health
MMC   Michigan Mechanical Code
MPC   Michigan Plumbing Code
MSS   Manufacturer's Standardization Society of the Valve and Fitting Industry
NCPWB National Certified Pipe Welding Bureau
NEC   National Electrical Code
NEMA  National Electrical Manufacturers Association
NFPA  National Fire Protection Association
NSF   National Sanitation Foundation
OSHA  Occupational Safety and Health Act
PDI   Plumbing and Drainage Institute
HYDI  Standards by the Hydronics Institute
UL    Underwriters' Laboratories, Inc.

K. Note: Latest edition applies unless otherwise noted on the drawings or herein.

1.6 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers shall be considered for material in accordance with the requirements of the Specification Section, subject to the approval of the Architect. Such approval concerns the manufacturer only and does not in any way act to permit any deviation from strict compliance with the requirements of these Specifications.
1.7 CONTRACT DRAWINGS

A. Contract Drawings for Plumbing Work are diagrammatic, intended to convey the scope of the work and indicate general arrangement of piping and approximate sizes and locations of equipment and outlets. Do not scale drawings for measurements.

B. Consult Civil, Architectural, Structural, Fire Protection, Mechanical and Electrical Contract Drawings and Specifications to become familiar with all conditions affecting the Work, coordinate interconnecting work with other Trades affected, and verify all spaces in which the work will be installed.

C. Where job conditions require reasonable changes in order to coordinate installation with other trades, these changes shall be made without extra cost to the Owner.

D. The Contract Drawings and Specifications are to be cooperative, and whatever is called for by either shall be binding as if called for by both.

1.8 USE OF EQUIPMENT

A. The use of any equipment, or any part thereof, for any purpose including testing even with the Owner's consent, shall not be construed to:

1. Be an acceptance of the work on the part of the Owner.
2. Obligate the Owner in any way to accept improper work or defective materials.
3. Be the basis for determining the beginning of the Contractor's guarantee or manufacturer's warrantee period.

1.9 LAYOUT DRAWINGS

A. Prepare layout drawings in accordance with Division 1 Section "Project Management and Coordination", and as specified below.

B. Prepare layout drawings drawn to scale showing the intended method of installation and construction. Coordinate work with all other trades. Use the Contract Drawings and Specifications as a guide in preparing coordination drawings. Comply with the full intent of the Contract Drawings. Deviate from the Contract Drawings only as required to resolve installation requirements. Layout drawings shall show the detailed routing of all piping and shall incorporate all requirements for; building structural systems; building architectural systems; and other items as may be required.

C. The layout drawings shall not be a repetition of the Contract Drawings. Prepare coordination drawings on a reproducible medium with dimensioned equipment and piping locations, elevations and mounting details. If available, electronic drawing files can be purchased from the Architect. Drawing size shall match contract drawing size. Post changes and modifications as they occur.
D. A set of layout drawings shall be kept on site and be available to the Architect, Owner's Project Representative, and others.

E. Layout drawings shall not be submitted to the Architect.

F. Update the layout drawings, when changes are made, so that these drawings represent the currently constructed (or about to be constructed) conditions.

G. Use the final layout drawings in preparing "Record Documents" as specified below and as specified in "Project Closeout Procedures" section.

1.10 RECORD DOCUMENTS

A. Prepare record documents in accordance with Division 1 Section "Project Closeout Procedures". In addition to the requirements specified in Division 1, indicate the following installed conditions:

1. Mains and branches of piping systems, and with items requiring maintenance located (i.e., backwater valves, etc.). Indicate actual inverts and horizontal locations of underground piping.
2. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

B. Engage the services of a Land Surveyor or Professional Engineer as specified in Division 1 Section "Field Engineering" to record the locations and invert elevations of underground installations.

1.11 MAINTENANCE AND OPERATING MANUALS

A. Prepare maintenance and operating manuals in accordance with Division 1 Section "Project Closeout Procedures". In addition to the requirements specified in Division 1, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating and maintenance data, parts list and procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures and schedule for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.
1.12 SUBMITTALS

A. General:
   1. Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Comply with the requirements of Section "Submittal Procedures" and as specified herein. All required submittals for an item shall be submitted in a complete single package.

C. Required submittals are listed in applicable Specification Sections. Submittals not required by these Specifications will not be reviewed and will not be returned.

D. After development and acceptance of the Contractor's construction schedule, prepare a complete schedule of submittals in accordance with the requirements of Section "Submittal Procedures".

E. The following submittals are required prior to bid submission:
   1. Proposed substitutions.
   2. The following submittals are required prior to construction start:
      a. Required product data.
      b. Required shop drawings.
   3. The following submittals are required prior to construction punch list:
      a. All required shop drawings and product data.
      b. Operating and maintenance manuals.
      c. Record documents.
      d. Guarantees and warranties.
      e. Certifications, inspection and test reports.

F. Shop Drawings:
   1. Submit manufacturer's technical product data, including rated capacities of selected model with clearly indicated, weights (shipping, installed, and operation), dimensions, required clearances, and methods of assembly of components, furnished specialties and accessories; and installation and start-up instructions.
   2. Submit maintenance data and parts list for all plumbing equipment; including "trouble shooting" maintenance guide; plus servicing, and preventative maintenance procedures and schedule. Include this data and product data in maintenance manual; in accordance with requirements of Division 1.
   3. Submit ladder-type wiring diagrams for power and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
1.13 CONSTRUCTION PUNCH LIST

A. Inspect the work and operate all systems prior to requesting the construction punch list to insure that the work is complete and operating in accordance with the requirements of the Contract Documents.

B. Prior to requesting construction punch list:
   1. Operate the system.
   2. Verify maintenance and operating manual work is complete, reviewed and accepted by the Owner's Representative.
   3. Verify system final adjustments and cleaning work is complete.

C. The final construction punch list time shall be coordinated with the Owner's Representative, providing; minimum one (1) week notice.

D. Provide sufficient personnel and portable telephones to demonstrate the operation of each system in each of the various modes of operation.

1.14 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Receive, properly house, handle, hoist, deliver to proper location, equipment and other material required.

C. After delivery, before and after installation, protect equipment and materials against theft, injury or damage from all causes.

D. Provide factory-applied plastic end-caps on each length of pipe and tube, except for concrete, corrugated metal, hub-and-spigot, clay piping. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

E. Protect stored pipes and tubes from moisture and dirt. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.

F. Protect flanges, fittings, and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

G. Protect stored plastic pipes from direct sunlight. Support to prevent sagging and bending.

H. Store equipment and materials in clean, dry space; store off the ground; protect from weather and physical damage.
1.15 QUALITY ASSURANCE

A. Applicable Codes and Standards.

B. Installer's qualifications: Minimum 5 years of installation experience on successful projects for the installing firm of the individual doing the installation, unless a higher minimum is otherwise specifically noted in other Specification Sections.

C. Welder's Qualifications:

1. Welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, and Brazing Qualifications.
4. Certifications: Submit welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" heading of this Section.

D. Provide the following stamps and labels:

1. "AGA" label on all gas fired equipment.
2. "UL" or "ETL" label on all equipment with electrical connections.
3. ASME Code stamp/label on all water heaters, tanks and receivers.

1.16 TEMPORARY PROTECTION AND UTILITIES

A. Provide temporary protection, construction water, heat and ventilation as specified in Division 1 Section "Temporary Facilities and Controls".

1.17 WARRANTY

A. All systems, components, parts, assemblies and labor furnished under this contract shall be warranted against defects in materials and workmanship in accordance with the General Conditions. Any manufacturing or component defects arising during this warranty period shall be corrected without cost to the Owner.

B. Additional warranty requirements, included in the individual specification sections, shall be considered requirements in addition to those of the General Conditions. In all instances, the most stringent requirements shall apply.
1.18 HOUSEKEEPING

A. Maintain the premises neat and orderly and thoroughly clean upon completion of the work.

PART 2 - PRODUCTS

A. All service water heating equipment; and all motors shall comply with the current state energy code, or the latest edition of the 2007 Edition of ASHRAE/IESNA Standard 90.1 – if no state energy code exists.

PART 3 - EXECUTION

3.1 ROUGH-INS

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in other Specification Sections and the Drawings for rough-in requirements.

3.2 INSTALLATION, COORDINATION AND SPECIAL PROVISIONS

A. Sequence, coordinate, and integrate the various elements of plumbing systems, materials, and equipment.

B. Sequence, coordinate, and integrate installations of plumbing materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

C. Coordinate plumbing systems, equipment, and materials installation with other building components.

D. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

E. Coordinate connection of plumbing systems with exterior underground services. Provide required connection for each service.

F. Verify all dimensions by field measurements.

G. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for plumbing installations.

I. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form.

J. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.3 CUTTING AND PATCHING

A. Perform cutting and patching in accordance with Division 1 Section "Cutting and Patching".

B. Perform cutting, fitting, and patching of plumbing equipment and materials required to:

1. Uncover Work to provide for installation of ill-timed Work.
2. Remove and replace defective Work.
3. Remove and replace Work not conforming to requirements of the Contract Documents.
4. Remove samples of installed Work as specified for testing.
5. Install equipment and materials in existing structures.
6. Upon written instructions from the Owner's Representative, uncover and restore Work to provide for observation of concealed Work.

C. Cut, remove and legally dispose of selected plumbing equipment, components and materials as indicated, including, but not limited to, removal of piping, and other plumbing items made obsolete by the new work.

D. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

E. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

F. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers. For installers' qualifications refer to the materials and methods required for the surface and building components being patched.

G. Refer to Division 1 Section "Definitions and Standards" for definition of "experienced Installer".

3.4 MAINTENANCE OF EXISTING UTILITY SERVICES

A. Uninterrupted normal use of the existing facilities must be maintained during the time required to perform the complete installation of the work indicated in the Contract Documents. It is mandatory that the existing buildings be maintained in service.
B. Investigate existing conditions and the location of all existing equipment and the location of all existing services before starting.

C. If a service is disturbed, immediately without regard for working hours, place the service back into operation.

D. Sufficient advance notice shall be given to the Owner and its permission obtained prior to interruption of present services. It should be assumed that disruption of utilities and services will be done at other than normal working hours. No additional or extra payment will be authorized to comply with these requirements.

E. Repair, replace and maintain in service any utilities, facilities, or services (underground, aboveground, interior or exterior) damaged, broken or otherwise rendered inoperative during the course of construction in the existing building.

F. All openings must be securely covered, or otherwise protected, to prevent injury due to carelessly or maliciously dropped tools or materials, grit, dirt, or any foreign matter. Damaged work shall be repaired or replaced until work is fully and finally accepted.

G. Protect motors, pumps, electrical equipment, plumbing equipment and all similar items of equipment from dirt, grime, plaster, paint and water during all phases of construction. This protection shall be provided by covering with transparent plastic sheeting.

3.5 DEMOLITION

A. General:

1. Demolish, remove, demount, and disconnect abandoned plumbing materials and equipment indicated to be removed and not indicated to be salvaged or saved.
2. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.
3. Locate, identify, and protect plumbing services passing through demolition area and serving other areas outside the demolition limits. Maintain services to areas outside demolition limits. When services must be interrupted, install temporary services for affected areas.
4. Clean area after demolition of work to satisfaction of Owner's Designated Representative.
5. Repair or replace equipment or materials damaged during demolition to satisfaction of Owner's designated representative.
6. Remove, reconnect, cap, plug and replace existing piping only where indicated in the Contract Documents.
7. Remove and/or replace existing equipment, valves, controls, etc., only where indicated in the Contract Documents.
B. Existing Active Piping:

1. When encountered protect, brace, and support existing active piping where required for proper execution of the work. If existing active piping is encountered that is not indicated or noted in the Contract Documents and that requires relocation, make request in writing to the Owner's Representative for a determination. Do not proceed with the work until written directions are received from the Owner's Representative. Do not prevent or disturb the operation of the active piping that is to remain.

C. Existing Inactive Piping:

1. When encountered in the Work, remove protect, cap or plug existing inactive piping. If existing inactive piping is encountered that is not indicated or noted in the Contract Documents and that interfere with the Work, make request in writing to the Owner's Representative for a determination.

D. Interruption of Existing Active Piping:

1. Where the Work makes temporary shut-down of services unavoidable, shut down at such time as approved by the Owner, which will cause least interference with established operating routine. Arrange to work continuously, including overtime, if required to make necessary connection to existing work.

E. Interruption of Existing Utility Service:

1. Coordinate the shut-off and disconnection of utility services with the Owner and the utility company.
2. Notify the Owner's Representative Owner's Project Representative at least 5 days prior to commencing demolition operations.

F. Scheduling:

1. Submit schedules indicating proposed methods and sequence of operations for demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.
2. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 1 Section "Summary of the Work".

3.6 TESTING, START-UP, AND TRAINING PROCEDURES

A. Develop and implement a plan and schedule for the testing, start-up, and training for all new plumbing equipment and systems. This plan will be specific to the project.

B. Provide any testing equipment and re-testing necessary.
C. In addition to all required submittal data for approval of the equipment, O & M Manuals, and warrantee information, provide documentation on all testing, start-up, and training activities. This documentation will include but is not limited to:

1. Installation, Start-up, and Check-out materials shipped with the equipment
2. Factory or Field Check-out forms used by factory or field technicians
3. Pre-functional and Functional Test Procedures and Check Lists
4. Re-testing of all deficiencies or non-conformance issues

D. All testing, start-up, and training will be scheduled in the Contractor’s Master Schedule. Seasonal testing and deferred testing will also be part of this contract. Seasonal tests will be delayed until weather conditions are closest to the system’s design. Deferred tests due to the building structure, required occupancy phasing, or other deficiencies will be completed as soon as possible. Seasonal and deferred testing will follow the same procedures, be witnessed by the same personnel, and require the same documentation.

E. All pre-functional and pre-start-up activities will be documented by the plumbing contractor and submitted before arrangements are made for the functional tests and start-up. At least 7 working days shall be provided.

F. Submit at project close-out with the as-built drawings, a document certifying that:

1. Systems were tested and function per design intent
2. Systems were installed per manufacturers recommendations and to industry accepted minimum standards
3. Systems received adequate operational check-out by installing contractors
4. Proper performance of equipment and systems was documented and given to the Owner.
5. O & M Manuals and as-built drawings are complete and accurate.
6. Owner’s operating personnel are adequately trained.

END OF SECTION
CEW
SECTION 220517 - SLEEVES AND SLEEVE SEALS 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.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 22 Section “Escutcheons for Plumbing Piping”.
2. Division 22 Section “Domestic Water Piping”.
3. Division 22 Section “Sanitary Waste And Vent Piping”.
4. Division 22 Section “Facility Storm Drainage Piping”.
5. Division 22 Section “Compressed-Air Piping For Laboratory And Healthcare Facilities”.
6. Division 22 Section “Lab Gas and Vacuum Piping”.
7. Division 22 Section “Vacuum Piping For Laboratory And Healthcare Facilities”.
8. Division 22 Section “Gas Piping For Laboratory And Healthcare Facilities”.
9. Division 22 Section “Chemical-Waste Systems”.

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.

1.3 SUBMITTALS

A. Product Data: None required.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
B. Galvanized-Steel Sleeves: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. Galvanized-Steel-Sheet Sleeves: 10 gauge minimum thickness; round tube closed with welded longitudinal joint.

2.2 STACK-SLEEVE FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.
2.4 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Presealed Systems.

B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT


B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.

   a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.

2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
Construction

1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION
A. Install stack-sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07 Section "Sheet Metal Flashing and Trim."
3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.
4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION
A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION
A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:
   a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves or Galvanized-steel wall sleeves or Sleeve-seal fittings.
   b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves or Galvanized-steel sleeves or Galvanized-steel-pipe sleeves.

2. Exterior Concrete Walls below Grade:
   a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel sleeves with sleeve-seal system or Sleeve-seal fittings.
      1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:
   a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel sleeves with sleeve-seal system or Sleeve-seal fittings.
      1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
4. Concrete Slabs above Grade:
   a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves or Stack-sleeve fittings or Sleeve-seal fittings.
   b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe sleeves or Stack-sleeve fittings.

5. Interior Partitions:
   b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 230517
CEW
SECTION 220518 - ESCUTCHEONS 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.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 22 Section “Sleeves And Sleeve Seals For Plumbing Piping”.
2. Division 22 Section “Domestic Water Piping”.
3. Division 22 Section “Sanitary Waste And Vent Piping”.
4. Division 22 Section “Facility Storm Drainage Piping”.
5. Division 22 Section “Commercial Water Closets and Urinals”.
6. Division 22 Section “Commercial Lavatories and Sinks”.
7. Division 22 Section “Commercial Showers”.
8. Division 22 Section “Emergency Plumbing Fixtures”.
9. Division 22 Section “Drinking Fountains And Water Coolers”.
10. Division 22 Section “Compressed-Air Piping For Laboratory And Healthcare Facilities”.
11. Division 22 Section “Compressed-Air Equipment For Laboratory And Healthcare Facilities”.
12. Division 22 Section “Vacuum Piping For Laboratory And Healthcare Facilities”.
13. Division 22 Section “Gas Piping For Laboratory And Healthcare Facilities”.
14. Division 22 Section “Chemical-Waste Systems”.

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

A. Product Data: None required.
PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.

E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.

1. Escutcheons for 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. Insulated Piping: One-piece, stamped-steel type.
   d. Bare Piping at Wall and Floor Penetrations: One-piece, cast-brass type with polished, chrome-plated finish.
   e. Bare Piping at Ceiling Penetrations: One-piece, cast-brass type with polished, chrome-plated finish.

2. Escutcheons for Existing Piping:
a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.

b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.

c. Bare Piping at Wall and Floor Penetrations: Split-casting brass type with polished, chrome-plated finish.

d. Bare Piping at Ceiling Penetrations: Split-casting brass type with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

   1. New Piping: One-piece, floor-plate type.
   2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 220518

CEW
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.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 5 Section “Post-Installed Anchors” for selection, design, and installation of post installed anchors.
2. Division 22 Section “Domestic Water Piping”.
3. Division 22 Section “Domestic Water Pumps”.
4. Division 22 Section “Domestic-Water Packaged Booster Pumps”.
5. Division 22 Section “Sanitary Waste and Vent Piping”.
6. Division 22 Section “Facility Storm Drainage Piping”.
7. Division 22 Section “Plumbing Pumps”.
8. Division 22 Section “Domestic Water Softeners”.
9. Division 22 Section “Domestic Water Filtration Equipment”.
10. Division 22 Section “Gas Fired Domestic Water Heaters”.
11. Division 22 Section “Commercial Water Closets and Urinals”.
12. Division 22 Section “Commercial Lavatories and Sinks”.
13. Division 22 Section “Commercial Showers”.
14. Division 22 Section “Emergency Plumbing Fixtures”.
15. Division 22 Section “Drinking Fountains and Water Coolers”.
16. Division 22 Section “Compressed-Air Piping for Laboratory and Healthcare Facilities”.
17. Division 22 Section “Compressed-Air Equipment for Laboratory and Healthcare Facilities”.
18. Division 22 Section “Vacuum Piping for Laboratory and Healthcare Facilities”.
19. Division 22 Section “Vacuum Equipment for Laboratory and Healthcare Facilities”.
20. Division 22 Section “Gas Piping for Laboratory and Healthcare Facilities”.
21. Division 22 Section “Chemical-Waste Systems”.
22. Division 22 Section “Processed Water Systems for Laboratory and Healthcare Facilities”.

1.2 SUMMARY

A. Section Includes:

1. Supplemental framing
2. Metal pipe hangers and supports (horizontal and vertical).
4. Saddles and shields.
5. Trapeze pipe hangers.
6. Metal framing systems.
7. Thermal-hanger shield inserts.
8. Fastener systems.
9. Roof pipe supports.
10. Equipment supports.
11. Miscellaneous materials.

B. Provide all supports, supplemental framing, anchors, guides, platforms, and bases for all new equipment, and piping as specified in this Section; and as indicated on the drawings; and/or specified in other Division-22 Sections.

C. Supports that are an integral part of factory-fabricated equipment are specified as part of equipment assembly in other Division-22 Sections.

D. Support components or systems shown on the Drawings are minimum requirements and are to be used as a guide only.

E. Provide all supports, supplemental framing, anchors, guides, platforms, and bases for all new equipment, and piping as specified in this Section; and as indicated on the drawings; and/or specified in other Division-22 Sections.

F. Supports that are an integral part of factory-fabricated equipment, are specified as part of equipment assembly in other Division-22 Sections.

G. Support components or systems shown on the Drawings are minimum requirements and are to be used as a guide only.

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, including comprehensive engineering analysis by a qualified professional structural engineer, 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. Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Section.

B. Shop Drawings: Provide fabrication and installation details and include calculations for each type of attachment for each piping system. Provide product data for all hanger and attachments.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis by a qualified professional structural engineer responsible for their preparation.
   1. Detail fabrication and assembly of trapeze hangers.
   2. Design Calculations: Calculate requirements for designing trapeze hangers.

D. Welding certificates.

1.6 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:
   1. Code Compliance: Comply with all applicable codes, including ANSI, pertaining to product materials and installation of supports and anchors.
   2. UL and FM Compliance: Provide products, where applicable, which are UL-listed and FM approved.
   3. MSS Standard Compliance:
      a. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.
      b. Select and install pipe hangers and supports, complying with MSS SP-69.
      c. Fabricate and install pipe hangers and supports, complying with MSS SP-89.
      d. Terminology used in this Section is defined in MSS SP-90.
   7. Pre-construction Meeting: Coordinate installation of concrete inserts and all building attachments with installers of related work, prior to the start of construction.
C. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver all materials to project site in manufacturer’s original packaging, marked with manufacturer’s name, product model names and catalog numbers, identification numbers, and other related information.

B. Store materials under cover until needed for installation.

PART 2 - PRODUCTS

2.1 GENERAL

A. All supports and parts shall conform to the latest requirements of ANSI Code for Power Piping B31.1. and MSS Standard Practice SP-58, except as supplemented or modified by the requirements of this Specification.

B. Hangers shall be designed so that they cannot become disengaged by movement of the supported pipe.

C. Rigid riser supports shall be designed so that the load is always equalized, and at no time can one side of the support be completely unloaded by the riser moving out of plumb, thereby transferring the entire load to the opposite side. Wherever practical, support riser piping independently of the connected horizontal piping.

D. Hangers, supports, hanger rod attachments and building attachments shall be provided by the same manufacturer where possible.

2.2 SUPPLEMENTAL FRAMING

A. Provide supplemental framing for the following conditions:

1. Where the anchor locations do not align with the structural framing.
2. Where the intended loads exceed the structural framing maximum load carrying capacity.
3. Floor mounted supplemental supports may only be used where indicated or with specific approval of the Owner's Representative.
2.3 METAL PIPE HANGERS AND SUPPORTS

A. The following are acceptable manufacturers subject to compliance with specified requirements.

1. Michigan Hanger Co.
2. Carpenter and Patterson, Inc.
3. Anvil International.

B. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-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.

C. Copper Pipe Hangers:

1. Description: MSS SP-58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

2.4 PIPING HANGERS AND SUPPORTS DESCRIPTION

A. General:

1. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping.

B. Adjustable Steel Clevis Hangers: MSS Type 1.

C. Steel Double Bolt Pipe Clamps: MSS Type 3.

D. U-Bolts: MSS Type 24, with plastic coating for glass, aluminum, brass and copper piping systems.
E. Pipe Stanchion Saddles: MSS Type 37, including steel pipe base support and cast-iron floor flange.

2.5 VERTICAL-PIPING CLAMPS

A. General:

1. Select size of vertical piping clamps to exactly fit pipe size of bare pipe.

B. Two-Bolt Riser Clamps: MSS Type 8.

C. Four-Bolt Riser Clamps: MSS Type 42.

2.6 HANGER-ROD ATTACHMENTS

A. General:

1. Hanger rods and attachments to the structure shall be subjected to tensile loading only and shall be designed with a minimum safety factor of five (5). Hanger rod diameters shall be compatible with the other component parts of the hanger assembly.

2. Select size of hanger-rod attachments to suit hanger rods.

B. Steel Turnbuckles: MSS Type 13.

C. Steel Clevises: MSS Type 14.
D. Swivel Tumbuckles: MSS Type 15.

E. Malleable Iron Sockets: MSS Type 16.

F. Steel Weldless Eye Nuts: MSS Type 17.

2.7 BUILDING ATTACHMENTS

A. General:

1. Select attachments to suit building substrate conditions.
2. Select size of building attachments to suit hanger rods, load restrictions and building material.
3. Provide supplemental framing wherever hanger locations are not directly below building attachment locations.
4. Do not attach supports to metal floor decking (or roof decking) panels.
5. “C” Clamps:

   a. The use of “C” clamps and beam clamps of “C” pattern and any modification thereof is prohibited for any and all attachments.

B. Concrete Inserts: MSS Type 18.
C. Center Beam Clamps: MSS Type 21.

D. Linked Steel Clamps w/ Eye Nut: MSS Type 29.

E. Steel Beam Clamp w/ Eye Nut: MSS Type 28.

F. Malleable Beam Clamp with Extension Piece: MSS Type 30.

G. Steel Brackets: One of the following for indicated loading:
   1. Loading up to 750 lbs.: MSS Type 31.
   2. Loading up to 1500 lbs.: MSS Type 32.
3. Loading up to 3000 lbs.: MSS Type 33.

2.8 SADDLES AND SHIELDS

A. General:
1. Except as otherwise indicated, provide factory-fabricated saddles or shields under piping hangers and supports for all insulated piping.
2. Size saddles and shields for exact fit to mate with pipe insulation.

B. Protection Saddles: MSS Type 39.
1. Fill interior voids with segments of insulation matching adjoining insulation.
2. Saddle shall be of same material as pipe.

C. Protection Shields: MSS Type 40.
1. Length and gage as recommended by manufacturer to prevent crushing of insulation.
2. Manufacturer: Subject to compliance with requirements, provide thermal hanger shields of one of the following:
   a. Pipe Shields, Inc.

2.9 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.
2.10 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.
   c. Flex-Strut Inc.
   d. GS Metals Corp.
   e. Thomas & Betts Corporation.
   f. Unistrut Corporation; Tyco International, Ltd.
   g. Wesanco, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.


4. Channels: Continuous slotted steel channel with inturned lips.

   a. Aluminum: Strut shall be manufactured of extruded aluminum alloy 6063-T6. All fittings and hardware shall be zinc plated according to ASTM B633. For outdoor use, all fittings and hardware shall be stainless steel Type 316 or chromium zinc, ASTM F1136 Gr.3.

   b. Epoxy Painted: Strut shall be made from steel meeting the minimum mechanical properties of ASTM A1011 33,000 PSI min. yield, then painted with water born epoxy applied by a cathodic electro-deposition process. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A1018 33,000 PSI min. yield. The fittings shall have the same epoxy finish as the strut. Threaded hardware shall be zinc plated in accordance with ASTM B633 Service Class 1. Service Class 1 in not an acceptable coating for fittings or components other than threaded hardware.

   c. Pre-Galvanized Steel: Strut shall be made from steel meeting the minimum mechanical properties of ASTM A653 33,000 PSI min. yield, mill galvanized coating designation G90. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A1018 33,000 PSI min. yield and zinc plated in accordance with ASTM B633 Service Class 3. Threaded hardware shall be zinc plated in accordance with ASTM B633 Service Class 1. Service Class 1 in not an acceptable coating for fittings or components other than threaded hardware.

   d. Hot-Dip Galvanized Steel: Strut shall be made from steel meeting the minimum mechanical properties of ASTM A1011 33,000 PSI min. yield and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A1018 33,000 PSI min. yield, and hot-dip galvanized after fabrication in accordance with ASTM A123. All hardware shall be stainless steel Type 316 or chromium zinc ASTM F1136 Gr.3. All hot-dip galvanized after fabrication products must be returned to point of manufacture after coating for inspection and removal of all sharp burrs.
e. Stainless Steel: All strut, fittings and hardware shall be made of AISI type 316 stainless steel.

5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.


7. Metallic Coating: Hot-dipped galvanized or Mechanically-deposited zinc.


2.11 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carpenter & Paterson, Inc.
3. ERICO International Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: 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) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.

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.

2.12 FASTENER SYSTEMS

A. Refer to Division 05 Section “Post-Installed Anchors”.

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2.13 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.14 ROOF PIPE SUPPORTS

A. System Description: Support piping on roof with an engineered, prefabricated system designed for installation without roof penetrations, flashings, or damage to the roofing material. The system shall consist of bases, made of high density, polypropylene plastics with UV Protection, a HDG structural steel frame, and suitable pipe hangers for the application. Nuts, threaded rods and washers shall be HDG, spring nuts, and bolts for spring nuts, will be electro-plated. System shall be custom designed to fit piping and conduit to be installed, and the actual conditions of service.

B. Support pipes, conduit, a minimum of 6 inches (150 mm) above roof surface

1. Support Spacing: 10 feet MAXIMUM.
2. On Sloped Roof Surfaces, where slope exceeds ¼ inch per foot (13 mm per 305 mm); provide base with swivel for slope adjustment. Note: Provide approved bracing when using base with swivel.
3. Un-insulated Piping: Roller support or clevis hanger.
4. Insulated Piping: Band hanger supported form horizontal channel or clevis hanger with Insulation Protection Shield.
5. Conduit: Band hanger supported from horizontal channel.
6. Bracing required when using base with swivel; when pipe exceeds 24 inches (610 mm) above roof, or when thermal expansion of pipe is great.

C. Materials

1. Portable Support System: Engineered, portable system specifically designed for installation without the need for roof penetrations, or flashings, and without causing damage to the roofing membrane.
   a. Design system using high density, high impact polypropylene bases with carbon black, anti-oxidants for UV protection, and steel framing of 1-5/8 inch (41 mm) or 1-7/8 inch (48 mm) for support.
   b. Custom design system to fit piping, conduits, to be installed and actual conditions of service and loading.
   c. Piping Supports: Provide suitable hangers and supports.

2. Bases: Injection molded high density, high impact polypropylene with UV-inhibitors and anti-oxidants, conforming to the following:
   a. Moisture Content: Negligible.
   b. Shrinkage/Swelling Due to Moisture: Negligible.
   c. Density: 55.8 lb/cu ft (894 kg/cu m).
d. Insect Resistance: No known insect damage potential.
ed. Chemical Resistance (oil, brake fluid, gasoline, diesel, antifreeze, battery acid, and sulfuric acid) No visual or physical change apparent.
f. Flammability: No ignition after 10 minutes, 25 kW/m, when tested in accordance with ASTM D 1929.
g. Sized as required by loading conditions and as indicated on the drawings.
h. Shop fabricated with inserts for square tubing or threaded rods as required.
i. Color: Integral black color as molded.
j. Bases for Mechanical Attachment: Sealant chamber around penetration point, with injection port for sealing after fastening; beveled lip for sealant bead around entire diameter.
k. Do not use bases containing carbonated plastics, press molded recycled rubber and plastics, steel, stainless steel, or any injection molded threaded receivers.

3. Steel Framing:
   a. Channel Types: 1-5/8 inch (41.3 mm) 1-7/8 inch (47.6 mm) as required for loading conditions.
b. Thickness: 12 gage (2.7 mm).
c. Form: Roll-formed 3-sided or tubular channel, perforated with 9/16 inch (14.2 mm) holes at 1-7/8 inch (47.6 mm) centers on three sides.
d. Finish: Hot dip galvanize in accordance with ASTM A 123 after fabrication, free of roughness, whiskers, unsightly spangles, icicles, runs, barbs, sags, droplets, and other surface blemishes.
e. Do not use tubing or tube steel.

4. Stainless Steel Framing:
   a. Channel Types: 1-5/8 inch (41.3 mm) or 1-7/8 inch (47.6 mm), as required for loading conditions.
b. Thickness: 12 gage (2.7 mm).
c. Form: Roll-formed 3-sided or tubular channel.
d. Finish: Mill finish.
e. Do not use tubing or tube steel.

5. Pipe Supports and Hangers: Conform to MSS SP-58 and MSS SP-69 and as follows:
   a. Fabricated of carbon steel where framing is carbon steel; fabricated of stainless steel where framing is stainless steel; finished same as framing.
b. Sizes 2-1/2 inch (63 mm) and smaller: Single roller supports for piping subject to expansion and contraction; 3-sided channels and pipe clamps.
c. Sizes 3 inches (76 mm) and larger: Rollers, clevis hangers, or band hangers, to allow for expansion and contraction without movement of the bases or framing.

6. Accessories: Clamps, bolts, nuts, washers, and other devices as required for a complete system.
   a. Carbon Steel: Hot-dip galvanizied in accordance with ASTM A 153/A 153M.
b. Stainless Steel: Mill finish.

2.15 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Metal Framing: NEMA STD ML 1.

C. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Heavy Duty Steel Trapezes: Fabricated steel shapes for loads required. Weld steel in accordance with AWS Standards.

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. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:
   1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions. Locate steel
reinforcing member with PACOMETER or other approved means to avoid resteel during anchor installation.

F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.


H. 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.

I. Install bracing with pipe hangers and supports to prevent swaying.

J. Install building attachments within concrete slabs or attach to supplemental 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.

K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

L. 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.

M. 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.

3.2 ROOF PIPE SUPPORTS

A. Examination
   1. Verify that roofing system is complete and roof surfaces are smooth, flat, and ready to receive work of this section.
   2. Verify that roof surface temperature is at minimum 60 °F (15.5°C) for proper adhesive performance.

B. Preparation
   1. Clean surfaces of roof in areas to receive portable support bases.
      a. Sweep loose gravel from gravel surfaced roofs.
      b. Remove dirt, dust, oils, and other foreign materials.
   2. Use care in handling portable supply system components during installation, to avoid damage to roofing, flashing, equipment, or related materials.

C. Installation
   1. Pipe Support Systems
      a. Locate bases and support framing as indicated on drawings and as specified herein. Provide complete and adequate support of all piping and conduit; whether or not all required devices are shown.
      b. The use of wood for supporting piping is not permitted.
      c. Provide support spacing so deflection of piping does not exceed 1/240 of span.
      d. Install framing at spacing indicated, but in no case at greater than 10 feet (3 m) on center.
      e. Accurately locate and align bases.
1) Consult manufacture of existing system as to the type of isolation pads required between the roof and base.

2) Set isolation panels in adhesive, if required by manufacturer’s instructions.

3) Place bases on isolation pads.

4) Adhere or mechanically attach, if required by code.

5) Where applicable, replace gravel around bases.

f. Set framing posts into bases and assemble framing structure as indicated.

g. Use galvanized fasteners for galvanized framing and stainless steel fasteners for stainless steel framing.

D. Cleaning and Protection

1. Remove all packaging, unused fasteners, adhesive and other installation materials from the project site.

2. Remove adhesive from exposed surfaces of supports and bases, and leave the work area in clean condition.

3. Provide protection as required, leaving the work area in undamaged condition at the time of completion of work.

3.3 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 bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

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

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve uniform slope of pipe to assure complete drainage and compensate for pipe deflection between hangers.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm) past the end of the nut.

3.6 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.7 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, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
F. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
2. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 (DN 20 to DN 900), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
3. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.
4. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
5. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8 (DN 20 to DN 200).
6. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
7. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8 (DN 15 to DN 200).
8. 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).
9. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8 (DN 10 to DN 200).
10. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3 (DN 10 to DN 80).
11. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
12. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
13. Pipe Saddle Supports (MSS Type 36): 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.
14. 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.
15. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (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.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
3. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
4. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
5. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
6. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Light (MSS Type 31): 750 lb. (340 kg).
   b. Medium (MSS Type 32): 1500 lb. (680 kg).
   c. Heavy (MSS Type 33): 3000 lb (1360 kg).

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

P. Install anchors in accordance with Division 05 Section “Post-Installed Anchors”.

END OF SECTION 230529
CEW
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.

B. Related Sections: The following Sections contain requirements that relate to this Section.

1. Division 22 Section “General-Duty Valves for HVAC Piping”.
2. Division 22 Section “Domestic Water Piping”.
3. Division 22 Section “Domestic Water Piping Specialties”.
4. Division 22 Section “Domestic Water Pumps”.
5. Division 22 Section “Domestic-Water Packaged Booster Pumps”.
6. Division 22 Section “Sanitary Waste and Vent Piping”.
7. Division 22 Section “Sanitary Waste Interceptors”.
8. Division 22 Section “Facility Storm Drainage Piping”.
9. Division 22 Section “Plumbing Pumps”.
10. Division 22 Section “Domestic Water Softeners”.
11. Division 22 Section “Domestic Water Filtration Equipment”.
12. Division 22 Section “Gas Fired Domestic Water Heaters”.
13. Division 22 Section “Compressed-Air Piping for Laboratory and Healthcare Facilities”.
14. Division 22 Section “Compressed-Air Equipment for Laboratory and Healthcare Facilities”.
15. Division 22 Section “Vacuum Piping for Laboratory and Healthcare Facilities”.
16. Division 22 Section “Vacuum Equipment for Laboratory and Healthcare Facilities”.
17. Division 22 Section “Gas Piping for Laboratory and Healthcare Facilities”.
18. Division 22 Section “Chemical-Waste Systems”.
19. Division 22 Section “Processed Water Systems for Laboratory and Healthcare Facilities”.

1.2 SUMMARY

A. Extent of plumbing identification work required by this Section is indicated on Drawings and/or specified in other Division Sections containing plumbing work.

B. Types of identification devices specified in this Section include the following:

1. Pipe identification labels.
2. Underground-type plastic line markers.
3. Equipment labels.
4. Warning signs and labels.
5. Valve tags.
6. Valve schedule frames.
7. Engraved plastic-laminate signs.
8. Plasticized tags.
9. Warning tags.

1.3 SUBMITTALS

A. General:

1. Submit each item in this Article according to the Conditions of the Contract and Division Specification Sections.

B. Product Data:

1. None required.

C. Shop Drawings:

1. None required.

D. Samples:

1. None required.

1.4 COORDINATION

A. Coordinate installation of underground pipe identifying devices with completion of trench backfilling.

B. Coordinate names, abbreviations and other designations used in plumbing identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of plumbing systems and equipment.

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.
PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide mechanical identification materials of one of the following:

1. Allen Systems, Inc.
3. Craftmark Products Inc.
4. Industrial Safety Supply Co., Inc.
5. Seton Name Plate Corp.

2.2 PIPE IDENTIFICATION LABELS

A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid, snap-on, color-coded pipe identification labels, complying with ANSI A13.1.

B. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125 deg. F or greater. Cut length to extend 2" beyond each end of plastic pipe marker.

C. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:

1. Snap-on application of pre-tensioned semi-rigid plastic pipe identification label.
2. Laminated or bonded application of pipe identification label to pipe (or insulation).

D. Large Pipes: For external diameters of 6" and larger (including insulation, if any), provide either full-band or strip-type pipe identification labels, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:

1. Laminated or bonded application of pipe identification label to pipe (or insulation).
2. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

E. Lettering: Comply with piping system nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application length.

1. Arrows: Print each pipe identification label with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.
2.3 UNDERGROUND-TYPE PLASTIC LINE MARKERS
A. Manufacturer's standard permanent, bright-colored continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe.

1. Provide multi-ply tape consisting of solid aluminum foil core between 2-layers of plastic tape.

2.4 EQUIPMENT LABELS
A. Plastic Labels for Equipment:

1. General: Provide manufacturer's standard laminated plastic, color coded equipment identification labels. Conform to the following color code, for background color.
   a. Green: Cooling equipment and components.
   b. Yellow: Heating equipment and components.
   c. Yellow/Green: Combination cooling and heating equipment and components.
   e. Blue: Equipment and components that do not meet any of the above criteria.
   f. Use colors and designs recommended by ANSI A13.1 for hazardous equipment.

2. Nomenclature: Include the following, matching terminology on schedules as closely as possible:
   a. Name and plan number.
   b. Equipment service.
   c. Design capacity.
   d. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.

3. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.


5. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

6. 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).

7. 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.

2.5 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

E. 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).

F. 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.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.6 VALVE TAGS

A. Provide 1-1/2" diameter 19-gage polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.

B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.

C. Access Panel Markers: Provide manufacturer's standard 1/16" thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8" center hole to allow attachment.

D. 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.

2.7 VALVE SCHEDULE FRAMES

A. For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

2.8 ENGRAVED PLASTIC-LAMINATE SIGNS

A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

B. Thickness: 1/16" for units up to 20 sq.in. or 8" length; 1/8" for larger units.

C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.9 PLASTICIZED TAGS

A. Manufacturer's standard pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matte finish suitable for writing, approximately 3-1/4" x 5-5/8", with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples: DANGER, CAUTION, DO NOT OPERATE).

2.10 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4 by 7 inches (100 by 178 mm).
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
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 plumbing equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Install pipe identification labels of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:

1. Plastic pipe identification labels, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.

B. Locate pipe identification labels and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.

1. Near each valve and control device.
2. Near each branch, excluding short take-offs for fixtures; mark each pipe at branch, where there could be question of flow pattern.
3. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
4. At access doors, manholes and similar access points which permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced intermittently at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment.
7. On piping above ceilings.

C. Pipe Label Color Schedule: Comply with Owner’s standards, if there are not standards then comply with ANSI A13.1.
3.4 UNDERGROUND PIPING IDENTIFICATION

A. During backfilling/topsoiling of underground piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker.

3.5 VALVE-TAG INSTALLATION

A. Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, plumbing fixture faucets, convenience and lawn-watering hose bibbs, and shut-off valves at plumbing fixtures, and similar rough-in connections of end-use fixtures and units. List each tagged valve in valve schedule for each piping system.

B. Mount valve schedule frames and schedules in machine rooms where indicated or, if not otherwise indicated, where directed by Architect/Engineer.

1. Where more than one major machine room is shown for project, install mounted valve schedule in each major machine room, and repeat only main valves which are to be operated in conjunction with operations of more than single machine room.

3.6 EQUIPMENT IDENTIFICATION

A. General: Install engraved plastic laminate sign or plastic equipment identification label on or near each major item of mechanical equipment and each operational device as specified herein, unless specified otherwise for each item or device. Provide signs for the following general categories of equipment and operational devices.

1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
2. Fuel-burning units.
3. Pumps.
4. Tanks and pressure vessels.
5. Strainers, filters, water treatment systems and similar equipment.

B. Lettering Size: Minimum 1/4" high lettering for name of unit where viewing distance is less than 2'-0", 1/2" high for distances up to 6'-0", and proportionately larger lettering for greater distances. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.

C. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
D. Optional use of Plasticized Tags: At Installer's option, where equipment to be identified is concealed above acoustical ceiling or similar concealment, plasticized tags may be installed within concealed space to reduce amount of text in exposed sign (outside concealment).

3.7 WARNING-TAG INSTALLATION

A. Record message on, and attach warning tags to, equipment and other items where required.

3.8 ADJUSTING AND CLEANING

A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.

B. Cleaning: Clean face of identification devices, and frames of valve charts.

3.9 EXTRA STOCK

A. Furnish minimum of 5% extra stock of each mechanical identification material required, including additional numbered valve tags (not less than 3) for each piping system, additional piping system identification markers and additional plastic laminate engraving blanks of assorted sizes.
SECTION 220719 - 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.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 22 Section “Basic Plumbing Requirements”.
2. Division 22 Section “Sleeves and Sleeve Seals for Plumbing Piping”.
3. Division 22 Section “Escutcheons for Plumbing Piping”.
4. Division 22 Section “General-Duty Valves for Plumbing Piping”.
5. Division 22 Section “Hangers and Supports for Plumbing Piping and Equipment”.
6. Division 22 Section “Identification for Plumbing Piping and Equipment”.
7. Division 22 Section “Domestic Water Piping”.
8. Division 22 Section “Domestic Water Piping Specialties”.
9. Division 22 Section “Plumbing Pumps”.
10. Division 22 Section “Domestic-Water Packaged Booster Pumps”.
11. Division 22 Section “Sanitary Waste and Vent Piping”.
12. Division 22 Section “Sanitary Waste Piping Specialties”.
13. Division 22 Section “Facility Storm Drainage Piping”.
14. Division 22 Section “Storm Drainage Piping Specialties”.
15. Division 22 Section “Chemical-Waste Systems”.
16. Division 22 Section “Processed Water Systems for Laboratory and Healthcare Facilities”.

1.2 SUMMARY

A. Section includes insulating the following plumbing piping services:

1. Domestic cold-water piping.
2. Domestic hot-water piping.
3. Domestic recirculating hot-water piping.
4. Storm-water piping.
5. Sanitary piping.

1.3 SUBMITTALS

A. Product Data: None required.
B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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. Firm with at least 5 years successful experience on projects with mechanical insulations similar to that for this Project.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

C. Comply with the following applicable standards and other requirements specified for miscellaneous components:


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 sizes and locations 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.
1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. Aeroflex USA, Inc.; Aerocel.
   b. Armacell LLC; AP Armaflex.
   c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.

F. 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.; SoftTouch Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Friendly Feel Duct Wrap.
   d. Manson Insulation Inc.; Alley Wrap.
   e. Owens Corning; SOFTR All-Service Duct Wrap.

G. Mineral-Fiber, Preformed Pipe Insulation:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Fibrex Insulations Inc.; Coreplus 1200.
   b. Johns Manville; Micro-Lok.
   c. Knauf Insulation; 1000-Degree Pipe Insulation.
   d. Manson Insulation Inc.; Alley-K.
   e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 Deg F (454 Deg C) Materials: Mineral or glass fibers bonded with a thermostetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 INSULATING CEMENTS

   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Ramco Insulation, Inc.; Super-Stik.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Ramco Insulation, Inc.; Thermokote V.

   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

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. Flexible Elastomeric: 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.; Aerosel.
      b. Armacell LLC; Armaflex 520 Adhesive.
      d. K-Flex USA; R-373 Contact Adhesive.
2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges - Marathon Industries; 225.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. ASJ, Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges - Marathon Industries; 225.
   d. Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
   b. Vimasco Corporation; 749.
2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges - Marathon Industries; 501.
   d. Mon-Eco Industries, Inc.; 55-10.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.03 metric perm) at 35-mil (0.9-mm) dry film thickness.
3. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).

2.5 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:
   b. Eagle Bridges - Marathon Industries; 405.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
   d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
6. For indoor applications, use sealants that have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.6 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

2.7 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. (68 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm) for covering pipe and pipe fittings.

1. Products: Subject to compliance with requirements, provide one of the following:


2.8 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:

   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Compac Corporation; 104 and 105.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches (75 mm).
3. Thickness: 11.5 mils (0.29 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

2.9 SECUREMENTS

A. Bands:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. ITW Insulation Systems; Gerrard Strapping and Seals.
      b. RPR Products, Inc.; Insul-Mate Strapping and Seals.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide with wing seal.

3. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) wide with wing seal.

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.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2.10 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Truebro; a brand of IPS Corporation.

2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

B. Protective Shielding Piping Enclosures:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Truebro; a brand of IPS Corporation.
2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

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 piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.
H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch- (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, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
P. For above-ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.

3.4 PENETRATIONS

A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

B. 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" for firestopping and fire-resistive joint sealers.

C. 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. 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 QUALITY CONTROL

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

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Testing Agency or 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.

2. Inspect ductwork, randomly selected by Testing Agency or 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.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on 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.

3.8 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
   4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe 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.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. 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.

3.10 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. Drainage piping located in crawl spaces.
   2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.11 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water:
   1. **NPS 1 (DN 25) and Smaller**: 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.
   2. **NPS 1-1/4 (DN 32) and Larger**: 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.

B. Domestic Hot and Recirculated Hot Water:

1. NPS 1-1/4 (DN 32) and Smaller: Insulation shall be one of the following:
   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

2. NPS 1-1/2 (DN 40) and Larger: Insulation shall be one of the following:
   a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inch (385 mm) thick.

C. Stormwater and Overflow:

a. Roof Drain Leader and Horizontal: Insulation shall be one of the following:

   1) Flexible Elastomeric: 1 inch (25 mm) thick.
   2) Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

D. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet (3 m) of Drain Receiving 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 (25 mm) thick.
   b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

END OF SECTION 220719
CEW
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.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 22 Section “Basic Plumbing Requirements.”
2. Division 22 Section “Sleeves and Sleeve Seals for Plumbing Piping”.
3. Division 22 Section “Escutcheons for Plumbing Piping”.
4. Division 22 Section “Meters and Gages for Plumbing Piping”.
5. Division 22 Section “General-Duty Valves for Plumbing Piping”.
6. Division 22 Section “Hangers and Supports for Plumbing Piping and Equipment”.
7. Division 22 Section “Identification for Plumbing Piping and Equipment”.
8. Division 22 Section “Domestic Water Piping Specialties”.
9. Division 22 Section “Plumbing Pumps”.
10. Division 22 Section “Domestic-Water Packaged Booster Pumps”.
11. Division 22 Section “Domestic Water Softeners”.
12. Division 22 Section “Domestic Water Filtration Equipment”.
13. Division 22 Section “Gas Fired Domestic Water Heaters”.
14. Division 22 Section “Commercial Water Closets and Urinals”.
15. Division 22 Section “Commercial Lavatories and Sinks”.
16. Division 22 Section “Commercial Showers”.
17. Division 22 Section “Emergency Plumbing Fixtures”.
18. Division 22 Section “Drinking Fountains and Water Coolers”.
19. Division 22 Section “Processed Water Systems for Laboratory and Healthcare Facilities”.

1.2 SUMMARY

A. Section Includes:

1. Aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
2. Specialty valves.

1.3 SUBMITTALS

A. Product Data: None required.
1.4 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
B. Comply with NSF 61 for potable domestic water piping and components.

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.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
4. Copper Pressure-Seal-Joint Fittings:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Elkhart Products Corporation; Industrial Division.
      2) NIBCO INC.
      3) Viega; Plumbing and Heating Systems.
   b. NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber O-ring seal in each end.
   c. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber O-ring seal in each end.

2.3 GALVANIZED-STEEL PIPE AND FITTINGS


2. Flanges: ASME B16.1, Class 125, cast iron.
2.4 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, unless otherwise indicated; full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

2.5 SPECIALTY VALVES

A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.

B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

2.6 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Central Plastics Company.
   d. Jomar International Ltd.
   e. Matco-Norca, Inc.
   g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   h. Wilkins; a Zurn company.

2. Description:
   b. Pressure Rating: 150 psig (1035 kPa).
   c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:
Construction

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Central Plastics Company.
   c. Matco-Norca, Inc.
   d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   e. Wilkins; a Zurn company.

2. Description:
   b. Factory-fabricated, bolted, companion-flange assembly.
   c. Pressure Rating: 150 psig (1035 kPa).
   d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.

2. Description:
   a. Nonconducting materials for field assembly of companion flanges.
   b. Pressure Rating: 150 psig (1035 kPa).
   c. Gasket: Neoprene or phenolic.
   d. Bolt Sleeves: Phenolic or polyethylene.
   e. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Elster Perfection.
   b. Grinnell Mechanical Products.
   c. Matco-Norca, Inc.
   d. Precision Plumbing Products, Inc.
   e. Victaulic Company.

2. Description:
a. Standard: IAPMO PS 66
b. Electroplated steel nipple, complying with ASTM F 1545.
c. Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
d. End Connections: Male threaded or grooved.
e. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Division 31 Section "Earthwork Outside Buildings" for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install shutoff valve immediately upstream of each dielectric fitting.

D. Install domestic water piping level without pitch and plumb.

E. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

F. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

G. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

H. Install piping adjacent to equipment and specialties to allow service and maintenance.

I. Install piping to permit valve servicing.

J. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

K. Install piping free of sags and bends.

L. Install fittings for changes in direction and branch connections.
M. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

N. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22 Section "Sleeves and Sleeve Seals for Plumbing Piping."

O. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22 Section "Escutcheons for Plumbing Piping."

3.3 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. Soldered Joints: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Pressure-Sealed Joints: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.

G. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures
that do not have supply stops. Use ball or gate valves for piping NPS 2 (DN 50) and smaller. Use butterfly or gate valves for piping NPS 2-1/2 (DN 65) and larger.

C. Install hose-end drain valves with chains and caps 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."


D. Install isolation valve, balancing valve and check valve with check valve and isolation valve in each hot-water circulation return branch. Set balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves.

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, 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 1 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/4 and NPS 2 (DN 25 to DN 50): 96 inches (1800 mm) with 3/8-inch (10-mm) rod.
3. NPS 2-1/2 (DN 65) to NPS 4 (DN 100): 10 feet (3 m) with 5/8-inch 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 1-1/2 (DN 40) and Smaller: 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
2. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
3. NPS 2-1/2 (DN 65) to NPS 3-1/2 (DN 90): 12 feet (3.4 m) with 1/2-inch (13-mm) rod.
4. NPS 4 (DN 100): 14 feet (3.7 m) with 5/8-inch (16-mm) rod.

G. Install supports for vertical steel piping every 15 feet (4.5 m).

H. 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. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
2. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (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 to stand 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 bibbs.
   2. Open shutoff valves to fully open position.
   3. Open throttling valves to proper setting.
   4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

   a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide 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.
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. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
   a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
   b. Fill and isolate system according to either of the following:
      1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
      2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
   c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
   d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

C. 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. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:
1. Hard copper tube, ASTM B 88, Type L; wrought-copper solder-joint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

D. Aboveground domestic water piping, NPS 2-1/2 (DN 65) and larger, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L wrought-copper solder-joint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
3. Galvanized-steel pipe; flanged joint, galvanized-steel-pipe appurtenances; and galvanized steel fittings.

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 2 (DN 50) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
2. Throttling Duty: Use ball 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.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.
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.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 22 Section “Basic Plumbing Requirements”.
2. Division 22 Section “Sleeves And Sleeve Seals For Plumbing Piping”.
3. Division 22 Section “Escutcheons for Plumbing Piping”.
4. Division 22 Section “General-Duty Valves For Plumbing Piping”.
5. Division 22 Section “Hangers And Supports For Plumbing Piping And Equipment”.
6. Division 22 Section “Identification For Plumbing Piping And Equipment”.
7. Division 22 Section “Sanitary Waste Piping Specialties”.
8. Division 22 Section “Plumbing Pumps”.
9. Division 22 Section “Commercial Water Closets and Urinals”.
10. Division 22 Section “Commercial Lavatories and Sinks”.
11. Division 22 Section “Commercial Showers”.
12. Division 22 Section “Drinking Fountains And Water Coolers”.
13. Division 22 Section “Chemical-Waste Systems”.
14. Division 11 Sections.

1.2 SUMMARY

A. Section Includes:

1. Pipe, tube, and fittings.
2. Specialty pipe fittings.

1.3 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

2. Waste, Force-Main Piping: 50 psig (345 kPa).
1.4 ACTION SUBMITTALS

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

B. LEED Submittals:
   1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
   2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Regulatory Requirements: Comply with the provisions of the following:

1.6 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Waste Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   1. Notify Construction Manager no fewer than two days in advance of proposed interruption of sanitary waste service.
   2. Do not proceed with interruption of sanitary waste service without Construction Manager'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.
2.2 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 following:
      a. ANACO-Husky.
      b. Clamp-All Corp.
      d. MIFAB, Inc.
      e. Mission Rubber Company; a division of MCP Industries, Inc.
      f. Stant.
      g. Tyler Pipe.
   3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Standard Weight class. Include square-cut-grooved or threaded ends matching joining method.


C. Galvanized Steel Pipe Pressure Fittings:

D. Cast-Iron Flanges: ASME B16.1, Class 125.
   1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
   2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

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, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

C. Adhesive Primer: ASTM F 656.
   1. Adhesive primer shall have a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Solvent Cement: ASTM D 2564.
   1. PVC solvent cement shall have a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 DOUBLE CONTAINMENT PIPING

A. Manufacturers: Subject compliance with the requirements, provide products by one of the following:
   1. Spears.
   2. IPEX.
   3. Orion.

B. Carrier Piping and Fittings: Schedule 40 CPVC.

C. Secondary Pipe and Fittings: Schedule 40 CPV.

2.6 SPECIALTY PIPE FITTINGS

A. Transition Couplings:
   1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
   2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
   3. Unshielded, Nonpressure Transition Couplings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         2) Fernco Inc.
         3) Mission Rubber Company; a division of MCP Industries, Inc.
         4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
d. Sleeve Materials:

2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Nonpressure Transition Couplings:

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2) Mission Rubber Company; a division of MCP Industries, Inc.

c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.
G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. 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 2-1/2 (DN 65) and smaller; 1 percent downward in direction of flow for piping NPS 3 (DN 80) 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.

M. 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."

N. Install steel piping according to applicable plumbing code.

O. Install underground PVC piping according to ASTM D 2321.

P. Install engineered soil and waste drainage and vent piping systems as follows:


Q. Install force mains at elevations indicated.

R. Install double containment piping and necessary fittings for piping inside electrical rooms. Terminate outside of room. Install in accordance with manufacturers recommendations.
S. Plumbing Specialties:

1. Install backwater valves in sanitary waster gravity-flow piping. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."

2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."


T. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.2 JOINT CONSTRUCTION

A. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

B. 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.

C. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.

D. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
2. PVC Piping: Join according to ASTM D 2855 and ASTM D 2665 Appendixes.

3.3 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in OD's.
   2. In Drainage Piping: Unshielded or shielded, nonpressure transition couplings depending on the application.

3.4 VALVE INSTALLATION

A. General valve installation requirements are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves:
   1. Install shutoff valve on each sewage pump discharge.
   2. Install gate or full-port ball valve for piping NPS 2 (DN 50) and smaller.
   3. Install gate valve for piping NPS 2-1/2 (DN 65) and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to 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. Comply with requirements for backwater valve specified in Section 221319 "Sanitary Waste Piping Specialties."

3.5 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
3. Vertical Piping: MSS Type 8 or Type 42, clamps.
4. Install individual, straight, horizontal piping runs:
a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.

5. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
6. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches (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 one 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 and NPS 8 (DN 150 and DN 200): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.
5. NPS 10 and NPS 12 (DN 250 and DN 300): 60 inches (1500 mm) with 7/8-inch (22-mm) rod.
6. Spacing for 10-foot (3-m) lengths may be increased to 10 feet (3 m). Spacing for fittings is limited to 60 inches (1500 mm).

F. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 (DN 32): 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 (DN 80): 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 and NPS 8 (DN 150 and DN 200): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.

H. Install supports for vertical steel piping every 15 feet (4.5 m).

I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.
3.6  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 test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
   5. Install horizontal backwater valves with cleanout cover flush with floor.
   6. Comply with requirements for backwater valves cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
   7. 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. Connect force-main piping to the following:
   1. Sewage Pump: To sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections according to the following unless otherwise indicated:
   1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.7  IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."
3.8 FIELD QUALITY CONTROL

A. 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.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). 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.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. 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 to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

4. Prepare reports for tests and required corrective action.

3.9 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.

3.10 PIPING SCHEDULE

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 (DN 100) and smaller shall be the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.

C. Aboveground, soil and waste piping NPS 5 (DN 125) and larger shall be the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.

D. Aboveground, vent piping NPS 4 (DN 100) and smaller shall be the following:
   1. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
   2. Galvanized-steel pipe, drainage fittings, and threaded joints.

E. Underground, soil, waste, and vent piping shall be the following:
   1. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
F. Aboveground sanitary-sewage force mains NPS 1-1/2 to NPS 6 (DN 65 to DN 150) shall be the following:

1. Galvanized-steel pipe, pressure fittings, and threaded joints.
SECTION 230010 - BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division -1 Specification Sections, apply to this Section.

B. This is a Basic Mechanical Requirement Section and forms a part of the following Sections:

1. Division 11 Sections referencing “Basic Mechanical Requirements”.
2. All Division 22 and Division 23 Sections.

1.2 SUMMARY

A. This Section includes general administrative and procedural requirements for mechanical and plumbing installations, including but not limited to:

1. Proposed substitutions
2. Codes, rules, regulations, ordinances and standards
3. Permits, inspections, tests and approvals
4. References
5. Acceptable manufacturers
6. Contract drawings
7. Use of equipment
8. Layout drawings
9. Record documents
10. Maintenance and Operating Manuals
11. Submittals
12. Construction punch list
13. Delivery, storage and handling
14. Quality Assurance
15. Temporary protection and utilities
16. Warranty
17. Housekeeping
18. Rough-ins
19. Installation, coordination and special provisions
20. System activation
21. System and equipment adjustment
22. Testing, Start-Up and Training Procedures
B. Provide all labor, materials, tools, and equipment necessary to complete all work as specified herein and noted on the Drawings.

C. All work shall be installed in accordance with manufacturer's recommendations, industry standards of good practice, and as specified herein and as noted on the Drawings.

1.3 PROPOSED SUBSTITUTIONS

A. Refer to Division 1 "Substitutions".

1.4 CODES, RULES, REGULATIONS, ORDINANCES AND STANDARDS

A. In addition to the requirements shown or specified, comply with all applicable State, County, City, Township and local Codes, Rules, Regulations, Ordinances and Standards.

B. Comply with the requirements shown or specified when those requirements are in excess of that required by Codes, Rules, Regulations, Standards and Ordinances.

C. Advise the Architect of changes required to conform to State, County, and Local regulations, ordinances and codes prior to the time that contract is awarded.

1.5 PERMITS, INSPECTIONS, TESTS, AND APPROVALS

A. Secure and pay for all required permits, inspections, tests and approvals.

B. Perform all tests required under applicable codes, rules, regulations, and ordinances.

C. All parts of each system and associated equipment shall be tested and adjusted to work properly and be left in good operating condition.

D. Provide all testing instruments, gauges, pumps and other equipment required or necessary for tests.

E. Notify the Owner's Representative in advance of all tests and conduct all tests to his entire satisfaction.

F. Correct all defects disclosed in the work by tests or otherwise without additional cost to the Owner.

G. Repeat tests after any defects disclosed thereby have been corrected.

H. Arrange and pay the cost of all utilities used in any tests.

I. Blank off all equipment prior to tests which could be damaged by the test pressure.
J. Listing of Referenced Associations, Codes, Standards and abbreviations:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>AGA</td>
<td>American Gas Association</td>
</tr>
<tr>
<td>ANSI</td>
<td>American National Standards Institute</td>
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<tr>
<td>ARI</td>
<td>Air-Conditioning and Refrigeration Institute</td>
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<tr>
<td>ASHRAE</td>
<td>American Society of Heating, Refrigeration and Air-Conditioning Engineers, Inc.</td>
</tr>
<tr>
<td>ASME</td>
<td>American Society of Mechanical Engineers</td>
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<tr>
<td>ASTM</td>
<td>American Society for Testing &amp; Materials</td>
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<tr>
<td>AWS</td>
<td>American Welding Society, Inc.</td>
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<tr>
<td>AWWA</td>
<td>American Water Works Association, Inc.</td>
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<tr>
<td>CISPI</td>
<td>Cast Iron Soil Pipe Institute</td>
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<tr>
<td>FM</td>
<td>Factory Mutual Engineering Corp.</td>
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<tr>
<td>IBC</td>
<td>International Building Code</td>
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<td>IMC</td>
<td>International Mechanical Code</td>
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<td>IPC</td>
<td>International Plumbing Code</td>
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<tr>
<td>IRI</td>
<td>Industrial Risk Insurance</td>
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<tr>
<td>MDCH</td>
<td>Michigan Department of Community Health</td>
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<td>MMC</td>
<td>Michigan Mechanical Code</td>
</tr>
<tr>
<td>MPC</td>
<td>Michigan Plumbing Code</td>
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<tr>
<td>MSS</td>
<td>Manufacturer’s Standardization Society of the Valve and Fitting Industry</td>
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<tr>
<td>NCPWB</td>
<td>National Certified Pipe Welding Bureau</td>
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<tr>
<td>NEC</td>
<td>National Electrical Code</td>
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<tr>
<td>NEMA</td>
<td>National Electrical Manufacturers Association</td>
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<td>NFPA</td>
<td>National Fire Protection Association</td>
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<td>NSF</td>
<td>National Sanitation Foundation</td>
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<tr>
<td>OSHA</td>
<td>Occupational Safety and Health Act</td>
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<tr>
<td>PDI</td>
<td>Plumbing and Drainage Institute</td>
</tr>
<tr>
<td>HYDI</td>
<td>Standards by the Hydronics Institute</td>
</tr>
<tr>
<td>UL</td>
<td>Underwriters’ Laboratories, Inc.</td>
</tr>
</tbody>
</table>

K. Note: Latest edition applies unless otherwise noted on the drawings or herein.

1.6 ACCEPTABLE MANUFACTURERS

A. Acceptable manufacturers shall be considered for material in accordance with the requirements of the Specification Section, subject to the approval of the Architect. Such approval concerns the manufacturer only and does not in any way act to permit any deviation from strict compliance with the requirements of these Specifications.
1.7 CONTRACT DRAWINGS

A. Contract Drawings for Mechanical and Plumbing Work are diagrammatic, intended to convey
the scope of the work and indicate general arrangement of equipment, ducts, piping and
approximate sizes and locations of equipment and outlets. Do not scale drawings for
measurements.

B. Consult Mechanical, Plumbing, Fire Protection, Civil, Architectural, Structural and Electrical
Contract Drawings and Specifications to become familiar with all conditions affecting the
Work, coordinate interconnecting work with other Trades affected, and verify all spaces in
which the work will be installed.

C. Where job conditions require reasonable changes in order to coordinate installation with other
trades, these changes shall be made without extra cost to the Owner.

D. The Contract Drawings and Specifications are to be cooperative, and whatever is called for by
either shall be binding as if called for by both.

1.8 USE OF EQUIPMENT

A. The use of any equipment, or any part thereof, for any purpose including testing even with the
Owner's consent, shall not be construed to:

1. Be an acceptance of the work on the part of the Owner.
2. Obligate the Owner in any way to accept improper work or defective materials.
3. Be the basis for determining the beginning of the Contractor's guarantee or
manufacturer's warrantee period.

1.9 LAYOUT DRAWINGS

A. Prepare layout drawings in accordance with Division 1 Section "Project Management and
Coordination", and as specified below.

B. Prepare layout drawings drawn to scale showing the intended method of installation and
construction. Coordinate work with all other trades. Use the Contract Drawings and
Specifications as a guide in preparing coordination drawings. Comply with the full intent of
the Contract Drawings. Deviate from the Contract Drawings only as required to resolve
installation requirements. Layout drawings shall show the detailed routing of all piping and
shall incorporate all requirements for; ductwork, electrical conduit, buss duct, lighting and
cable tray systems; building structural systems; building architectural systems; and other items
as may be required.

C. Layout drawings shall show all hangers, supports, swaybraces, guides, and anchors.
D. Layout drawings shall show all equipment, valves, dampers, and specialties including the required access spaces.

E. The layout drawings shall not be a repetition of the Contract Drawings. Prepare coordination drawings on a reproducible medium with dimensioned equipment and piping locations, elevations and mounting details. Distinguish between construction concealed above ceilings and exposed construction. If available, electronic drawing files can be purchased from the Architect. Drawing size shall match contract drawing size. Post changes and modifications as they occur.

F. A set of layout drawings shall be kept on site and be available to the Architect, Owner's Project Representative, and others.

G. Layout drawings shall not be submitted to the Architect.

H. Update the layout drawings, when changes are made, so that these drawings represent the currently constructed (or about to be constructed) conditions.

I. Use the final layout drawings in preparing "Record Documents" as specified below and as specified in "Project Closeout Procedures" section.

1.10 RECORD DOCUMENTS

A. Prepare record documents in accordance with Division 1 Section "Project Closeout Procedures". In addition to the requirements specified in Division 1, indicate the following installed conditions:

1. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Indicate actual inverts and horizontal locations of underground piping.
2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.

1.11 MAINTENANCE AND OPERATING MANUALS

A. Prepare maintenance and operating manuals in accordance with Division 1 Section "Project Closeout Procedures". In addition to the requirements specified in Division 1, include the following information for equipment items:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating and maintenance data, parts list and procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures and schedule for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.

1.12 SUBMITTALS

A. General:
   1. Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

B. Comply with the requirements of Section "Submittal Procedures" and as specified herein. All required submittals for an item shall be submitted in a complete single package.

C. Required submittals are listed in applicable Specification Sections. Submittals not required by these Specifications will not be reviewed and will not be returned.

D. After development and acceptance of the Contractor's construction schedule, prepare a complete schedule of submittals in accordance with the requirements of Section "Submittal Procedures".

E. The following submittals are required prior to bid submission:
   1. Proposed substitutions.
   2. The following submittals are required prior to construction start:
      a. Required product data.
      b. Required shop drawings.

F. Shop Drawings:
1. Submit manufacturer's technical product data, including rated capacities of selected model with clearly indicated, weights (shipping, installed, and operation), dimensions, required clearances, and methods of assembly of components, furnished specialties and accessories; and installation and start-up instructions.

2. Submit ladder-type wiring diagrams for power and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

3. Submit maintenance data and parts list for all mechanical equipment; including "trouble shooting" maintenance guide; plus servicing, and preventative maintenance procedures and schedule. Include this data and product data in maintenance manual; in accordance with requirements of Division 1.

1.13 CONSTRUCTION PUNCH LIST

A. Inspect the work and operate all systems prior to requesting the construction punch list to insure that the work is complete and operating in accordance with the requirements of the Contract Documents.

B. Prior to requesting construction punch list:

1. Operate the system.
2. Verify maintenance and operating manual work is complete, reviewed and accepted by the Owner's Representative.
3. Verify system final adjustments and cleaning work is complete.

C. The final construction punch list time shall be coordinated with the Owner's Representative, providing; minimum one (1) week notice.

D. Provide sufficient personnel and portable telephones to demonstrate the operation of each system in each of the various modes of operation.

1.14 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Receive, properly house, handle, hoist, deliver to proper location, equipment and other material required.

C. After delivery, before and after installation, protect equipment and materials against theft, injury or damage from all causes.

D. Provide factory-applied plastic end-caps on each length of pipe and tube, except for concrete, corrugated metal, hub-and-spigot, clay piping. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.
E. Protect stored pipes and tubes from moisture and dirt. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.

F. Protect flanges, fittings, and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

G. Protect stored plastic pipes from direct sunlight. Support to prevent sagging and bending.

H. Store equipment and materials in clean, dry space; store off the ground; protect from weather and physical damage.

1.15 QUALITY ASSURANCE

A. Applicable Codes and Standards.

B. Installer's qualifications: Minimum 5 years of installation experience on successful projects for the installing firm of the individual doing the installation, unless a higher minimum is otherwise specifically noted in other Specification Sections.

C. Welder's Qualifications:

1. Welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, and Brazing Qualifications.
4. Certifications: Submit welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" heading of this Section.

D. Provide the following stamps and labels:

1. "AGA" label on all gas fired equipment.
2. "UL" or "ETL" label on all equipment with electrical connections.
3. ASME Code stamp/label on all boilers, heat exchangers, water heaters, tanks and receivers.

1.16 TEMPORARY PROTECTION AND UTILITIES

A. Provide temporary protection, construction water, heat and ventilation as specified in Division 1 Section "Temporary Facilities and Controls".
B. Permanent HVAC equipment shall not be used for temporary heating, ventilating or air conditioning unless written Owner approval is obtained. Refer to Division 1 Section “Temporary Facilities and Controls”.

1.17 WARRANTY

A. All systems, components, parts, assemblies and labor furnished under this contract shall be warranted against defects in materials and workmanship in accordance with the General Conditions. Any manufacturing or component defects arising during this warranty period shall be corrected without cost to the Owner.

B. All applicable software as detailed in this specification shall be updated by the supplier free of charge during and at the end of the warranty period. This will ensure that all system software will be the most up-to-date software available.

C. Additional warranty requirements, included in the individual specification sections, shall be considered requirements in addition to those of the General Conditions. In all instances, the most stringent requirements shall apply.

1.18 HOUSEKEEPING

A. Maintain the premises neat and orderly and thoroughly clean upon completion of the work.

PART 2 - PRODUCTS

A. All air conditioning equipment, all boilers, all heat rejection equipment, all service water heating equipment; and all motors shall comply with the current state energy code, or the latest edition of the 2007 Edition of ASHRAE/IESNA Standard 90.1 – if no state energy code exists.

PART 3 - EXECUTION

3.1 ROUGH-INS

A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

B. Refer to equipment specifications in other Specification Sections and the Drawings for rough-in requirements.
3.2 INSTALLATION, COORDINATION AND SPECIAL PROVISIONS

A. Sequence, coordinate, and integrate the various elements of mechanical and plumbing systems, materials, and equipment.

B. Coordinate connection of electrical services to mechanical and plumbing equipment.

C. Sequence, coordinate, and integrate installations of mechanical and plumbing materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

D. Coordinate mechanical and plumbing systems, equipment, and materials installation with other building components.

E. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

F. Coordinate connection of mechanical and plumbing systems with exterior underground and overhead utilities and services. Provide required connection for each service.

G. Coordinate installation of roof curbs and roof openings with roof structure and other construction trades. Refer to Division 7 Section "Roof Accessories".

H. Verify all dimensions by field measurements.

I. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical and plumbing installations.

J. Coordinate installation of identifying devices after completing covering and painting where identifying devices are applied to surfaces. Install identifying devices prior to installing ceilings.

K. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

L. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form.

M. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components.

N. Roof mounted equipment shall be set "dead level" on curbs, grillage and supports constructed to compensate for roof pitch.
O. Install mechanical and plumbing equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

P. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

3.3 SYSTEM ACTIVATION

A. All piping, strainers, etc., shall be thoroughly flushed and chemically cleaned before the systems are activated. Submit report from the chemical treatment agency. All strainers shall be cleaned at least once each week for the first month of system operation and then once each month thereafter until Owner's final acceptance of the work. The entire system shall be re-checked for compliance with the plans and specifications to establish that it is free of all defects. Before final acceptance of the work by the Owner, again flush, clean and adjust the systems.

3.4 SYSTEM AND EQUIPMENT ADJUSTMENT

A. After the testing has been completed, energize all systems and equipment.

B. Adjust all equipment and auxiliary devices for smooth and quiet operation.

C. Check motor and coupling alignment to verify compliance with manufacturer's tolerances; make adjustments as necessary.

D. Lubricate all bearings.

E. Check all motors and bearings for overheating and make necessary adjustments - if required.

F. Submit a "System and Equipment Adjustment" report to the Architect. This report shall address all of the items listed above.

3.5 TESTING, START-UP, AND TRAINING PROCEDURES

A. Develop and implement a plan and schedule for the testing, start-up, and training for all new mechanical and plumbing equipment. This plan will be specific to the project.

B. Provide any testing equipment and re-testing necessary.

C. In addition to all required submittal data for approval of the equipment, O & M Manuals, and warrantee information, provide documentation on all testing, start-up, and training activities. This documentation will include but is not limited to:
1. Installation, Start-up, and Check-out materials shipped with the equipment
2. Factory or Field Check-out forms used by factory or field technicians
3. Pre-functional and Functional Test Procedures and Check Lists
4. Start-up and System Operational Procedures and Check Lists
5. Sequences of Operation, Control Drawings, or other equipment documentation
6. Training Manuals
7. Re-testing of all deficiencies or non-conformance issues
8. Video record of all training sessions

D. Develop project-specific forms and check-lists for the equipment on this project.

E. All testing, start-up, and training will be scheduled in the Contractor’s Master Schedule. Seasonal testing and deferred testing will also be part of this contract. Seasonal tests will be delayed until weather conditions are closest to the system’s design. Deferred tests due to the building structure, required occupancy phasing, or other deficiencies will be completed as soon as possible. Seasonal and deferred testing will follow the same procedures, be witnessed by the same personnel, and require the same documentation.

F. Functional performance testing and verification may be achieved by manual testing or monitoring the performance and analyzing the results using the control system’s trend log capabilities. Simulating conditions may be allowed, though timing the testing to experience actual conditions is encouraged wherever practical. Each function and test shall be performed under conditions that simulate actual conditions as close as is practically possible. The contractor executing the test shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the test according to the specified conditions. At completion of the test the contractor shall return all affected building equipment and systems to their pre-test condition.

G. All pre-functional and pre-start-up activities will be documented by the mechanical and plumbing contractors and submitted before arrangements are made for the functional tests and start-up. At least 7 working days shall be provided.

H. Submit at project close-out with the as-built drawings, a document certifying that:
   1. Systems were tested and function per design intent
   2. Systems were installed per manufacturers recommendations and to industry accepted minimum standards
   3. Systems received adequate operational check-out by installing contractors
   4. Proper performance of equipment and systems was documented and given to the Owner.
   5. O & M Manuals and as-built drawings are complete and accurate
   6. Owner’s operating personnel are adequately trained

I. Owner training shall include a minimum of 16 hours of instruction for all equipment and systems. Where individual Sections specify hours of Owner training, they shall be in addition to the base 16 hours of training.
END OF SECTION 230010
CEW
SECTION 230517 - SLEEVES AND SLEEVE SEALS 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.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 23 Section “Expansion fittings and Loops for HVAC Piping”.
2. Division 23 Section “Escutcheons for HVAC Piping”.
3. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment”.
4. Division 23 Section “Vibration Controls for HVAC Piping and Equipment”.
5. Division 23 Section “HVAC Insulation”.
6. Division 23 Section “Natural-Gas Piping”.
7. Division 23 Section “Hydronic Piping”.
8. Division 23 Section “Steam and Condensate Heating Piping”.

1.2 SUMMARY

A. Section Includes:

1. Sleeves.
2. Stack-sleeve fittings.
3. Sleeve-seal systems.
4. Sleeve-seal fittings.
5. Grout.

1.3 SUBMITTALS

A. Product Data: None required.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
B. Galvanized-Steel Sleeves: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. Galvanized-Steel-Sheet Sleeves: 10 gauge minimum thickness; round tube closed with welded longitudinal joint.

2.2 STACK-SLEEVE FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.

B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Advance Products & Systems, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Products, Inc.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure Plates: Stainless steel.
3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.
2.4 SLEEVE-SEAL FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Presealed Systems.

B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

2.5 GROUT


B. Characteristics: Nonshrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.

B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core-drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Cut sleeves to length for mounting flush with both surfaces.

   a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level.

2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.

D. Install sleeves for pipes passing through interior partitions.
1. Cut sleeves to length for mounting flush with both surfaces.
2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."

E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

A. Install stack-sleeve fittings in new slabs as slabs are constructed.
   1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
   2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07 Section "Sheet Metal Flashing and Trim."
   3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.
   4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   5. Using grout, seal the space around outside of stack-sleeve fittings.

B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:
   a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves or Galvanized-steel wall sleeves or Sleeve-seal fittings.
   b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves or Galvanized-steel sleeves or Galvanized-steel-pipe sleeves.

2. Exterior Concrete Walls below Grade:
   a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel sleeves with sleeve-seal system or Sleeve-seal fittings.
      1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

3. Concrete Slabs-on-Grade:
   a. Piping Smaller Than NPS 6 (DN 150): Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel sleeves with sleeve-seal system or Sleeve-seal fittings.
      1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
   b. Piping NPS 6 (DN 150) and Larger: Cast-iron wall sleeves with sleeve-seal system or Galvanized-steel sleeves with sleeve-seal system.
      1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.

4. Concrete Slabs above Grade:
Construction

a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves or Stack-sleeve fittings or Sleeve-seal fittings.

b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe sleeves or Stack-sleeve fittings.

5. Interior Partitions:


b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 230517
CEW
SECTION 230518 - ESCUTCHEONS 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.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 22 Section “HVAC Insulation”.
2. Division 22 Section “Fuel-Oil Piping”.
3. Division 22 Section “Natural-Gas Piping”.
4. Division 22 Section “Hydronic Piping”.
5. Division 22 Section “Steam and Condensate Heating Piping”.
6. Division 22 Section “Custom Air-Handling Units”.

1.2 SUMMARY

A. Section Includes:

1. Escutcheons.
2. Floor plates.

1.3 ACTION SUBMITTALS

A. Product Data: None required.

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.

C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

2.2 FLOOR PLATES

A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. Escutcheons for 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. Insulated Piping: One-piece, stamped-steel type.
   d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
   e. Bare Piping at Ceiling Penetrations: One-piece, cast-brass type with polished, chrome-plated finish.

2. Escutcheons for Existing Piping:
   a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
   b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
   c. Bare Piping at Wall and Floor Penetrations: Split-casting brass type with polished, chrome-plated finish.
   d. Bare Piping at Ceiling Penetrations: Split-casting brass type with polished, chrome-plated finish.

C. Install floor plates for piping penetrations of equipment-room floors.

D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

1. New Piping: One-piece, floor-plate type.
2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

A. Replace broken and damaged escutcheons and floor plates using new materials.
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.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 23 Section “Testing, Adjusting, and Balancing for HVAC”.
2. Division 23 Section “Instrumentation and Control Systems”.
3. Division 23 Section “Fuel-Oil Piping”.
4. Division 23 Section “Natural-Gas Piping”.
5. Division 23 Section “Hydronic Piping”.
6. Division 23 Section “Hydronic Pumps”.
7. Division 23 Section “Steam and Condensate Heating Piping”.
8. Division 23 Section “Steam Condensate Pumps”.
9. Division 23 Section “HVAC Water Treatment”.
10. Division 23 Section “Condensing Boilers”.
11. Division 23 Section “Water-Tube Boilers”.
12. Division 23 Section “Deaerators”.
13. Division 23 Section “Heat Exchangers for HVAC”.
14. Division 23 Section “Air-Cooled Dry Fluid Coolers”.
15. Division 23 Section “Rotary-Screw Water Chillers”.
17. Division 23 Section “Custom Air-Handling Units”.
18. Division 23 Section “Air Coils”.

1.2 SUMMARY

A. Section Includes:

1. Filled-system thermometers.
2. Liquid-in-glass thermometers.
3. Thermowells.
4. Dial-type pressure gages.
5. Gage attachments.
6. Test plugs.
1.3 SUBMITTALS

A. Product Data: None required.

B. Operation and Maintenance Data: Submit maintenance data and spare parts lists for each type of meter and gage. Include this data and product data in Maintenance Manual; in accordance with requirements of Division 1.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of meters and gages, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. UL Compliance: Comply with applicable UL standards pertaining to meters and gages.
2. ANSI and ISA Compliance: Comply with applicable portions of ANSI and Instrument Society of America (ISA) standards pertaining to construction and installation of meters and gages.

C. Certification: Provide meters and gages whose accuracies, under specified operating conditions are certified by manufacturer.

PART 2 - PRODUCTS

A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Trerice, H. O. Co.
   b. Weiss Instruments, Inc.
   c. Weksler Instrument Corp.
   d. Winters Instrument – US.

3. Case: Sealed type, drawn steel or brass nominal diameter; 4-1/2” nominal diameter.
4. Thermal Bulb: Copper with phosphor bronze bourdon pressure tube, one scale division accuracy.
5. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.
6. Dial: White background with black embossed markings, in deg F.
8. Window: Glass.
9. Ring: Metal.
10. Connector Type: Cast aluminum union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
11. Stem: Liquid-filled bulb in copper-plated steel, or brass stem and of length to suit installation.
   a. Design for Thermowell Installation: Bare stem.

12. Accuracy: Plus or minus 1 percent of scale range.
13. Range: Minimum which spans the system range with 2 deg.F scale divisions and mid-range at operating point.

2.2 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Compact-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.
   c. Weklser Instruments Corp.

3. Case: Cast aluminum finished in baked epoxy enamel; 9-inch nominal size.
4. Adjustable Joint: Die cast aluminum, finished to match case, 180 deg. adjustment in vertical plane, 360 deg. adjustment in horizontal plane, with locking device.
5. Tube: Glass with magnifying lens and mercury-free indicating medium.
6. Tube Background: White background with black embossed markings.
7. Stem: Copper-plated steel, or brass, for separable socket, length to suit installation.
   a. Design for Thermowell Installation: Bare stem.
8. Connector: 3/4 inch (19 mm), with ASME B1.1 screw threads.
9. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.
10. Range: Minimum which spans the system range with 2 deg.F scale divisions and mid-range at operating point.

2.3 THERMOWELLS

A. Thermowells:

2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting. Pressure rated to match piping design pressure.
3. Material: Brass or stainless steel.
4. Type: Stepped shank unless straight or tapered shank is indicated.
5. Cap Nut: Cap nut with chain fastened permanently to thermometer well.
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 2” extension on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

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. Marsh Bellofram.
   c. Trerice, H. O. Co.
   d. Weiss Instruments, Inc.
   e. Weklser Instruments Corp.
   f. Winters Instruments - U.S.

3. Case: Liquid-filled, sealed type; drawn steel 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated. Provide protective syphon when used for steam service.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: White background with black embossed markings graduated in psi.
10. Ring: Metal, Brass.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
12. Range: Minimum which spans the system operating range with mid-range at operating point. Provide gauge on pump suction.

2.5 GAGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping. Disc material compatible for fluid served and pressure rating.
B. Valves: Brass or stainless-steel needle, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads, “T” handel.

C. Syphon: 1/4" straight coil constructed of brass tubing with 1/4" male NPT on each end.

2.6 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Peterson Equipment Co., Inc.
2. Trerice, H. O. Co.
3. Weklser Instruments Corp.
4. Weiss Instruments, Inc.
5. Winters Instruments - US.

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), ASME B1.20.1 pipe thread.

E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 MPa at 93˚C).

F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.7 FLOW MEASURING STATIONS

A. General: Provide flow measuring stations as indicated on the drawings, pressure rated for 150 psig at 250 deg. F, consist of a forged steel weld-o-let fitting, bronze full port ball valve, packing gland, insertion gland mechanism and cage nipple. Provide a stainless steel, pitot tube probe for each pipe size which is 4" and larger (one per pipe size). Pitot tube probe shall include a brass block and two (2), 1/8" size stainless steel needles valves.

B. Manufacturer: Subject to compliance with requirements, provide products by one of the following:

1. Dieterich Standard Corp.
2. Taco Corp.
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 so as to be easily read by observer standing on floor.

F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.

G. Install valve and snuber in piping for each pressure gage for fluids.

H. Install siphon in piping for each pressure gage for steam service.

I. Install test plugs in piping tees.

J. Install thermometers in the following locations:

1. At inlet and outlet of each hydronic zone.
2. At inlet and outlet of each boiler, chiller, and heat exchanger.
3. At inlet and outlet of each hydronic coil in air handling units.
4. As shown on the Drawings.

K. Install pressure gages in the following locations:

1. At suction and discharge of each pump.
2. At discharge of each pressure reducing valve.
3. At inlet and outlet of each chiller, boiler, and heat exchanger.
4. As shown on the Drawings.

L. General: Install flow measuring meters on piping systems located in accessible locations at most readable position.

M. Flow Metering Station: Install in piping where indicated, in accordance with manufacturer's installation instructions.
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 Chilled-Water Piping: 0 to 100 deg F.
   B. Scale Range for Heating-Water Piping: 30 to 240 deg F.

3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE
   A. Scale Range for Hydronic Piping: 0 to minimum of twice the operating pressure of the system pump in PSI.

END OF SECTION 220519
CEW
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.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 23 Section “Meters and Gages for HVAC Piping”.
2. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment”.
3. Division 23 Section “Vibration Controls for HVAC Piping and Equipment”.
4. Division 23 Section “Identification for HVAC Piping and Equipment”.
5. Division 23 Section “Testing, Adjusting, and Balancing for HVAC”.
6. Division 23 Section “HVAC Insulation”.
7. Division 23 Section “Commissioning of HVAC”.
8. Division 23 Section “Instrumentation and Control Systems”.
9. Division 23 Section “Fuel-Oil Piping”.
10. Division 23 Section “Natural-Gas Piping”.
11. Division 23 Section “Hydronic Piping”.
12. Division 23 Section “Hydronic Pumps”.
13. Division 23 Section “Steam and Condensate Heating Piping”.
14. Division 23 Section “Steam Condensate Pumps”.
15. Division 23 Section “HVAC Water Treatment”.
16. Division 23 Section “Condensing Boilers”.
17. Division 23 Section “Water-Tube Boilers”.
18. Division 23 Section “Deaerators”.
19. Division 23 Section “Heat Exchangers for HVAC”.
20. Division 23 Section “Air-Cooled Dry Fluid Coolers”.
21. Division 23 Section “Rotary-Screw Water Chillers”.
22. Division 23 Section “Custom Air-Handling Units”.
23. Division 23 Section “Air Coils”.
24. Division 23 Section “Fan Coil Units”.
25. Division 23 Section “Propeller Unit Heaters”.
26. Division 23 Section “Radiators”.
27. Division 23 Section “Chilled Beams”.
28. Division 23 Section “Humidifiers”.

1.2 SUMMARY

A. Section Includes:
1. Bronze angle valves.
2. Bronze ball valves.
3. Iron ball valves.
5. Bronze lift check valves.
11. Iron gate valves.
14. Lubricated plug valves.
15. Eccentric plug valves.

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.
H. WOG: Water, oil, gas.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of valve indicated.
B. Certificate of Origin: Submit certificate of origin indicating valve products are manufactured in
the United States, or Canada.
C. Maintenance Data: Submit maintenance data for all valves in O & M manuals in accordance
with Division 1.
1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. All valves shall be manufactured in the United States, or Canada. Submit certificate of origin for each type of valve used on this Project.

C. 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 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 and smaller except plug valves.
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.
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 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.

F. Valve-End Connections:
   1. Flanged: With flanges according to ASME B16.1 for iron valves.
   2. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE ANGLE VALVES

A. Class 125, Bronze Angle Valves with Bronze Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hammond Valve.
      b. Milwaukee Valve Company.
   2. Description:
      a. Standard: MSS SP-80, Type 1.
      b. CWP Rating: 200 psig.
      d. Ends: Threaded.
      e. Stem and Disc: Bronze.
      f. Packing: Asbestos free.
      g. Handwheel: Malleable iron.

2.3 BRONZE BALL VALVES

A. 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:
   b. Crane Co.; Crane Valve Group; Crane Valves.
   c. Hammond Valve.
   d. Lance Valves; a division of Advanced Thermal Systems, Inc.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   b. SWP Rating: 150 psig.
   c. CWP Rating: 600 psig.
   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.

2.4 IRON BALL VALVES

A. Class 125, Iron Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Valve, Inc.
   b. Conbraco Industries, Inc.; Apollo Valves.
   c. Kitz Corporation.
   d. Sure Flow Equipment Inc.
   e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   b. CWP Rating: 200 psig.
   d. Body Material: ASTM A 126, gray iron.
   e. Ends: Flanged.
   f. Seats: PTFE or TFE.
   g. Stem: Stainless steel.
   h. Ball: Stainless steel.
i. Port: Full.

2.5 IRON, SINGLE-FLANGE BUTTERFLY VALVES

A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
   b. Bray Controls; a division of Bray International.
   c. Conbraco Industries, Inc.; Apollo Valves.
   d. Cooper Cameron Valves; a division of Cooper Cameron Corp.
   e. Crane Co.; Crane Valve Group; Jenkins Valves.
   f. Crane Co.; Crane Valve Group; Stockham Division.
   g. DeZurik Water Controls.
   h. Hammond Valve.
   i. Kitz Corporation.
   j. Milwaukee Valve Company.
   k. NIBCO INC.
   l. Norriseal; a Dover Corporation company.
   m. Red-White Valve Corporation.
   n. Spence Strainers International; a division of CIRCOR International.
   o. Tyco Valves & Controls; a unit of Tyco Flow Control.
   p. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

   a. Standard: MSS SP-67, Type I.
   b. CWP Rating: 150 psig.
   c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
   d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
   e. Seat: EPDM.
   f. Stem: One- or two-piece stainless steel.
   g. Disc: Aluminum bronze.

2.6 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
2. Description:
   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 200 psig.
   e. Ends: Threaded.
   f. Disc: Bronze.

2.7 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. American Valve, 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. Kitz Corporation.
   g. Milwaukee Valve Company.
   h. NIBCO INC.
   i. Powell Valves.
   j. Red-White Valve Corporation.
   k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   l. Zy-Tech Global Industries, Inc.

2. Description:
   a. Standard: MSS SP-80, Type 3.
   b. CWP Rating: 200 psig.
   c. Body Design: Horizontal flow.
   e. Ends: Threaded.
   f. Disc: Bronze.

2.8 IRON SWING CHECK VALVES

A. Class 125, Iron Swing Check Valves with Metal Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Hammond Valve.
e. Kitz Corporation.
f. Legend Valve.
g. Milwaukee Valve Company.
h. NIBCO INC.
i. Powell Valves.
j. Red-White Valve Corporation.
k. Sure Flow Equipment Inc.
l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
m. Zy-Tech Global Industries, Inc.

2. Description:

a. Standard: MSS SP-71, Type I.
b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
d. Body Design: Clear or full waterway.
e. Body Material: ASTM A 126, gray iron with bolted bonnet.
f. Ends: Flanged.
g. Trim: Bronze.
h. Gasket: Asbestos free.

2.9 IRON, PLATE-TYPE CHECK VALVES

A. Class 125, Iron, Dual-Plate Check Valves with Metal Seat:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. APCO Willamette Valve and Primer Corporation.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Flomatic Corporation.
d. Mueller Steam Specialty; a division of SPX Corporation.

2. Description:

b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
c. NPS 14 to NPS 24, CWP Rating: 150 psig.
e. Body Material: ASTM A 126, gray iron.
f. Seat: Bronze.
2.10 BRONZE GATE VALVES

A. Class 125, RS Bronze Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. American Valve, 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. Kitz Corporation.
   g. Milwaukee Valve Company.
   h. NIBCO INC.
   i. Powell Valves.
   j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   k. Zy-Tech Global Industries, Inc.

2. Description:

   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 200 psig.
   d. Ends: Threaded.
   e. Stem: Bronze.
   f. Disc: Solid wedge; bronze.
   g. Packing: Asbestos free.
   h. Handwheel: Malleable iron.

2.11 IRON GATE VALVES

A. Class 125, OS&Y, Iron Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Division.
   d. Flo Fab Inc.
   e. Hammond Valve.
   f. Kitz Corporation.
   g. Legend Valve.
   h. Milwaukee Valve Company.
   i. NIBCO INC.
   j. Powell Valves.
k. Red-White Valve Corporation.
l. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
m. Zy-Tech Global Industries, Inc.

2. Description:
   a. Standard: MSS SP-70, Type I.
   b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.
   c. NPS 14 to NPS 24, CWP Rating: 150 psig.
   d. Body Material: ASTM A 126, gray iron with bolted bonnet.
   e. Ends: Flanged.
   f. Trim: Bronze.
   g. Disc: Solid wedge.
   h. Packing and Gasket: Asbestos free.

2.12 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Stockham Division.
   c. Hammond Valve.
   d. Kitz Corporation.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Powell Valves.
   h. Red-White Valve Corporation.
   i. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   j. Zy-Tech Global Industries, Inc.

2. Description:
   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 200 psig.
   d. Ends: Threaded.
   e. Stem and Disc: Bronze.
   f. Packing: Asbestos free.
   g. Handwheel: Malleable iron.

2.13 IRON GLOBE VALVES

A. Class 125, Iron Globe Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Crane Co.; Crane Valve Group; Crane Valves.
   b. Crane Co.; Crane Valve Group; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Division.
   d. Hammond Valve.
   e. Kitz Corporation.
   f. Milwaukee Valve Company.
   g. NIBCO INC.
   h. Powell Valves.
   i. Red-White Valve Corporation.
   j. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   k. Zy-Tech Global Industries, Inc.

2. Description:
   a. Standard: MSS SP-85, Type I.
   b. CWP Rating: 200 psig.
   c. Body Material: ASTM A 126, gray iron with bolted bonnet.
   d. Ends: Flanged.
   e. Trim: Bronze.
   f. Packing and Gasket: Asbestos free.

2.14 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Babbitt Steam Specialty Co.
   2. Roto Hammer Industries.
   3. Trumbull Industries.

B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.

   1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
   2. Attachment: For connection to ball, butterfly, plug, gate, and globe valve stems.
   3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve.
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 ball, butterfly, gate, globe and plug valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

F. 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 and Plate-Type 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: Ball, butterfly, or gate valves.
3. Throttling Service: Globe or angle valves.
4. Pump-Discharge Check Valves:
   a. NPS 2 and Smaller: Bronze swing check valves with bronze disc.
   b. NPS 2-1/2 and Larger: Dual-plate, metal-seat check 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 and Smaller: Threaded ends.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.

3.5 CHILLED-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

2. Bronze Angle Valves: Class 125, bronze disc.
3. Ball Valves: Two piece, full port, stainless-steel trim.
4. Bronze Swing Check Valves: Class 125, bronze disc.
5. Bronze Gate Valves: Class 125, RS, bronze.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Ball Valves, NPS 2-1/2 to NPS 10: Class 125.
4. Iron Swing Check Valves: Class 125, metal seats.
5. Iron, Plate-Type Check Valves: Class 125; dual plate; metal seat.
6. Iron Gate Valves: Class 125, OS&Y.

3.6 HEATING-WATER VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:
   2. Bronze Angle Valves: Class 125, bronze disc.
   3. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
   4. Bronze Swing Check Valves: Class 125, bronze disc.
   5. Bronze Gate Valves: Class 125, RS.

B. Pipe NPS 2-1/2 and Larger:
   1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
   2. Iron Ball Valves, NPS 2-1/2 to NPS 10: Class 125.
   4. Iron Swing Check Valves: Class 125, metal seats.
   5. Iron, Plate-Type Check Valves: Class 125; dual plate; metal seat.
   6. Iron Gate Valves: Class 125, OS&Y.

3.7 LOW-PRESSURE STEAM VALVE SCHEDULE (15 PSIG OR LESS)

A. Pipe NPS 2 and Smaller:
   1. Bronze Angle Valves: Class 125, bronze disc.
   2. Bronze Swing Check Valves: Class 125, bronze disc.
   3. Bronze Gate Valves: Class 125, RS.
   4. Bronze Globe Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2 and Larger:
   1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
   2. Iron Swing Check Valves: Class 125, metal seats.
   3. Iron Gate Valves: Class 125, OS&Y.

3.8 HIGH-PRESSURE STEAM VALVE SCHEDULE (MORE THAN 15 PSIG)

A. Pipe NPS 2 and Smaller:
1. Bronze Angle Valves: Class 125, bronze disc.
2. Bronze Swing Check Valves: Class 125, bronze disc.
3. Bronze Gate Valves: Class 125, RS, bronze.

B. Pipe Sizes NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Swing Check Valves: Class 125, metal seats.
3. Iron Swing Check Valves with Closure Control, NPS 2-1/2 to NPS 12: Class 125, lever and weight.
4. Iron Gate Valves: Class 125, OS&Y.
5. Iron Globe Valves, NPS 2-1/2 to NPS 12: Class 125.

3.9 STEAM-CONDENSATE VALVE SCHEDULE

A. Pipe NPS 2 and Smaller:

1. Bronze Angle Valves: Class 125, bronze disc.
2. Bronze Swing Check Valves: Class 125, bronze disc.
3. Bronze Gate Valves: Class 125, RS.
4. Bronze Globe Valves: Class 125, bronze disc.

B. Pipe NPS 2-1/2 and Larger:

1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
2. Iron Swing Check Valves: Class 125, metal seats.
3. Iron Gate Valves: Class 125, OS&Y.

END OF SECTION 230523
CEW
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.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 5 Section “Post-Installed Anchors” for selection, design, and installation of post-installed anchors.
2. Division 23 Section “Expansion Fittings and Loops for HVAC Piping”.
3. Division 23 Section “General-Duty Valves for HVAC Piping”.
4. Division 23 Section “Vibration Controls for HVAC Piping and Equipment”.
5. Division 23 Section “HVAC Insulation”.
6. Division 23 Section “Fuel-Oil Piping”.
7. Division 23 Section “Natural-Gas Piping”.
8. Division 23 Section “Hydronic Piping”.
9. Division 23 Section “Hydronic Pumps”.
10. Division 23 Section “Steam and Condensate Heating Piping”.
11. Division 23 Section “Steam Condensate Pumps”.
12. Division 23 Section “Air Terminal Units”.
13. Division 23 Section “Fan Coil Units”.
14. Division 23 Section “Propeller Unit Heaters”.
15. Division 23 Section “Radiators”.
16. Division 23 Section “Chilled Beams”.

1.2 SUMMARY

A. Section Includes:

1. Metal pipe hangers and supports (horizontal and vertical).
2. Trapeze pipe hangers.
3. Metal framing systems.
4. Saddles and shields.
5. Fastener systems.
6. Pipe stands.
7. Equipment supports.
8. Roof pipe supports.
9. Spring hangers and supports.
B. Provide all supports, supplemental framing, anchors, guides, platforms, and bases for all new equipment, piping, and ductwork as specified in this Section; and as indicated on the drawings; and/or specified in other Division-23 Sections.

C. Supports that are an integral part of factory-fabricated equipment, are specified as part of equipment assembly in other Division-23 Sections.

D. Support components or systems shown on the Drawings are minimum requirements and are to be used as a guide only.

E. Provide all supports, supplemental framing, anchors, guides, platforms, and bases for all new equipment, piping, and ductwork as specified in this Section; and as indicated on the drawings; and/or specified in other Division-23 Sections.

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, including comprehensive engineering analysis by a qualified professional engineer structural engineer, 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.

1.5 SUBMITTALS

A. Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Section.

B. Product Data: None required.

C. Shop Drawings: Signed and sealed by a qualified professional engineer structural engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
1. Trapeze pipe hangers.
2. Metal framing systems.
3. Pipe stands.
4. Equipment supports.

D. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer structural engineer responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Design Calculations: Calculate requirements for designing trapeze hangers.

E. Welding certificates.

1.6 QUALITY ASSURANCE

A. Manufacturer's Qualifications:

1. Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. Code Compliance: Comply with all applicable codes, including ANSI, pertaining to product materials and installation of supports and anchors.
2. UL and FM Compliance: Provide products, where applicable, which are UL-listed and FM approved.
3. MSS Standard Compliance:
   a. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58.
   b. Select and install pipe hangers and supports, complying with MSS SP-69.
   c. Fabricate and install pipe hangers and supports, complying with MSS SP-89.
   d. Terminology used in this Section is defined in MSS SP-90.
4. Pre-construction Meeting: Coordinate installation of concrete inserts and all building attachments with installers of related work, prior to the start of construction.

C. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver all materials to project site in manufacturer’s original packaging, marked with manufacturer’s name, product model names and catalog numbers, identification numbers, and other related information.

B. Store materials under cover until needed for installation.

PART 2 - PRODUCTS

2.1 GENERAL

A. All supports and parts shall conform to the latest requirements of ANSI Code for Power Piping B31.1. and MSS Standard Practice SP-58, except as supplemented or modified by the requirements of this Specification.

B. Hangers shall be designed so that they cannot become disengaged by movement of the supported pipe.

C. Rigid riser supports shall be designed so that the load is always equalized, and at no time can one side of the support be completely unloaded by the riser moving out of plumb, thereby transferring the entire load to the opposite side. Wherever practical, support riser piping independently of the connected horizontal piping.

D. Hangers, supports, hanger rod attachments and building attachments shall be provided by the same manufacturer where possible.

2.2 SUPPLEMENTAL FRAMING

A. Provide supplemental framing for the following conditions:

1. Where the anchor locations do not align with the structural framing.
2. Where the intended loads exceed the structural framing maximum load carrying capacity.
3. Floor mounted supplemental supports may only be used where indicated or with specific approval of the Owner's Representative.

B. Provide supplemental framing or reinforcing straps, within the joist, to transfer the load to a panel point wherever proposed hanger locations do not align with a steel joist panel point. Refer to structural drawings for typical joist reinforcing details.
2.3 PIPING HANGERS AND SUPPORTS DESCRIPTION

A. General:

1. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping.

B. Adjustable Steel Clevis Hangers: MSS Type 1.

C. Steel Double Bolt Pipe Clamps: MSS Type 3.

D. U-Bolts: MSS Type 24, with plastic coating for glass, aluminum, brass and copper piping systems.

E. Pipe Stanchion Saddles: MSS Type 37, including steel pipe base support and cast-iron floor flange.

F. Single Pipe Rolls: MSS Type 41.

G. Pipe Roll Stands: MSS Type 44.
Construction

H. Adjustable Roller Hanger: MSS Type 43

I. Adjustable Roller Hanger: MSS Type 46

2.4 VERTICAL-PIPING CLAMPS
A. General:
1. Select size of vertical piping clamps to exactly fit pipe size of bare pipe.

B. Two-Bolt Riser Clamps: MSS Type 8.

C. Four-Bolt Riser Clamps: MSS Type 42.

2.5 HANGER-ROD ATTACHMENTS
A. General:
1. Hanger rods and attachments to the structure shall be subjected to tensile loading only and shall be designed with a minimum safety factor of five (5). Hanger rod diameters shall be compatible with the other component parts of the hanger assembly.
2. Select size of hanger-rod attachments to suit hanger rods.
B. Steel Turnbuckles: MSS Type 13.

C. Steel Clevises: MSS Type 14.

D. Swivel Turnbuckles: MSS Type 15.

E. Malleable Iron Sockets: MSS Type 16.

F. Steel Weldless Eye Nuts: MSS Type 17.

2.6 BUILDING ATTACHMENTS

A. General:

1. Select attachments to suit building substrate conditions.
2. Select size of building attachments to suit hanger rods, load restrictions and building material.
3. Provide supplemental framing wherever hanger locations are not directly below building attachment locations.
4. Do not attach supports to metal floor decking (or roof decking) panels.
5. “C” Clamps.

   a. The use of “C” clamps and beam clamps of “C” pattern and any modification thereof is prohibited for any and all attachments.
Construction

B. Concrete Inserts: MSS Type 18.

C. Center Beam Clamps: MSS Type 21.

D. Linked Steel Clamps w/ Eye Nut: MSS Type 29.

E. Steel Beam Clamp w/ Eye Nut: MSS Type 28.

F. Malleable Beam Clamp with Extension Piece: MSS Type 30.

G. Steel Brackets: One of the following for indicated loading:
   1. Loading up to 750 lbs.: MSS Type 31.
2. Loading up to 1500 lbs.: MSS Type 32.

3. Loading up to 3000 lbs.: MSS Type 33.

2.7 SADDLES AND SHIELDS

A. General:

1. Except as otherwise indicated, provide factory-fabricated saddles or shields under piping hangers and supports for all insulated piping.
2. Size saddles and shields for exact fit to mate with pipe insulation.

B. Protection Saddles: MSS Type 39.

1. Fill interior voids with segments of insulation matching adjoining insulation.
2. Saddle shall be of same material as pipe.

C. Protection Shields: MSS Type 40.

1. Length and gage as recommended by manufacturer to prevent crushing of insulation.

2. Manufacturer: Subject to compliance with requirements, provide thermal hanger shields of one of the following:
   a. Pipe Shields, Inc.
Construction

2.8 SPRING HANGERS AND SUPPORTS (Refer to Division 15 "Mechanical Vibration Control")

A. General:

   1. Select spring hangers and supports to suit pipe size, loading and load restrictions.

B. Spring Cushion Hangers: MSS Type 48.

C. Spring Cushion Roll Hangers: MSS Type 49.

D. Spring Sway Braces: MSS Type 50.

E. Variable Spring Hangers: MSS Type 51.

   1. Preset to indicated load and limit variability factor to 25%.

F. Variable Spring Base Supports: MSS Type 52.

   1. Preset to indicated load and limit variability factor to 25%; include load flange.
G. Variable Spring Trapeze Hangers: MSS Type 53.
   1. Preset to indicated load and limit variability factor to 25%.

H. Constant Supports:
   1. Provide one of the following types, selected to suit piping system.
      a. Horizontal Type: MSS Type 54.
      b. Vertical Type: MSS Type 55.
      c. Trapeze Type: MSS Type 56.
   2. Include auxiliary stops for erection and hydrostatic test, and field load-adjustment capability.

2.9 METAL PIPE HANGERS AND SUPPORTS
   A. The following are acceptable manufacturers subject to compliance with specified requirements.
1. Michigan Hanger Co.
2. Carpenter and Patterson, Inc.
3. Anvil International.

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.

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 or stainless steel.

2.10 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.

2.11 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.
   c. Flex-Strut Inc.
   d. GS Metals Corp.
   e. Thomas & Betts Corporation.
   f. Unistrut Corporation; Tyco International, Ltd.
   g. Wesanco, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
4. Channels: Continuous slotted steel channel with inturned lips.

   a. Aluminum: Strut shall be manufactured of extruded aluminum alloy 6063-T6. All fittings and hardware shall be zinc plated according to ASTM B633. For outdoor use, all fittings and hardware shall be stainless steel Type 316 or chromium zinc, ASTM F1136 Gr3.

   b. Epoxy Painted: Strut shall be made from steel meeting the minimum mechanical properties of ASTM A1011 33,000 PSI min. yield, then painted with water born epoxy applied by a cathodic electro-deposition process. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A1018 33,000 PSI min. yield. The fittings shall have the same epoxy finish as the strut. Threaded hardware shall be zinc plated in accordance with ASTM B633 Service Class 1. Service Class 1 in not an acceptable coating for fittings or components other than threaded hardware.

   c. Pre-Galvanized Steel: Strut shall be made from steel meeting the minimum mechanical properties of ASTM A653 33,000 PSI min. yield, mill galvanized coating designation G90. Fittings shall be manufactured form steel meeting the minimum requirements of ASTM A1018 33,000 PSI min. yield and zinc plated in accordance with ASTM B633 Service Class 3. Threaded hardware shall be zinc plated in accordance with ASTM B633 Service Class 1. Service Class 1 in not an acceptable coating for fittings or components other than threaded hardware.

   d. Hot-Dip Galvanized Steel: Strut shall be made from steel meeting the minimum mechanical properties of ASTM A1011 33,000 PSI min. yield and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A1018 33,000 PSI min. yield, and hot-dip galvanized after fabrication in accordance with ASTM A123. All hardware shall be stainless steel Type 316 or chromium zinc ASTM F1136 Gr.3. All hot-dip galvanized after fabrication products must be returned to point of manufacture after coating for inspection and removal of all sharp burrs.

   e. Stainless Steel: All strut, fittings and hardware shall be made of AISI type 316 stainless steel.

5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.


7. Metallic Coating: Hot-dipped galvanized or Mechanically-deposited zinc.


2.12 THERMAL-HANGER SHIELD INSERTS

   A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1. Carpenter & Paterson, Inc.
3. ERICO International Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

B. Insulation-Insert Material for Cold Piping: 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) or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig (862-kPa) minimum compressive strength.

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.

2.13 FASTENER SYSTEMS

A. Refer to Division 5 Section “Post-Installed Anchors”.

2.14 ROOF PIPE STANDS

A. System Description: Support piping on roof with an engineered, prefabricated system designed for installation without roof penetrations, flashings, or damage to the roofing material. The system shall consist of bases, made of high density, polypropylene plastics with UV Protection, a HDG structural steel frame, and suitable pipe hangers for the application. Nuts, threaded rods and washers shall be HDG, spring nuts, and bolts for spring nuts, will be electro-plated. System shall be custom designed to fit piping and conduit to be installed, and the actual conditions of service.

B. Support pipes, conduit, a minimum of 6 inches (150 mm) above roof surface

1. Support Spacing: 10 feet MAXIMUM.
2. On Sloped Roof Surfaces, where slope exceeds ¼ inch per foot (13 mm per 305 mm); provide base with swivel for slope adjustment. Note: Provide approved bracing when using base with swivel.
3. Un-insulated Piping: Roller support or clevis hanger.
4. Insulated Piping: Band hanger supported form horizontal channel or clevis hanger with Insulation Protection Shield.
5. Conduit: Band hanger supported from horizontal channel.
6. Bracing required when using base with swivel; when pipe exceeds 24 inches (610 mm) above roof, or when thermal expansion of pipe is great.

C. Materials

1. Portable Support System: Engineered, portable system specifically designed for installation without the need for roof penetrations, or flashings, and without causing damage to the roofing membrane.
   a. Design system using high density, high impact polypropylene bases with carbon black, anti-oxidants for UV protection, and steel framing of 1-5/8 inch (41 mm) or 1-7/8 inch (48 mm) for support.
   b. Custom design system to fit piping, conduits, to be installed and actual conditions of service and loading.
   c. Piping Supports: Provide suitable hangers and supports.

2. Bases: Injection molded high density, high impact polypropylene with UV-inhibitors and anti-oxidants, conforming to the following:
   a. Moisture Content: Negligible.
   b. Shrinkage/Swelling Due to Moisture: Negligible.
   c. Density: 55.8 lb/cu ft (894 kg/cu m).
   d. Insect Resistance: No known insect damage potential.
   e. Chemical Resistance (oil, brake fluid, gasoline, diesel, antifreeze, battery acid, and sulfuric acid) No visual or physical change apparent.
   f. Flammability: No ignition after 10 minutes, 25 kW/m, when tested in accordance with ASTM D 1929.
   g. Sized as required by loading conditions and as indicated on the drawings.
   h. Shop fabricated with inserts for square tubing or threaded rods as required.
   i. Color: Integral black color as molded.
   j. Bases for Mechanical Attachment: Sealant chamber around penetration point, with injection port for sealing after fastening; beveled lip for sealant bead around entire diameter.
   k. Do not use bases containing carbonated plastics, press molded recycled rubber and plastics, steel, stainless steel, or any injection molded threaded receivers.

3. Steel Framing:
   a. Channel Types: 1-5/8 inch (41.3 mm) 1-7/8 inch (47.6 mm) as required for loading conditions.
   b. Thickness: 12 gage (2.7 mm).
   c. Form: Roll-formed 3-sided or tubular channel, perforated with 9/16 inch (14.2 mm) holes at 1-7/8 inch (47.6 mm) centers on three sides.
   d. Finish: Hot dip galvanize in accordance with ASTM A 123 after fabrication, free of roughness, whiskers, unsightly spangles, icicles, runs, barbs, sags, droplets, and other surface blemishes.
   e. Do not use tubing or tube steel.
4. Stainless Steel Framing:
   a. Channel Types: 1-5/8 inch (41.3 mm) or 1-7/8 inch (47.6 mm), as required for loading conditions.
   b. Thickness: 12 gage (2.7 mm).
   c. Form: Roll-formed 3-sided or tubular channel.
   d. Finish: Mill finish.
   e. Do not use tubing or tube steel.

5. Pipe Supports and Hangers: Conform to MSS SP-58 and MSS SP-69 and as follows:
   a. Fabricated of carbon steel where framing is carbon steel; fabricated of stainless steel where framing is stainless steel; finished same as framing.
   b. Sizes 2-1/2 inch (63 mm) and smaller: Single roller supports for piping subject to expansion and contraction; 3-sided channels and pipe clamps.
   c. Sizes 3 inches (76 mm) and larger: Rollers, clevis hangers, or band hangers, to allow for expansion and contraction without movement of the bases or framing.

6. Accessories: Clamps, bolts, nuts, washers, and other devices as required for a complete system.
   a. Carbon Steel: Hot-dip galvanized in accordance with ASTM A 153/A 153M.
   b. Stainless Steel: Mill finish.

2.15 EQUIPMENT SUPPORTS
A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.16 MISCELLANEOUS MATERIALS
A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

B. Metal Framing: NEMA STD ML 1.

C. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Heavy Duty Steel Trapezes: Fabricated steel shapes for loads required. Weld steel in accordance with AWS Standards.
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. Locate steel reinforcing members with PACOMETER or other approved means to avoid resteel during anchor installation.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

2. Locate steel reinforcing members with PACOMETER or other approved means to avoid resteel during anchor installation.

F. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 Section "Roof Accessories" for curbs.

G. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.

I. 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.

J. Install bracing with pipe hangers and supports to prevent swaying.

K. Install building attachments within concrete slabs or attach to supplement 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.

L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. 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.

N. 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 and thermal-hanger shield inserts on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   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.

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 bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ROOF PIPE SUPPORTS

A. Examination
   1. Verify that roofing system is complete and roof surfaces are smooth, flat, and ready to receive work of this section.
   2. Verify that roof surface temperature is at minimum 60 °F (15.5°C) for proper adhesive performance.

B. Preparation
   1. Clean surfaces of roof in areas to receive portable support bases.
a. Sweep loose gravel from gravel surfaced roofs.
b. Remove dirt, dust, oils, and other foreign materials.

2. Use care in handling portable supply system components during installation, to avoid damage to roofing, flashing, equipment, or related materials.

C. Installation

1. Pipe Support Systems

a. Locate bases and support framing as indicated on drawings and as specified herein. Provide complete and adequate support of all piping and conduit; whether or not all required devices are shown.
b. The use of wood for supporting piping is not permitted.
c. Provide support spacing so deflection of piping does not exceed 1/240 of span.
d. Install framing at spacing indicated, but in no case at greater than 10 feet (3 m) on center.
e. Accurately locate and align bases.
   1) Consult manufacture of existing system as to the type of isolation pads required between the roof and base.
   2) Set isolation panels in adhesive, if required by manufacturer’s instructions.
   3) Place bases on isolation pads.
   4) Adhere or mechanically attach, if required by code.
   5) Where applicable, replace gravel around bases.

f. Set framing posts into bases and assemble framing structure as indicated.
g. Use galvanized fasteners for galvanized framing and stainless steel fasteners for stainless steel framing.

D. Cleaning and Protection

1. Remove all packaging, unused fasteners, adhesive and other installation materials from the project site.
2. Remove adhesive from exposed surfaces of supports and bases, and leave the work area in clean condition.
3. Provide protection as required, leaving the work area in undamaged condition at the time of completion of work.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve uniform slope of pipe to assure complete drainage and compensate for pipe deflection between hangers.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm) past end of the nut.
3.6 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.7 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 metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use copper-plated pipe hangers and copper attachments for copper piping and tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Use thermal-hanger shield inserts for insulated piping and tubing.

I. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).

2. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
3. 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.

4. 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.

5. 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.

6. 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.

J. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (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.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.

2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

3. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

4. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

5. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

6. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
a. Light (MSS Type 31): 750 lb (340 kg).
b. Medium (MSS Type 32): 1500 lb (680 kg).
c. Heavy (MSS Type 33): 3000 lb (1360 kg).

M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

N. 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.

O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
Q. Install anchors in accordance with Division 5 Section “Post-Installed Anchors”.

END OF SECTION 230529
CEW
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.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 23 Section “Common Motor Requirements for HVAC Equipment”.
2. Division 23 Section “Meters and Gages for HVAC Piping”.
3. Division 23 Section “General-Duty Valves for HVAC Piping”.
4. Division 23 Section “HVAC Insulation”.
5. Division 23 Section “Instrumentation and Control Systems”.
6. Division 23 Section “Fuel-Oil Piping”.
7. Division 23 Section “Natural-Gas Piping”.
8. Division 23 Section “Hydronic Piping”.
9. Division 23 Section “Hydronic Pumps”.
10. Division 23 Section “Steam and Condensate Heating Piping”.
11. Division 23 Section “Steam Condensate Pumps”.
12. Division 23 Section “HVAC Water Treatment”.
13. Division 23 Section “Metal Ducts”.
14. Division 23 Section “HVAC Casings”.
15. Division 23 Section “Air Duct Accessories”.
16. Division 23 Section “Centrifugal HVAC Fans”.
17. Division 23 Section “HVAC Power Ventilators”.
18. Division 23 Section “Air Terminal Units”.
19. Division 23 Section “HVAC Gravity Ventilators”.
20. Division 23 Section “Particulate Air Filtration”.
21. Division 23 Section “Gas-Phase Filtration”.
22. Division 23 Section “Condensing Boilers”.
23. Division 23 Section “Water-Tube Boilers”.
24. Division 23 Section “Deaerators”.
25. Division 23 Section “Heat Exchangers for HVAC”.
26. Division 23 Section “Air-Cooled Dry Fluid Coolers”.
27. Division 23 Section “Rotary-Screw Water Chillers”.
29. Division 23 Section “Custom Air-Handling Units”.
30. Division 23 Section “Fan Coil Units”.
31. Division 23 Section “Propeller Unit Heaters”.
32. Division 23 Section “Radiators”.
33. Division 23 Section “Chilled Beams”.
34. Division 23 Section “Humidifiers”.

1.2 SUMMARY

A. Extent of mechanical identification work required by this Section is indicated on Drawings and/or specified in other Division Sections containing mechanical work.

B. Types of identification devices specified in this Section include the following:

1. Pipe identification labels.
2. Underground-type plastic line markers.
3. Equipment labels.
4. Warning signs and labels.
5. Valve tags.
6. Duct labels.
7. Valve schedule frames.
8. Engraved plastic-laminate signs.
10. Warning tags.

1.3 SUBMITTALS

A. General:

1. Submit each item in this Article according to the Conditions of the Contract and Division Specification Sections.

B. Product Data:

1. None required.

C. Shop Drawings:

1. None required.

D. Samples:

1. None required.

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.
D. Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.

E. Multiple Systems: Where multiple systems of same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, Air Supply No. 1H, Standpipe F12).

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide mechanical identification materials of one of the following:

1. Allen Systems, Inc.
3. Craftmark Products Inc.
4. Industrial Safety Supply Co., Inc.
5. Seton Name Plate Corp.

2.2 PIPE IDENTIFICATION LABELS

A. Snap-On Type: Provide manufacturer's standard pre-printed, semi-rigid, snap-on, color-coded pipe identification labels, complying with ANSI A13.1.

B. Insulation: Furnish 1" thick molded fiberglass insulation with jacket for each plastic pipe marker to be installed on uninsulated pipes subjected to fluid temperatures of 125°F or greater. Cut length to extend 2" beyond each end of plastic pipe marker.
C. Small Pipes: For external diameters less than 6" (including insulation if any), provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:

1. Snap-on application of pre-tensioned semi-rigid plastic pipe identification label.
2. Laminated or bonded application of pipe identification label to pipe (or insulation).

D. Large Pipes: For external diameters of 6" and larger (including insulation, if any), provide either full-band or strip-type pipe identification labels, but not narrower than 3 times letter height (and of required length), fastened by one of the following methods:

1. Laminated or bonded application of pipe identification label to pipe (or insulation).
2. Strapped-to-pipe (or insulation) application of semi-rigid type, with manufacturer's standard stainless steel bands.

E. Lettering: Manufacturer's standard pre-printed nomenclature which best describes piping system in each instance, as selected by Architect/Engineer in cases of variance with name as shown or specified.

1. Arrows: Print each pipe identification label with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as separate unit of plastic.

2.3 UNDERGROUND-TYPE PLASTIC LINE MARKERS

A. Manufacturer's standard permanent, bright-colored continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe.

1. Provide multi-ply tape consisting of solid aluminum foil core between 2-layers of plastic tape.

2.4 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. General: Provide manufacturer's standard laminated plastic, color coded equipment identification labels. Conform to the following color code, for background color.

   a. Green: Cooling equipment and components.
   b. Yellow: Heating equipment and components.
   c. Yellow/Green: Combination cooling and heating equipment and components.
   e. Blue: Equipment and components that do not meet any of the above criteria.
   f. Use colors and designs recommended by ANSI A13.1 for hazardous equipment.
2. **Nomenclature:** Include the following, matching terminology on schedules as closely as possible:
   
   a. Name and plan number.
   b. Equipment service.
   c. Design capacity.
   d. Other design parameters such as pressure drop, entering and leaving conditions, rpm, etc.
   e. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
   g. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
   h. 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).
   i. 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.
   j. Fasteners: Stainless-steel rivets or self-tapping screws.

B. **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.

2.5 **WARNING SIGNS AND LABELS**

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.

B. **Letter Color:** Black.

C. **Background Color:** Yellow.

D. **Maximum Temperature:** Able to withstand temperatures up to 160 deg F (71 deg C).

E. **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).

F. **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.
G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Label Content: Include caution and warning information, plus emergency notification instructions.

2.6 DUCT IDENTIFICATION LABELS

A. Provide manufacturers standard, or custom pre-printed, color coded duct identification labels fabricated from heavy vinyl with pressure sensitive adhesive and in compliance with ANSI A13.1.

B. Lettering: Comply with air system nomenclature specified on Contract Documents, abbreviate only if necessary to accommodate lettering on standard length label.

C. Each label shall contain system type (i.e. supply air, return air, etc.) in not less than 1-1/4" high lettering, system designation (i.e. AHU - etc.) in not less than 3/4" high lettering, and design air volume in CFM at the location of the label in lettering not less than 3/4" high.

D. Arrows: Provide manufacturer's standard, roll type, heavy vinyl flow arrows on one end of the identification label. Length of arrow band shall be not less than the width of the identification label. Arrows shall be attached with pressure sensitive adhesive.

E. Color Code: Provide color code as follows, if no listing is given, follow ANSI A13.1 or Owner's Color Coding System:

Supply Air: White lettering on green background.
Cold Air: White lettering on green background.
Hot Air: Black lettering on yellow background.
Exhaust Air: White lettering on blue background.
Outside Air: White lettering on blue background.
Return Air: White lettering on blue background.
Mixed Air: White lettering on blue background.
Hazardous Exhaust: White lettering on red background or as specified by ANSI A13.1.

2.7 VALVE TAGS

A. Provide 1-1/2" diameter 19-gage polished brass valve tags with stamp-engraved piping system abbreviation in 1/4" high letters and sequenced valve numbers 1/2" high, and with 5/32" hole for fastener.

B. Valve Tag Fasteners: Provide manufacturer's standard solid brass chain (wire link or beaded type), or solid brass S-hooks of the sizes required for proper attachment of tags to valves, and manufactured specifically for that purpose.
C. Access Panel Markers: Provide manufacturer's standard 1/16" thick engraved plastic laminate access panel markers, with abbreviations and numbers corresponding to concealed valve. Include 1/8" center hole to allow attachment.

D. 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.

2.8 VALVE SCHEDULE FRAMES

A. For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls. Provide frames of finished hardwood or extruded aluminum, with SSB-grade sheet glass.

2.9 ENGRAVED PLASTIC-LAMINATE SIGNS

A. General: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in the sizes and thicknesses indicated, engraved with engraver's standard letter style of the sizes and wording indicated, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

B. Thickness: 1/16" for units up to 20 sq.in. or 8" length; 1/8" for larger units.

C. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate the substrate.

2.10 PLASTICIZED TAGS

A. Manufacturer's standard pre-printed or partially pre-printed accident-prevention tags, of plasticized card stock with matte finish suitable for writing, approximately 3-1/4" x 5-5/8", with brass grommets and wire fasteners, and with appropriate pre-printed wording including large-size primary wording (as examples: DANGER, CAUTION, DO NOT OPERATE).

2.11 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4 by 7 inches (100 by 178 mm).
2. Fasteners: Brass grommet and wire.
3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

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.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Install pipe identification labels of one of the following types on each system indicated to receive identification, and include arrows to show normal direction of flow:

1. Plastic pipe identification labels, with application system as indicated under "Materials" in this section. Install on pipe insulation segment where required for hot non-insulated pipes.

B. Locate pipe identification labels and color bands as follows wherever piping is exposed to view in occupied spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.

1. Near each valve and control device.
2. Near each branch, excluding short take-offs for terminal units; mark each pipe at branch, where there could be question of flow pattern.
3. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
4. At access doors, manholes and similar access points which permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment.
7. On piping above ceilings.
C. Pipe Label Color Schedule: Comply with Owner’s standards, if there are not standards then comply with ANSI A13.1.

3.4 UNDERGROUND PIPING IDENTIFICATION

A. During backfilling/topsoiling of each exterior underground piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6” to 8” below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16”, install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.

3.5 DUCTWORK IDENTIFICATION

A. General: Identify air supply, return, exhaust, intake and relief ductwork with duct identification labels with arrows, showing ductwork service and direction of flow, in black or white (whichever provides most contrast with ductwork color).

B. Location: In each space where ductwork is exposed, or concealed only by removable ceiling system, locate signs near points where ductwork originates or continues into concealed enclosures (shaft, underground or similar concealment), and at 50’ spacings along exposed runs.

C. Access Doors: Provide duct identification labels or stenciled signs on each access door in ductwork and housings, indicating purpose of access (to what equipment) and other maintenance and operating instructions, and appropriate safety and procedural information.

D. Concealed Doors: Where access doors are concealed above acoustical ceilings or similar concealment, plasticized tags may be installed for identification in lieu of specified signs, at Installer's option.

3.6 VALVE-TAG INSTALLATION

A. Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, and shut-off valves at HVAC terminal devices and similar rough-in connections of end-use units. List each tagged valve in valve schedule for each piping system.

B. Mount valve schedule frames and schedules in machine rooms where indicated or, if not otherwise indicated, where directed by Architect/Engineer.

1. Where more than one major machine room is shown for project, install mounted valve schedule in each major machine room, and repeat only main valves which are to be operated in conjunction with operations of more than single machine room.
3.7 EQUIPMENT IDENTIFICATION

A. General: Install engraved plastic laminate sign or plastic equipment identification label on or near each major item of mechanical equipment and each operational device as specified herein, unless specified otherwise for each item or device. Provide signs for the following general categories of equipment and operational devices.

1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
2. Fuel-burning units including boilers, furnaces, heaters, stills and absorption units.
3. Pumps, compressors, chillers, condensers and similar motor-driven units.
4. Heat exchangers, coils, evaporators, cooling towers, heat recovery units and similar equipment.
5. Fans, blowers, primary balancing dampers and air terminal units.
6. Packaged HVAC central-station and zone-type units.
7. Tanks and pressure vessels.
8. Strainers, filters, humidifiers, water treatment systems and similar equipment.

B. Lettering Size: Minimum 1/4" high lettering for name of unit where viewing distance is less than 2'-0", 1/2" high for distances up to 6'-0", and proportionately larger lettering for greater distances. Provide secondary lettering 2/3 to 3/4 of size of principal lettering.

C. Text of Signs: In addition to name of identified unit, provide lettering to distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations and indicate the source of the air handling unit that is providing supply air.

D. Optional use of Plasticized Tags: At Installer's option, where equipment to be identified is concealed above acoustical ceiling or similar concealment, plasticized tags may be installed within concealed space to reduce amount of text in exposed sign (outside concealment).

3.8 WARNING-TAG INSTALLATION

A. Record message on, and attach warning tags to, equipment and other items where required.

3.9 ADJUSTING AND CLEANING

A. Adjusting: Relocate any mechanical identification device which has become visually blocked by work of this division or other divisions.

B. Cleaning: Clean face of identification devices, and frames of valve charts.
3.10 EXTRA STOCK

A. Furnish minimum of 5% extra stock of each mechanical identification material required, including additional numbered valve tags (not less than 3) for each piping system, additional piping system identification markers and additional plastic laminate engraving blanks of assorted sizes.

END OF SECTION 220553
CEW
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.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 23 Section “Commissioning of HVAC”.
2. Division 23 Section “Instrumentation and Control Systems”.
3. Division 23 Section “Hydronic Piping”.
4. Division 23 Section “Hydronic Pumps”.
5. Division 23 Section “Steam and Condensate Heating Piping”.
6. Division 23 Section “Steam Condensate Pumps”.
7. Division 23 Section “HVAC Water Treatment”.
8. Division 23 Section “Air Duct Accessories”.
9. Division 23 Section “Centrifugal HVAC Fans”.
10. Division 23 Section “HVAC Power Ventilators”.
11. Division 23 Section “Air Terminal Units”.
12. Division 23 Section “Diffusers, Registers, and Grilles”.
13. Division 23 Section “HVAC Gravity Ventilators”.
14. Division 23 Section “Heat Exchangers for HVAC”.
15. Division 23 Section “Air-Cooled Dry Fluid Coolers”.
16. Division 23 Section “Rotary-Screw Water Chillers”.
17. Division 23 Section “Custom Air-Handling Units”.
18. Division 23 Section “Fan Coil Units”.
19. Division 23 Section “Propeller Unit Heaters”.
20. Division 23 Section “Radiators”.
21. Division 23 Section “Chilled Beams”.

1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:
   a. Constant-volume air systems.
   b. Variable-air-volume systems.
   c. Induction-unit systems.
2. Balancing Hydronic Piping Systems:
   a. Constant-flow hydronic systems.
   b. Variable-flow hydronic systems.
   c. Primary-secondary hydronic systems.

1.3 DEFINITIONS


C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 ACTION SUBMITTALS

A. LEED Submittals:

1. Air-Balance Report for Prerequisite IEQ 1: Documentation of work performed for ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

2. TAB Report for Prerequisite EA 2: Documentation of work performed for ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.


D. Certified TAB reports.

E. Sample report forms.
F. Instrument calibration reports, to include the following:
   1. Instrument type and make.
   2. Serial number.
   3. Application.
   4. Dates of use.
   5. Dates of calibration.

1.6 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB, or TABB.
   1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB, or TABB.
   2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB, or TABB as a TAB technician.

B. TAB Conference: Meet with Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.
   1. Agenda Items:
      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."

F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
G. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.7 PROJECT CONDITIONS
A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.8 COORDINATION
A. Notice: 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.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 TAB SPECIALISTS
A. Subject to compliance with requirements, engage one of the following:
   1. Absolut Balance.
   3. Enviro-Aire/Total Balance, Inc.

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 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.

F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. 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.

I. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.

J. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

K. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

M. Examine system pumps to ensure absence of entrained air in the suction piping.

N. Examine operating safety interlocks and controls on HVAC equipment.

O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.3 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Complete system-readiness checks and prepare reports. Verify the following:
   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" or 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.

1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230700 "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. 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.

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 Section 233113 "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 Commissioning Authority for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload 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. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.

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. 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. Remeasure 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. 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.
8. Record final fan-performance data.
3.8 PROCEDURES FOR INDUCTION-UNIT SYSTEMS

A. Balance primary-air risers by measuring static pressure at the nozzles of the top and bottom units of each riser to determine which risers must be throttled. Adjust risers to indicated airflow within specified tolerances.

B. Adjust each induction unit.

3.9 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.

3.10 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 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 Commissioning Authority and comply with requirements in Section 232123 "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 presetsettings.

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.
3.11 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.

3.12 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS
   A. Balance the primary circuit flow first and then balance the secondary circuits.

3.13 PROCEDURES FOR STEAM SYSTEMS
   A. Measure and record upstream and downstream pressure of each piece of equipment.
   B. Measure and record upstream and downstream steam pressure of pressure-reducing valves.
   C. Check settings and operation of automatic temperature-control valves, self-contained control
      valves, and pressure-reducing valves. Record final settings.
   D. Check settings and operation of each safety valve. Record settings.
   E. Verify the operation of each steam trap.

3.14 PROCEDURES FOR HEAT EXCHANGERS
   A. Measure water flow through all circuits.
   B. Adjust water flow to within specified tolerances.
   C. Measure inlet and outlet water temperatures.
   D. Measure inlet steam pressure.
   E. Check settings and operation of safety and relief valves. Record settings.

3.15 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.
      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.

3.16 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator 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. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
3. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
4. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
5. Capacity: Calculate in tons of cooling.
6. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

3.17 PROCEDURES FOR BOILERS

A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.

B. Steam Boilers: Measure and record entering-water temperature and flow and leaving-steam pressure, temperature, and flow.

3.18 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.
3.19 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 5% to zero.
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.

3.20 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.

B. Status Reports: Prepare 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.

3.21 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.

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.
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.
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.
E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Make and type.
   d. Model number and unit size.
   e. Manufacturer's serial number.
   f. Unit arrangement and class.
   g. Discharge arrangement.
   h. Sheave make, size in inches (mm), and bore.
   i. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
   j. Number, make, and size of belts.
   k. Number, type, and size of filters.

2. Motor Data:
   a. Motor make, and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches (mm), and bore.
   f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

3. Test Data (Indicated and Actual Values):
   a. Total air flow 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. Filter static-pressure differential in inches wg (Pa).
   f. Preheat-coil static-pressure differential in inches wg (Pa).
   g. Cooling-coil static-pressure differential in inches wg (Pa).
   h. Heating-coil static-pressure differential in inches wg (Pa).
   i. Outdoor airflow in cfm (L/s).
   j. Return airflow in cfm (L/s).
   k. Outdoor-air damper position.
   l. Return-air damper position.
   m. Vortex damper position.
F. Apparatus-Coil Test Reports:

1. Coil Data:
   a. System identification.
   b. Location.
   c. Coil type.
   d. Number of rows.
   e. Fin spacing in fins per inch (mm) o.c.
   f. Make and model number.
   g. Face area in sq. ft. (sq. m).
   h. Tube size in NPS (DN).
   i. Tube and fin materials.
   j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):
   a. Air flow rate in cfm (L/s).
   b. Average face velocity in fpm (m/s).
   c. Air pressure drop in inches wg (Pa).
   d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
   e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).
   f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
   g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
   h. Water flow rate in gpm (L/s).
   i. Water pressure differential in feet of head or psig (kPa).
   j. Entering-water temperature in deg F (deg C).
   k. Leaving-water temperature in deg F (deg C).
   l. Refrigerant expansion valve and refrigerant types.
   m. Refrigerant suction pressure in psig (kPa).
   n. Refrigerant suction temperature in deg F (deg C).
   o. Inlet steam pressure in psig (kPa).

G. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:
   a. System identification.
   b. Location.
   c. Make and type.
   d. Model number and unit size.
   e. Manufacturer's serial number.
   f. Fuel type in input data.
   g. Output capacity in Btu/h (kW).
   h. Ignition type.
   i. Burner-control types.
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j. Motor horsepower and rpm.
k. Motor volts, phase, and hertz.
l. Motor full-load amperage and service factor.
m. Sheave make, size in inches (mm), and bore.
n. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

2. Test Data (Indicated and Actual Values):

a. Total air flow rate in cfm (L/s).
b. Entering-air temperature in deg F (deg C).
c. Leaving-air temperature in deg F (deg C).
d. Air temperature differential in deg F (deg C).
e. Entering-air static pressure in inches wg (Pa).
f. Leaving-air static pressure in inches wg (Pa).
g. Air static-pressure differential in inches wg (Pa).
h. Low-fire fuel input in Btu/h (kW).
i. High-fire fuel input in Btu/h (kW).
j. Manifold pressure in psig (kPa).
k. High-temperature-limit setting in deg F (deg C).
l. Operating set point in Btu/h (kW).
m. Motor voltage at each connection.
n. Motor amperage for each phase.
o. Heating value of fuel in Btu/h (kW).

H. 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).

I. 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).

J. 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).
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e. Final air flow rate in cfm (L/s).
f. Final velocity in fpm (m/s).
g. Space temperature in deg F (deg C).

K. 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).

L. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Service.
   d. Make and size.
   e. Model number and serial number.
   f. Water flow rate in gpm (L/s).
   g. Water pressure differential in feet of head or psig (kPa).
   h. Required net positive suction head in feet of head or psig (kPa).
   i. Pump rpm.
   j. Impeller diameter in inches (mm).
   k. Motor make and frame size.
   l. Motor horsepower and rpm.
   m. Voltage at each connection.
   n. Amperage for each phase.
   o. Full-load amperage and service factor.
   p. Seal type.
2. Test Data (Indicated and Actual Values):
   a. Static head in feet of head or psig (kPa).
   b. Pump shutoff pressure in feet of head or psig (kPa).
   c. Actual impeller size in inches (mm).
   d. Full-open flow rate in gpm (L/s).
   e. Full-open pressure in feet of head or psig (kPa).
   f. Final discharge pressure in feet of head or psig (kPa).
   g. Final suction pressure in feet of head or psig (kPa).
   h. Final total pressure in feet of head or psig (kPa).
   i. Final water flow rate in gpm (L/s).
   j. Voltage at each connection.
   k. Amperage for each phase.

M. Instrument Calibration Reports:

1. Report Data:
   a. Instrument type and make.
   b. Serial number.
   c. Application.
   d. Dates of use.
   e. Dates of calibration.

3.22 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 Commissioning Authority.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Commissioning Authority.

3. Commissioning Authority 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.

3.23 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.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593
CEW
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.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 23 Section “Expansion Fittings and Loops for HVAC Piping”.
2. Division 23 Section “Sleeves and Sleeve Seals for HVAC Piping”.
3. Division 23 Section “Escutcheons for HVAC Piping”.
4. Division 23 Section “General-Duty Valves for HVAC Piping”.
5. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment”.
6. Division 23 Section “Hydronic Piping”.
7. Division 23 Section “Hydronic Pumps”.
8. Division 23 Section “Steam and Condensate Heating Piping”.
9. Division 23 Section “Steam Condensate Pumps”.
10. Division 23 Section “HVAC Water Treatment”.
11. Division 23 Section “Metal Ducts”.
12. Division 23 Section “HVAC Casings”.
13. Division 23 Section “Air Duct Accessories”.
14. Division 23 Section “Air Terminal Units”.
15. Division 23 Section “Diffusers, Registers, and Grilles”.
16. Division 23 Section “Gas-Phase Filtration”.
17. Division 23 Section “Water-Tube Boilers”.
18. Division 23 Section “Deaerators”.
19. Division 23 Section “Heat Exchangers for HVAC”.
20. Division 23 Section “Rotary-Screw Water Chillers”.

1.2 SUMMARY

A. Section includes insulating the following HVAC piping systems:

1. Condensate drain piping.
2. Chilled-water and chilled glycol/water piping.
3. Heating hot-water piping.
4. Steam and steam condensate piping.
5. Heat-recovery piping.
B. Section includes insulating the following duct services:

1. Supply air.
2. Outdoor air.
3. Return air.
5. Exhaust between isolation damper and penetration of building exterior.

C. Section includes insulating the following HVAC equipment that is not factory insulated:

1. Chillers.
3. Chilled-water and chilled glycol/water pumps.
4. Heating hot-water pumps.
5. Heat-recovery pumps.
6. Steam condensate pumps.
8. Air separators.
10. Deaerators.

1.3 SUBMITTALS

A. Product Data: None required.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
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. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove damaged or wet insulation from project site.

B. Deliver insulation materials in new unbroken cartons which are clearly marked by the manufacturer's label describing the product. Protect them from moisture and weather damage during job site storage and installation.

1.6 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.7 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


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 (IIG); Thermo-12 Gold.
      b. Owens Corning Fiberglass Corp.
   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.
   5. Material shall have a density of 14.5 lb./cu.ft. and thermal 0.41 BTU-in/hr-sq.ft.-F or less at 200 degree F mean temperature.

G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA, Inc.; Aerocel.
      b. Armacell LLC; AP Armaflex.
      c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
2. Elastomeric foam pipe and sheet insulation shall be of a flexible closed cell structure with a thermal conductivity of not more than 0.27 Btu-in/hr-sqft-degree F at 75 degree F mean temperature, and a water vapor permeability of 0.1 perm-in. or less.

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 III with factory-applied FSK jacket.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; SoftTouch Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Friendly Feel Duct Wrap.
   d. Owens Corning; SOFTR All-Service Duct Wrap.

2. Insulation shall have an installed thermal conductivity k of 0.27 Btu-in/hr-sqft-degree F or less at 75 degree F mean temperature, minimum density of 1.0 lb per cu.ft., and maximum vapor permeability of 0.02 perm-in.

I. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Fibrex Insulations Inc.; Coreplus 1200.
   b. Johns Manville; Micro-Lok.
   c. Knauf Insulation; 1000-Degree Pipe Insulation.
   d. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

J. Mineral-Fiber, Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ 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 6 lb/cu. ft. (96 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.
2.2 INSULATING CEMENTS


1. Products: Provide product(s) per the published requirements of the associated insulating materials.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

1. Products: Provide product(s) per the published requirements of the associated insulating materials.


1. Products: Provide product(s) per the published requirements of the associated insulating materials.

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).

1. Products: Provide product(s) per the published requirements of the associated insulating materials.

2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Provide product(s) per the published requirements of the associated insulating materials.

2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Provide product(s) per the published requirements of the associated insulating materials.
   2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

   1. Products: Provide product(s) per the published requirements of the associated insulating materials.
   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

F. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. Products: Provide product(s) per the published requirements of the associated insulating materials.
   2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   3. Adhesive shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
   1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
   1. Products: Provide product(s) per the published requirements of the associated insulating materials.
   2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
   4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.

C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
   1. Products: Provide product(s) per the published requirements of the associated insulating materials.
   2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.
   3. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).
   4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.

D. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
   1. Products: Provide product(s) per the published requirements of the associated insulating materials.
   2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
   4. Solids Content: 60 percent by volume and 66 percent by weight.

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.
   1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   2. Products: Provide product(s) per the published requirements of the associated insulating materials.
   3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
   4. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
2.6 SEALANTS

A. Joint Sealants:
1. Subject to compliance with requirements, provide product(s) per the published requirements of the associated insulating materials.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
5. Color: White or gray.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. FSK and Metal Jacket Flashing Sealants:
1. Products: Provide product(s) per the published requirements of the associated insulating materials.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
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.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm (0.013 metric perm) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
   a. Products: Provide insulation manufacturer’s standard product.
6. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm (0.007 metric perm) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
   a. Products: Provide insulation manufacturer’s standard product.
   a. Products: Provide insulation manufacturer’s standard product.
8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perms) when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.8 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).

1. Products: Provide product(s) per the published requirements of the associated insulating materials.
2.9 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.
   c. Proto Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.


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.

D. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:
   b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
   c. RPR Products, Inc.; Insul-Mate.

   a. Factory cut and rolled to size.
   b. Finish and thickness are indicated in field-applied jacket schedules.
   c. Moisture Barrier for Indoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
   d. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) 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.

2.10 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Provide product(s) per the published requirements of the associated insulating materials.
   2. Width: 3 inches (75 mm).
   3. Thickness: 11.5 mils (0.29 mm).
   4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   7. 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. Products: Provide product(s) per the published requirements of the associated insulating materials.
   2. Width: 3 inches (75 mm).
   3. Thickness: 6.5 mils (0.16 mm).
   4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   7. 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. Products: Provide product(s) per the published requirements of the associated insulating materials.
   2. Width: 2 inches (50 mm).
   3. Thickness: 6 mils (0.15 mm).
   4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
   5. Elongation: 500 percent.
   6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.
D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. **Products**: Provide product(s) per the published requirements of the associated insulating materials.
2. **Width**: 2 inches (50 mm).
3. **Thickness**: 3.7 mils (0.093 mm).
4. **Adhesion**: 100 ounces force/inch (1.1 N/mm) in width.
5. **Elongation**: 5 percent.
6. **Tensile Strength**: 34 lbf/inch (6.2 N/mm) in width.

E. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. **Products**: Provide product(s) per the published requirements of the associated insulating materials.
2. **Width**: 3 inches (75 mm).
3. **Film Thickness**: 6 mils (0.15 mm).
4. **Adhesive Thickness**: 1.5 mils (0.04 mm).
5. **Elongation at Break**: 145 percent.
6. **Tensile Strength**: 55 lbf/inch (10.1 N/mm) in width.

2.11 SECUREMENTS

A. Bands:

1. **Aluminum**: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 3/4 inch (19 mm) wide with wing seal or closed seal.
2. **Springs**: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. 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.

D. 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. 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.

2.12 CORNER ANGLES

A. 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.

2.13 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by an NRTL acceptable to authorities having jurisdiction.

   1. Products: Subject to compliance with requirements, provide one of the following:

      a. CertainTeed Corp.; FlameChek.
      b. Johns Manville; Firetemp Wrap.
      c. Nelson Fire Stop Products; Nelson FSB Flameshield Blanket.
      d. Thermal Ceramics; FireMaster Duct Wrap.
      e. 3M; Fire Barrier Wrap Products.
      f. Unifrax Corporation; FyreWrap.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

   1. Verify that systems to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
B. 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 piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (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 4 inches (100 mm) o.c.

   a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:

   1. Vibration-control devices.
   2. Testing agency labels and stamps.
   3. Nameplates and data plates.
   5. Handholes.
   6. Cleanouts.

Q. All exposed interior ductwork shall be painted.

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 Section 078413 "Penetration Firestopping" for firestopping 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 Section 078413 "Penetration Firestopping."
3. Duct: 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).

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, 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. Label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (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 INSTALLATION OF CALCIUM SILICATE PIPE INSULATION

A. 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 two-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.

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 block insulation of same material and thickness as pipe insulation.
4. Finish flange insulation same as pipe insulation.
Construction

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 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.

D. 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.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC PIPE INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
   4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on 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.

3.8 INSTALLATION OF MINERAL-FIBER PIPE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches (150 mm) o.c.
   4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe 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.
3.9 INSTALLATION OF MINERAL-FIBER DUCT INSULATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. On duct sides with dimensions 18 inches (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 one edge and one 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 two 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.

B. 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, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. On duct sides with dimensions 18 inches (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 one edge and one 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 two 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.

3.10 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Firestopping."

3.11 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

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 100 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.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch (150-mm) centers, starting at corners. Install 3/8-inch- (10-mm-) diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.

2. Fabricate boxes from aluminum or stainless steel, at least 0.050 inch (1.3 mm) thick.

3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.12 FIELD QUALITY CONTROL

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

B. Perform tests and inspections.
C. Tests and Inspections:

1. Inspect pipe, fittings, strainers, and valves, randomly selected by Testing Agency or 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.

2. Inspect ductwork, randomly selected by Testing Agency or 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.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.13 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. Drainage piping located in crawl spaces.
2. Underground piping.
3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
<table>
<thead>
<tr>
<th>SERVICE TYPE</th>
<th>INSULATION MATERIAL</th>
<th>VAPOUR BARRIER</th>
<th>NOMINAL PIPE DIAMETER (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt;1</td>
</tr>
<tr>
<td>Chilled Water</td>
<td>Mineral Fiber</td>
<td>Yes</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Flexible Elastomeric</td>
<td>N/R</td>
<td>1</td>
</tr>
<tr>
<td>Hot Water Heating</td>
<td>Mineral Fiber</td>
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</tr>
<tr>
<td></td>
<td>Flexible Elastomeric</td>
<td>N/R</td>
<td>1</td>
</tr>
<tr>
<td>LP Steam (15# &amp; less)</td>
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<td>Calcium Silicate</td>
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<td>Mineral Fiber</td>
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<td>Refrigerant Hot Gas</td>
<td>Mineral Fiber</td>
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<td>Refrigeration Suction (40 degree F &amp; above)</td>
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<tr>
<td></td>
<td>Flexible Elastomeric</td>
<td>N/R</td>
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### Construction

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<thead>
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<th>Refrigeration Suction (below 40 degree F)</th>
<th>Mineral Fiber</th>
<th>Yes</th>
<th>1</th>
<th>1.5</th>
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<th>1.5</th>
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<tr>
<td>Flexible Elastomeric</td>
<td>N/R</td>
<td></td>
<td>1</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
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</tbody>
</table>

| Engine Exhaust                           | Calcium Silicate | N/R | 4 | 4 | 4 | 4 | 4 | 4 |

| Energy Recovery System                    | Mineral Fiber   | Yes | 1 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |
|                                          | Flexible Elastomeric | N/R | 1 | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 |

N/R - Not Required

### 3.15 DUCTWORK INSULATION SCHEDULE

<table>
<thead>
<tr>
<th>DUCT TYPE</th>
<th>LOCATION</th>
<th>INSULATION MATERIAL</th>
<th>MINIMUM THICKNESS (inches)</th>
<th>VAPOR BARRIER</th>
<th>FIELD APPLIED JACKET</th>
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<tbody>
<tr>
<td>Supply</td>
<td>Mechanical Room</td>
<td>Mineral Fiber Board¹</td>
<td>1.5</td>
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<td>Woven Glass Fiber</td>
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<td></td>
<td>Mineral Fiber Board</td>
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<td>Yes</td>
<td>N/R</td>
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<tr>
<td></td>
<td></td>
<td>Mineral Fiber Blanket</td>
<td>1.5</td>
<td>Yes</td>
<td>N/R</td>
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<td>Unconditioned Space, Indirectly Conditioned Space</td>
<td>Mineral Fiber Board with Paintable ASJ or Blanket with Paintable PSK Jacket or Flexible Rigid with Paintable ASJ</td>
<td>1.5</td>
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<td>Exposed Conditioned Space</td>
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<td>Mineral Fiber Board</td>
<td>1.5</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Exterior</td>
<td></td>
<td>Mineral Fiber Board</td>
<td>2</td>
<td>Yes</td>
<td>Aluminum</td>
</tr>
</tbody>
</table>
### Equipment Insulation Schedule

<table>
<thead>
<tr>
<th>Return</th>
<th>Mechanical Room</th>
<th>Insulation Material</th>
<th>Thickness</th>
<th>N/R</th>
<th>Woven Glass Fiber</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirectly Conditioned Space, and Conditioned Space</td>
<td></td>
<td>Mineral Fiber Board&lt;sup&gt;1&lt;/sup&gt;</td>
<td>1.5</td>
<td>N/R</td>
<td>N/R</td>
</tr>
<tr>
<td>Unconditioned Space</td>
<td></td>
<td>Mineral Fiber Blanket</td>
<td>1.5</td>
<td>N/R</td>
<td>N/R</td>
</tr>
<tr>
<td>Exterior</td>
<td></td>
<td>Mineral Fiber Board</td>
<td>1.5</td>
<td>N/R</td>
<td>Aluminum</td>
</tr>
<tr>
<td>OA Intake</td>
<td>All</td>
<td>Mineral Fiber Board</td>
<td>2</td>
<td>Yes</td>
<td>Aluminum</td>
</tr>
<tr>
<td>Exhaust</td>
<td>From 10 feet upstream of the isolation damper to point of leaving the building</td>
<td>Mineral Fiber Board&lt;sup&gt;1&lt;/sup&gt;</td>
<td>1.5</td>
<td>N/R</td>
<td>Woven Glass Fiber</td>
</tr>
<tr>
<td>Boiler Breeching</td>
<td>All</td>
<td>Calcium Silicate</td>
<td>4</td>
<td>N/R</td>
<td>Aluminum</td>
</tr>
</tbody>
</table>

**N/R - Not Required**

Unconditioned Space: Includes Shafts, Crawl Spaces, and Unvented Attics.
Indirectly Conditioned Space: Includes Ceiling Spaces and Return Air Plenums.
Exterior: Includes Vented Attics.

1. Where exposed up to 10'-0” above floor. Provide metal corner beads.
2. Concealed or exposed higher than 10'-0” above floor.

### 3.16 EQUIPMENT INSULATION SCHEDULE

A. Hot Water Converters: Insulate with 1-1/2 inch thick mineral fiber board insulation.

B. Steam Humidifiers: Insulate with a 1-1/2 inch thick mineral fiber board insulation.

C. Chilled Water Expansion Tanks and Air Separator Tanks: Insulate with a 3/4 inch thick elastomeric foam insulation.

D. Chilled Water Pumps: Insulate with removable insulation covers. The cover shall enclose pump surfaces and flanges, and shall be fabricated with galvanized box frame and 1” thick elastomeric foam insulation.
E. Hot Water Pumps: Insulate with removable insulation covers. The cover shall enclose pump surfaces and flanges, and shall be fabricated with galvanized box frame and 1-1/2" thick calcium silicate.

3.17 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. Duct, Equipment, and Pipe Outdoors and Exposed:

1. Aluminum, Smooth with Z-Shaped Locking Seam: 0.024 inch (0.61 mm)] thick.

END OF SECTION 230719
CEW
SECTION 230900 - INSTRUMENTATION AND CONTROL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All work of this Division shall be coordinated and provided by a single Controls Provider.

B. The work of this Division shall be scheduled, coordinated, and interfaced with the associated work of other trades. Reference additional Sections within this Specification for details:

C. The work of this Division shall be as required by the Specifications, Point Schedules and Drawings.

D. If the Controls System Provider believes there are conflicts or missing information in the project documents, the Provider shall promptly request clarification and instruction from the design team.

1.2 SYSTEM ARCHITECTURE DESCRIPTION

A. The Instrumentation and Control System shall consist of direct digital control and data collection panels located in equipment spaces. These local control panels shall contain the necessary software and hardware to provide stand alone capability. The local control panels shall be connected to the operators work station (OWS) through a data transmission network. The system shall include the capability of addressing remote off-site facilities through internet access. From the OWS the operator shall be able to access the local control panels through menu driven selection process.

1.3 CONTROLS SYSTEM DESCRIPTION

A. The work of the single Controls System Provider shall be as defined individually and collectively in all Sections of this Division specifications together with Drawings and the associated interfacing work as referenced in the related documents within additional Sections.

B. The controls work shall consist of the provision of all labor, materials, tools, equipment, software, software licenses, software configurations and database entries, interfaces, wiring, tubing, installation, labeling, engineering, calibration, documentation, samples, submittals, testing, commissioning, training services, permits and licenses, transportation, shipping, handling, administration, supervision, management, insurance, temporary protection, cleaning, cutting and patching. Also include warranties, services, and items, even though not specifically mentioned in these Division documents which are required for the complete, fully functional and commissioned controls system.
C. Provide a complete, neat and workmanlike installation. Use only manufacturer employees who are skilled, experienced, trained, and familiar with the specific equipment, software and configurations to be provided for this Project.

D. The Controls Provider shall be a recognized national manufacturer, installer and service provider of control systems. Distributors, manufacturer’s representatives and/or wholesalers are not acceptable Controls Providers for this project.

1.4 ACCEPTABLE CONTROL SYSTEM PROVIDERS

A. General: Corporate Office.

1. The Controls Provider shall be the primary manufacturer-owned branch office that is regularly engaged in the engineering, programming, installation and service of total integrated controls system of similar size, scope and complexity to the controls specified in this Contract.

2. The Controls Provider shall have a local branch facility supplying complete maintenance and support services on a 24 hour, 7-day-a-week basis. This support facility shall have a spare parts inventory valued at a minimum of 10% of the contract value and all necessary test and diagnostic equipment required to install, commission and service the specified controls. Control system shall be furnished and installed only by those companies listed below.

3. As evidence and assurance of the contractor’s ability to support the Owner's system with service and parts, the provider must have been in the controls business for at least the last ten (10) years.

4. The Controls Provider shall be a recognized national manufacturer, installer and service provider of controls.

5. The Controls System architecture shall consist of the products of a manufacturer regularly engaged in the production of Controls Systems, and shall be the manufacturer’s latest standard of design at the time of Contract award.

6. The Building Management System software shall be updated to the latest currently available revision at the start of Warranty.

B. The Controls System shall be engineered, installed, and provided by one of the following Providers.

1. Siemens Building Technologies - Corporate Office

1.5 REFERENCES

A. All work shall conform to the following Codes and Standards, as applicable:


3. Underwriters Laboratories (UL) listing and labels.

4. UL 864 UOJZ Fire Protective Signaling Systems.
5. UL 864 UUKL Smoke Control
6. UL 268 Smoke Detectors.
7. UL 521 Heat Detectors.
8. UL 1480 Fire Alarm Signaling Devices.
10. UL 916 Energy Management
17. American Society of Mechanical Engineers (ASME).
18. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
19. Air Movement and Control Association (AMCA).
20. Institute of Electrical and Electronic Engineers (IEEE).
22. Electronics Industries Association (EIA).
23. Occupational Safety and Health Administration (OSHA).
26. Americans Disability Act (ADA)
27. CAN/ULC-S524 - Installation Of Fire Alarm Systems
28. CAN/ULC-S537 - Verification Of Fire Alarm Systems
29. CAN/ULC-S536 - Inspection And Testing Of Fire Alarm Systems

B. In the case of conflicts or discrepancies, the more stringent regulation shall apply.

C. All work shall meet the approval of the Authorities Having Jurisdiction at the project site.

1.6 SUBMITTALS

A. Shop Drawings, and Product Data

1. Submittals shall be in defined packages. Each package shall be complete and shall only reference itself and previously submitted packages.

2. At a minimum, submit the following:

   a. Controls system network architecture diagrams including all Controllers and interconnections.
   b. Schematics, sequences.
   c. A sample of each Graphic Display screen type and associated menu penetrations to show hierarchy and functional interrelationships.
   d. A sample of each data visualization display type.
e. Detailed Bill of Material list for each Controller, identifying quantity, part number, description, and optional features.

f. Control Damper Schedule including a separate line for each damper and a column for each of the damper attributes, including: Code Number, Fail Position, Damper Type, Damper Operator, Blade Type, Bearing Type, Seals, Duct Size, Damper Size, Mounting, and Actuator Type.

g. Control Valve Schedules including a separate line for each valve and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off Pressure, Capacity, Valve CV, Calculated CV, Design Pressure, Actual Pressure, and Actuator Type.

h. Room Schedule including a separate line for each VAV box and terminal unit indicating minimum/maximum CFM, pickup gain, box area, and bias setting.

i. Details of all control interfaces and connections to the work of other trades.

1.7 WARRANTY

A. Optional Preventive and Extended Material and Labor Warranty:

1. If within twelve (12) months from the date of acceptance of product, upon written notice from the Owner, it is found to be defective in operation, workmanship or materials, it will be replaced, repaired or adjusted at the option of the Controls Provider at the cost of the provider.

2. The Controls Provider shall clean, adjust and recalibrate the controls system to maintain control integrity and performance as originally accepted, on a regular scheduled basis.

3. Maintain a record on-site of all work done, all items removed from site, all items returned to site, all new replacement items installed and all remedial programming and database entry work undertaken including software revisions installed. Maintain a record of all calibrations done.

4. Controls Provider is to have a qualified employee on-site within 4 hours from the receipt of an emergency service call, Monday through Friday, between 8 AM and 5 PM. The Controls Provider must have the capability to respond after normal working hours if required. All costs for after hours work will be invoiced to the owner above and beyond this contract.

1.8 TRAINING

A. The Control System Provider shall provide 24 hours of training services according to the following breakdown:

1. One day of on-site orientation by a field engineer who is fully knowledgeable of the specific installation details of the project. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the BAS software layout and naming conventions, and a walk through of the facility to identify panel and device locations.

2. Training for two Owner Representatives on site. This training shall be performed by a factory-certified professional trainer and, at a minimum, shall consist of:
a. Two days training covering basic system operation.
b. One-half day training covering system reporting and alarm management.
c. One-half day training of scheduling and point trending.

3. The Owner Representatives shall be issued Continuing Education Credits (C.E.U.s) for the factory training.

1.9 OPERATING AND MAINTENANCE MANUALS

A. The operation and maintenance manuals shall contain all information necessary for the operation, maintenance, replacement, installation, and parts procurement for the entire BAS. This documentation shall include specific part numbers and software versions and dates. A complete list of recommended spare parts shall be included with the leadtime and expected frequency of use of each part clearly identified.

B. Following project completion and testing, the BAS contractor will submit as-built drawings reflecting the exact installation of the system. The as-built documentation shall also include a copy of all application software both in written form and on diskette.

PART 2 - PRODUCTS

2.1 BUILDING MANAGEMENT SYSTEM (BAS) ARCHITECTURE

A. General

1. The control system shall consist of the necessary DDC Controllers and associated equipment connected by industry standard network practices. The completed system including the Supervisory and System levels when programmed to monitor Building Facilities functions shall be deemed a Building Automation System (BAS).

2. The Building Automation System (BAS) shall consist of Network Router/Controllers (NRCs), a family of Standalone Digital Control Units, Administration and Programming Workstations, Web-based Operator Workstations (WOW), and one File Server to support system configurations where multiple operator workstations are required. The BAS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable, from a single ODBC-compliant database.

3. The BAS shall support accessibility through Enterprise Intranet and Internet browser to allow PC communication to outside sources with security protection for user access.

4. The PC Workstations, File servers and principal network equipment shall be standard products of recognized major manufacturers available through normal PC vendor channels. “Clones” are not acceptable.

5. Provide licenses for all software residing in the BAS system and transfer these licenses to the Owner prior to completion.
B. Network Topology (Architecture)

1. The BAS shall incorporate a supervisory Tier 1 (Enterprise) network. The BAS may also incorporate integrated system Tier 2 (Field Level) and tertiary Tier 3 networks as required.
2. The BAS Network shall utilize an open architecture capable of:
   a. Connecting via BACnet over Ethernet I/P at Tier 1 level operating at 10 mb/sec minimum. Control system contractor shall provide a stand alone Ethernet I/P data bus, not a shared bus system.
   b. BACNET MSTP (Master Slave Token Passing) Tier II.
   c. Connecting via LonMark utilizing FTT10A transceiver technology at Tier 2 level operating at 78K baud minimum.
3. The BAS network shall support both copper and optical fiber communication media.

C. Tier 1 Network Description

1. Tier1, the main backbone of the system, shall be an Ethernet 10/100bT LAN/WAN, using BACnet/IP as the communications protocol. Network Router/Controllers, Operator Workstations, and the Central File Server shall connect directly to this network without the need for Gateway devices.

D. Tier 2 Network Description

1. Tier 2 of the system shall consist of one or more BACnet MS/TP field buses managed by the Network Router/Controllers. Minimum speed shall be 76.8kbps. The Tier 2 field bus consists of token passing bus that supports standalone field level DDC controllers

E. Third-Party Interfaces

1. Control System Provider shall integrate real-time data from systems supplied by other trades as required.
2. The system shall include necessary Control hardware equipment and software to allow data communications between the BAS system at the Tier 1 or Tier 2 level, and systems supplied by other trades.
3. The trade contractor supplying other systems will provide their necessary hardware and software and will cooperate fully with the Controls Provider in a timely manner at their cost to ensure the complete data integration.

F. BAS LAN Segmentation

1. The BAS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN), sharing a single file server. This enables workstations to manage a single LAN (or building), and/or the entire system with all devices being assured of being updated by and sharing the most current data.
database. In the case of a single workstation system, the workstation shall contain the entire database – with no need for a separate file server.

G. Power Fail / Auto Restart

1. Provide for the automatic orderly and predefined shutdown/start-up of parts or all of the BAS following total loss of power to parts or all of the BAS.
2. Archive and annunciate time and details of restoration.
3. Provide for the orderly and predefined scheduling of controlled return to normal, automatically time-scheduled operation of controlled equipment as a result of the auto restart processes.
4. Maintain the BAS real-time clock operation during periods of power outage for a minimum of 72 hours.

H. Standard Network Support

1. All routers and controllers, Workstation(s) and File Server shall be capable of residing directly on the owner’s Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the routers and controllers, Workstation(s) and File Server shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner’s Information Systems Department as all devices utilize standard TCP/IP components.

I. System Expansion

1. The BAS system shall be scalable and expandable at all levels of the system using the same software interface, and the same Tier 1 and Tier 2 controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.
2. The BAS shall be capable of expansion in the future to include Security and Access Control functions at any time in the future with no additional workstations, front-end software or Tier 1 controllers required.
3. Additional web-based operator licenses shall be available in the field through an upgrade of the web server’s security key, additional programming required.
4. The system shall use the same application programming language for all levels: Operator Workstation, Network Router/Controller, and Standalone Digital Control Unit.

J. Support For Open Systems Protocols

1. All hardware and software included under this section shall conform to BACnet standard 135-2001, to promote interoperability between building subsystems. Additionally, the BAS design must include solutions for the integration of the following “open systems” protocols: Modbus, and digital data communication to third party microprocessors such as chiller controllers, fire panels and variable frequency drives (VFDs).
2.2 NETWORK ROUTER/CONTROLLERS (NRCs)

A. General

1. Network Router Controllers shall combine both network routing functions and control functions into a single unit. NRC’s shall route communications between the BACnet/IP network and the BACnet MS/TP field network.

2. Each NRC shall be classified as a “native” BACnet device, supporting the BACnet Building Controller (B-BC) profile. Controllers that support a lesser profile such as B-SA are not acceptable. NRCs shall be tested and certified by the BACnet Testing Laboratory (BTL) as Advanced Application Controllers (B-BC).

B. Downloading and Uploading

1. Provide the capability to generate system software-based sequences, database items and associated operational definition information and user-required revisions to same on designated Operator Workstation (OWS), and the means to download same to the associated application Controller.

C. Hardware Specifications

1. Memory:
   a. Both the operating system of the controller, plus the application program for the controller, shall be stored in non-volatile, FLASH memory. Controllers shall contain enough memory for the current application, plus required history logging.

D. Communication Ports:

1. Each NRC shall provide communication to both the Workstation(s) and the field buses. An on-board 10/100bT Ethernet port shall be provided, as well as a USB port for communications.

E. Modular Expandability:

1. The system shall employ a modular I/O design to allow easy expansion. Input and output capacity is to be provided through plug-in modules of various types. It shall be possible to combine I/O modules as desired to meet the I/O requirements for individual control applications.

F. Local Status Indicator Lamps:

1. Provide as a minimum LED indication of CPU status, Ethernet LAN status, and field bus status. For each output, provide LED indication of the value of the output (On/Off). For each output module provide an LED which gives a visual indication of whether any outputs on the module are manually overridden.
G. Real Time Clock (RTC):

1. Each NRC shall include a battery-backed, real time clock, accurate to 10 seconds per day. The RTC shall provide the following: time of day, day, month, year, and day of week. The system shall automatically correct for daylight savings time and leap years.

H. Power Supply:

1. The controller shall contain over voltage surge protection, and require no additional AC power signal conditioning.

I. Automatic Restart After Power Failure:

1. Upon restoration of power after an outage, the NRC shall automatically and without human intervention: update all monitored functions; resume operation based on current, synchronized time and status, and implement special start-up strategies as required.

J. Battery backup:

1. The NRC shall include an on-board battery to back up the controller’s RAM memory. The battery shall provide accumulated backup of all RAM and clock functions for at least 72 hours. In the case of a power failure, the NRC shall first try to restart from the RAM memory. If that memory is corrupted or unusable, then the NRC shall restart itself from its application program stored in its FLASH memory.

2.3 BAS OPERATOR WORKSTATION AT SUPERVISORY LEVEL

A. The Operator Workstations (OWS) shall provide the primary means of communication with the controls system and shall be used for operations, engineering, management, audit, reporting and other related functions.

B. The OWS shall consist of fixed and/or portable units as scheduled in Part 3 of this Specification. The fixed units shall consist of installed PC-based configurations. The portable units shall consist of digital hand-held, PC Laptop or similar designed unit, complete with keypad or similar entry/selection device and complete with display and communication arrangements with DDC Controllers.

C. Each fixed OWS shall:

1. Latest tested and supported PC platform, details such as displays, printer, etc. shall be project specific.
2.4 SOFTWARE SPECIFICATIONS

A. General.

1. The NRC shall be a multi-tasking, multi-user, and real-time digital control processor. The NRC size and capability shall be sufficient to fully meet the requirements of this Specification. The NRC shall contain sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.

B. User Programming Language:

1. The application software shall be user programmable. This includes all strategies, sequences of operation, control algorithms, parameters, and setpoints. The source program shall be English language-based and programmable by the user. The language shall be structured to allow for the easy configuration of control programs, schedules, alarms, reports, telecommunications, local displays, mathematical calculations, passwords, and histories.

2. Controllers that use a “canned” program method will not be accepted.

2.5 CONTROL SOFTWARE:

A. The NRC shall have the ability to perform the following pre-tested control algorithms:

1. Proportional, Integral plus Derivative Control (PID)
2. Self Tuning PID
3. Two Position Control
4. Digital Filter
5. Ratio Calculator
6. Equipment Cycling Protection

B. Mathematical Functions:

1. Each controller shall be capable of performing basic mathematical functions (+, -, *, /), squares, square roots, exponential, logarithms, Boolean logic statements, or combinations of both. The controllers shall be capable of performing complex logical statements including operators such as >, <, =, and, or, exclusive or, etc. These must be able to be used in the same equations with the mathematical operators and nested up to five parentheses deep.

C. Energy Management Applications:

1. Network Router Controllers (NRC): Shall have the ability to perform any or all of the following energy management routines:
a. Time of Day Scheduling  
b. Calendar Based Scheduling  
c. Holiday Scheduling  
d. Temporary Schedule Overrides  
e. Optimal Start  
f. Optimal Stop  
g. Night Setback Control  
h. Enthalpy Switchover (Economizer)  
i. Peak Demand Limiting  
j. Temperature Compensated Duty Cycling  
k. CFM Tracking  
l. Heating/Cooling Interlock  
m. Hot/Cold Deck Reset  
n. Free Cooling  
o. Hot Water Reset  
p. Chilled Water Reset  
q. Condenser Water Reset  
r. Chiller Sequencing  

D. History Logging:  

1. Each controller shall be capable of LOCALLY logging any input, output, calculated value or other system variable over user defined time intervals over a wide range. Any system can be logged in history. Logged data shall be downloadable to the Operator Workstation for long term archiving based upon user-defined time intervals, or manual command.  

E. Alarm Management:  

1. For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms will be tested each scan of the NRC and can result in the display of one or more alarm messages or reports.  
2. Alarms will be generated based on their priority.  
3. If communication with the Operator Workstation is temporarily interrupted, the alarm will be time-stamped and buffered in the NRC. When communications return, the alarm will be transmitted to the Operator Workstation if the point is still in the alarm condition.  
4. Alarms must be capable of being routed to any BACnet workstation that conforms to the B-OWS device profile and uses the BACnet/IP protocol.  

F. Local Keypad/Display:  

1. For each NRC, provide a local display of at least 4 lines, providing current display of all critical inputs and outputs that the NRC is controlling. Provide a keypad such that an operator can log on, scroll through point values, and change setpoints that are changeable. Optional USB port for laptop computer connection in lieu of local display and keypad.
G. Embedded Web Server

1. Each NRC must have the ability to serve out customized web pages containing any desired I/O values from the entire BAS.

2.6 BAS OPERATOR INTERFACE AT SUPERVISORY TIER 1 LEVEL

A. General

1. The Control System Operator Interface at the supervisory level shall be user friendly, readily understood and shall make maximum use of colors, graphics, icons, embedded images, animation, text based information and data visualization techniques to enhance and simplify the use and understanding of the BAS by authorized users at the OWS.

2. User access to the BAS shall be protected by a flexible and Owner redefinable software-based password access protection. Password protection shall be multi-level and partitionable to accommodate the varied access requirements of the different user groups. Provide the means to define unique access privileges for each individual authorized user. Provide the means to on-line manage password access control under the control of a Master Password.

3. The operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:

   a. User access for selective information retrieval and control command execution
   b. Monitoring and reporting
   c. Alarm and non-normal condition annunciation
   d. Selective operator override and other control actions
   e. Information archiving, manipulation, formatting, display and reporting
   f. BAS internal performance supervision and diagnostics
   g. On-line access to user HELP menus
   h. On-line access to current BAS control system as-built records and documentation
   i. Means for the controlled re-programming, re-configuration of control system operation and for the manipulation of control system database information in compliance with the prevailing codes, approvals and regulations for individual BAS control system applications.

4. Provide reports and displays making maximized use of simple English language descriptions and readily understood acronyms, abbreviations and the like to assist user understanding and interpretation. All text naming conventions shall be consistent in their use and application throughout the control system.

5. All PC-based configurations shall operate on Microsoft® Windows XP.

6. Each fixed and portable OWS shall be on-line configurable for specific applications, functions and groups of control system points.
B. Alarms

1. Designated fixed OWS shall annunciate alarms generated by the BAS. The alarm management portion of the OWS software shall, at the minimum, provide the following functions:
   a. Log date and time of alarm occurrence.
   b. Generate a “Pop-Up” window, with audible alarm, informing a user that an alarm has been received.
   c. Allow a user, with the appropriate security level, to acknowledge, or disable an alarm.
   d. Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.
   e. System shall be capable of offsite remote alarm notification to secondary parties.

2. The BAS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions.

C. Reports

1. Reports shall be generated and directed to one or more of the following: OWS display, printer, or archive at the user’s option. As a minimum, the system shall provide the following reports:
   a. All points in the control system.
   b. All points in each control system application.
   c. All points in a specific Controller.
   d. All points in a user-defined group of points.
   e. All points currently in alarm in a control system application.
   f. All points locked out in a control system application.
   g. All control system schedules.
   h. All user defined and adjustable variables, schedules, interlocks and the like.
   i. Control system diagnostic and system status reports.

2. Provide all applicable standard reports of the BAS manufacturer.

D. Dynamic Graphics

1. An unlimited number of graphic displays shall be able to be generated and executed.
2. The graphic displays shall be able to display and provide animation based on real-time BAS data that is acquired, derived, or entered.
3. The user shall be able to change values (setpoints) and states in system controlled equipment.
4. Provide a graphic editing tool that allows for the creation and editing of graphic files.
5. BAS shall be provided with a complete user expandable symbol library containing all of the basic symbols used to represent components of a typical BAS.

6. Graphics shall also be capable of converting graphics from AutoCad or Revit.

E. Schedules

1. Provide a spreadsheet-type schedule input form for automatic control system time-of-day scheduling and override scheduling of control system operations shall be provided. At a minimum, the following spreadsheet types shall be accommodated:

   a. Weekly schedules.
   b. Temporary override schedules.
   c. Special “Only Active If Today Is A Holiday” schedules.
   d. Monthly schedules.

2. Schedules shall be provided for each control system in the BAS. Each schedule shall include all commandable points residing within the system. Each system may have a unique schedule of operation relative to the system use schedule, allowing for sequential starting and control of equipment within the system. Scheduling and rescheduling of points shall be accomplished easily via the system schedule spreadsheets.

3. Monthly calendars for a 12-month period shall be provided that allow for simplified scheduling of holidays and special days in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the weekly schedules.

F. Historical Trending and Data Collection

1. Trend and store point history data for all control system points and values as selected by the user.

2. The trend data shall be stored in a manner that allows custom queries and reports using industry-standard software tools.

3. At a minimum, provide the capability to perform statistical functions on the historical database:

   a. Average.
   b. Arithmetic mean.
   c. Maximum/minimum values.
   d. Range – difference between minimum and maximum values.
   e. Standard deviation.
   f. Sum of all values.
   g. Variance.

G. Paging / E-Mail Notification

1. Provide the means of automatic alphanumeric paging or e-mailing of personnel for user-defined BAS events.
a. System shall support both numeric and alpha-numeric pagers, using Alphanumeric, PET, or IXO Protocol at the owner’s option.
b. Users shall have the ability to modify the phone number or message to be displayed on the pager or e-mail through the system software.
c. System shall utilize schedules to send notification to the personnel that are “on-call”.
d. Contractor shall be responsible for providing a modem for connection to the paging or e-mail service DIRECT.

2.7 BUILDING MANAGEMENT SYSTEM SPECIFIC REQUIREMENTS (SUPERVISORY LEVEL)

A. BAS Reports

1. Historical
2. Trending
3. Alarms
4. Etc.

B. Graphic Displays

1. Provide 3-Dimensional, Dynamic color graphics. Provide a color graphic system flow diagram display for each system with all points as indicated on the point list or temperature control drawings. Provide Historical Data Viewer functionality.
2. Provide a color graphic display for each floor in the facility. Indicate each HVAC zone, color coded to indicate zone values and status. Provide Historical Data Viewer functionality.
3. User shall have the ability to access the various system schematics and floor plans via a graphical penetration scheme and/or menu selection.
   a. User shall penetrate from floor plan to associated HVAC system graphic.

C. Actuation / Control Type

1. Primary Equipment
   a. Controls shall be provided by equipment manufacturer as specified herein.
   b. All damper and valve actuation shall be electric.

2. Air Handling Equipment
   a. All air handlers shall be controlled with DDC controllers
   b. All damper and valve actuation shall be electric.

3. Terminal Equipment
   a. Terminal Air Boxes (VAV, etc.) shall have electric damper and valve actuation.
2.8 DIGITAL CONTROLLERS (DDC)

A. General

1. The term “Direct Digital Controllers (DDC)” shall include all monitoring, control and information Controllers including field panels.
2. The DDC shall be programmable and governed by the requirements of their applicable codes, approvals and regulations.
3. The DDC shall be designed, packaged, installed, programmed and commissioned in consideration of their specific service and prevailing operating conditions. They shall be proven standard product of their original manufacturer and not a custom product for this Project.
4. A failure at a DDC shall not cause failures or non-normal operation at any other system DDC other than the possible loss of active real-time information from the failed DDC.
5. Ancillary DDC, including interfaces and power supplies, shall not be operated at more than 80% of their rated service capacity.
6. All DDC’s shall be listed by Underwriters Laboratories (UL).

B. System Level Direct Digital Controller

1. A System Controller shall be a fully user-programmable, supervisory controller. The System Controller shall monitor the network of distributed application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other System Level Controllers.
2. System Controller(s) shall reside on the first tier network and shall support a sub-network of controllers on optional secondary and tertiary networks.
3. Each System Controller shall have the ability to connect to third-party control systems.
4. Processor System Controllers shall be microprocessor-based. They shall be multi-tasking, multi-user, and real-time digital control processors. Controller size and capability shall be sufficient to fully meet the requirements of this Specification.
5. Memory – Each System Controller shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all sub-network controllers.
6. Hardware Real Time Clock – System Controllers shall have an integrated, hardware-based, real-time clock.
7. Communication Ports – System Controllers shall provide at least two ISB serial data communication ports for operation of operator I/O devices, such as industry-standard printers, operator terminals, modems, and portable operator’s terminals. Controllers shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers, or terminals.
8. Diagnostics – System Controllers shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. System controllers shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
9. Power Failure – In the event of the loss of normal power, there shall be an orderly shutdown of System Controllers to prevent the loss of database or operating system software. Nonvolatile memory shall be incorporated for all critical controller configuration data, and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions.

b. Upon restoration of normal power and after a minimum off-time delay, the System Controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

c. Should a System Controller memory be lost for any reason, the operator workstation shall automatically reload the program without any intervention by the system operators.

10. Portable OWS at system level shall operate under user password protection and using subsets of the fixed OWS programming arrangements with common point and device designations designed to meet the application.

11. In lieu of portable OWS provide a fixed panel touch-screen or LCD display at controller face.

C. HVAC Field Level Direct Digital Controllers (Also Identified as Application Specific Controllers; ASC)

1. HVAC DDC Controller shall provide both standalone and networked direct digital control of HVAC systems.

2. A dedicated HVAC DDC Controller shall be configured and provided for each primary HVAC system (air handler, chiller, boiler) and each terminal HVAC system (VAV Box, Unit Heater, Fan Coil Unit, Cabinet Heater, Heat Pump, Fan Powered Box, CV Box)

3. Each HVAC DDC Controller shall be able to retain program, control algorithms, and setpoint information for at least 72 hours in the event of a power failure, and shall return to normal operation upon restoration of power.

4. Each HVAC DDC shall report its communication status to the System Level Controller. The System Level Controller shall provide a advisory upon communication failure and restoration.

5. For each primary HVAC system, provide means of indication of system performance and setpoints at, or adjacent to the HVAC DDC Controller.

6. For each primary HVAC system, provide a means to adjust setpoints and start/stop equipment at, or adjacent to the HVAC DDC.

7. Provide a means to prevent unauthorized personnel from accessing setpoint adjustments and equipment control functions.

8. The HVAC DDC shall provide the ability to download and upload configuration data, both locally at the panel and via the control system communications network.

9. The HVAC DDC shall be provided with a permanently mounted local graphic terminal where required in the sequences of this specification. The local graphic terminal shall provide dynamic graphical representation of the associated system status, with the ability for the operator to enter commands with proper password protection.
2.9 APPLICATION SOFTWARE

A. HVAC Application Software

1. Event Messaging: Provide for the automatic execution of user-defined messages on the occurrence of each predefined control system real-time event including equipment/point status change, approaching limit or alarm, time of day and the like.

2. Indoor Air Quality: Provide monitoring of outside air, return air and supply air CO2 concentration, calculate and maintain fresh air requirements. Adjust outdoor air intake to ensure return air CO2 high level limit is not exceeded. Optimum Start/Stop: Provide software to start equipment on a sliding schedule based upon indoor and outdoor conditions, to determine the minimum time of HVAC system operation needed to satisfy the space environmental requirements. The program shall also determine the earliest possible time to stop the mechanical systems. The optimum start/stop program shall operate in conjunction with, and be coordinated with, the scheduled start/stop and night setback programs.

3. Auto Alarm Lockout: Provide for scheduled and automatic lockout of alarm annunciation from equipment during non-normal operating conditions including shutdown, emergency power operation, fire alarm and the like.

4. Demand Limiting: Provide software to limit excess utility charges caused by uncontrolled demand. Provide the ability to prioritize the demand limiting actions based on control system parameters.

5. System Restart: Upon restoration of the AC power to an HVAC DDC, automatically restart all equipment and restore all loads to the state as required by the control system. Provide appropriate time delays to prevent demand surges or overload trips.

6. Heavy Equipment Delays: The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

7. Runtime Totalization: Automatically sample, calculate and store runtime hours for binary input and output points as listed in the point schedule of this specification.

8. Zone thermostats that control both heating and cooling must be capable of providing a temperature range or dead band of at least 5°F between heating and cooling modes.

9. Analog/Pulse Totalization: Sample, calculate and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.

2.10 FIELD DEVICES

A. Electric/Electronic

1. Air Flow Monitoring Fan Inlet Probe
   a. Materials: Aluminum, copper, or stainless steel
   b. Rating: 300 – 10000 FPM
   c. Mounting: Fan inlets(s)
   d. Type: Air flow traverse probe
2. Air Flow Monitoring Duct
   a. Materials: Anodized aluminum-duct mounted stainless steel probe
   b. Rating: 100 – 5000 FPM
   c. Mounting: Duct, multiple probe
   d. Microprocessor-based transmitter
   e. LCD display
   f. 24 VAC
   g. Type: Thermal dispersion
   h. Accuracy: +/-2% over entire range
   i. 4 – 20 MA / 0 – 10 VDC output
   j. Ebtron, Inc.

3. Air Flow Monitoring Duct
   a. Materials: Copper w/aluminum air straightner
   b. Rating: 900 – 40000 FPM
   c. Mounting: Round/rectangle duct
   d. Accuracy: +/-2%
   e. Transmitter: Veltron DPT 2500, 0 – 10 VDC or 4-20 ma
   f. Manufacturer: Air Monitor Corporation “Fan Evaluator”
   g. Alternate: “Volu Probe/VS” air flow traverse station without air straightner

4. Domestic Water Monitoring
   a. Material: Brass and Epoxy Coated Iron
   b. Range: 20-660 GPM
   c. Mounting: Inline Pipe Flanged
   d. Accuracy: +/- 1.0% of rate
   e. Protection: Maximum 227 psig
   f. Output: Pulse (rate)
   g. 3” Niagara WPX Series turbine flow meter with 860 infra-red pulse. Optional pulse to DC converter.

5. Temperature Sensors
   a. General:
      1) Sensors shall be 1000 ohm Platinum or Balco RTDs with the following minimum performance.
a) Temperature Coefficient of Resistivity (TCR) of .00385 ohm/ohm/°C for platinum RTD’s or .00396 ohm/ohm/°C for Balco RTD’s.

b) Accuracy of 0.1% at 32 degrees F (Class B) for platinum RTDs and +0.1% at 70 degrees F for Balco RTDs.

c) Operating range of 0 to 99% Relative Humidity non-condensing.

2) Thermocouples, thermistors, RTD’s with transmitters or pneumatic sensors with transmitters are not acceptable.

b. Immersion Sensors:

1) RTD must be installed within a 316 stainless steel thermowell using a non-hardening heat conducting paste.

2) Thermowell shall be rated for a minimum static pressure of 500 psig at the maximum operating temperature and be capable of withstanding water velocities of up to 27 fps.

3) The sensor must be mounted so that it extends into the flow stream.

c. Duct Mounted Sensors:

1) For averaging service, provide 1000 ohm RTD sensing element. Sensing element shall have a minimum of 1 foot of sensor length for each 2 square feet of duct or coil area. Sensor shall be arranged evenly across the duct or coil such that no point in the duct or coil is more than 1 foot away from the sensor.

2) Install stainless steel flanges where elements penetrate ducts. Support elements with appropriate clips on coil faces, or ½” conduit in open ducts and plenums.

d. Space Temperature Sensors and Thermostats:

1) Electronic thermostats shall be used in conjunction with DDC VAV controllers.

2) Each thermostat in an office, classroom, lecture hall, laboratory, or other nonpublic area shall incorporate an accessible setpoint adjustment feature.

3) Each thermostat in a corridor, lobby, atrium, stairwell, lounge, restroom or other public area should incorporate a blank cover with no adjustment feature.

4) Each thermostat must digitally display the current setpoint and temperature.

5) Each thermostat must have a communications port to allow access to the VAV controller from a laptop computer.

e. Outdoor Air Temperature shall be a 1000 Ohm Platinum RTD sensor, preferably located on the north side of the building and shaded with sun shield. Sensor shall be located above grade away from window wells and exhaust openings.
6. Freeze Protection Thermostats
   a. Sensing elements shall have a minimum of 1 foot of sensor length for each 1 square foot of duct or coil area. The element must be of the vapor tension type, so that any 18” section along the entire length of measuring element is capable of triggering the switch. Sensor shall be arranged evenly across the duct or coil such that no point in the duct or coil is more than 6” away from the sensor.
   b. Locate sensing element on the downstream side of the preheat coil making sure that the bottom horizontal run of the sensing element is at the same elevation as the bottom row of the steam coil. If there are multiple steam coils that are stacked and trapped separately, make sure the sensing element protects the bottom row of all coils. If no preheat coil is installed, place in the upstream face of cooling coil.
   c. Furnish each thermostat with one single pole, single throw normally opened switch and one single pole, single throw normally closed auxiliary switch.
   d. Setpoint range shall be 15 degrees F to 55 degrees F with a permanent stop set at 35 degrees F.
      1) Differential shall be fixed at approximately 5 degrees F, and supplied with manual reset.

7. Pressure Transducers
   a. General:
      1) Select device suitable for intended application; water, steam, or air, static or differential.
      2) Select for appropriate range, including negative if applicable. Must be able to withstand all pressures expected in installed location without need for recalibration.
      3) Pressure sensor shall be a loop-powered device fed from a 24 VDC power supply.
   b. Static Pressure:
      1) Hydronic:
         a) 100 percent solid state device, temperature compensated, suitable for pressures of 200 percent rated range with averaging to stabilize output, accuracy of ±0.25 percent, and a 4-20 mA or 0-10 VDC output.
         b) Device shall be rated for liquid service.
         c) SETRA Model 256 or pre-approved equal.
8. Differential Pressure
   a. Hydronic:
      1) 100 percent solid state device, temperature compensated, suitable for pressures of 200 percent rated range with averaging to stabilize output, accuracy of ±0.25 percent, and a 4-20 mA or 0-10 VDC output.
      2) Device shall be rated for liquid service.
      3) SETRA Model 230 or pre-approved equal.
   b. Air:
      1) 100 percent solid state device, temperature compensated, suitable for pressures of 200 percent rated range with averaging to stabilize output, accuracy of ±1 percent, and a 4-20 mA or 0-10 VDC output.
      2) MAMAC Model PR-274 or pre-approved equal.

9. Humidity Sensors
   a. General Eastern bulk resistive polymer type sensor or capacitance style sensor that is available in duct insertion and a room sensor. Accuracy shall be ±2% of reading.
   b. Room Humidistats: Wall mounted, proportioning type, with adjustable 2% RH throttling range, operating range from 30% or 80% at temperatures up to 110 degrees F, cover with concealed setpoint.
   c. Duct Humidistats: Proportioning insertion type, with adjustable 2% RH throttling range and operating range from 20% to 80% at temperatures up to 150 degrees F.

10. Signal Converters and Isolators
    a. Isolation Modules – Dwyer Isoverter II Model 4380 or pre-approved equal. Isolation Modules must be used when a voltage or current signal is transmitted between 2 devices that do not share the same power supply. They can be used to convert from current to voltage or vice versa and rescale the signal to an appropriate range.
    b. Electronic to Pneumatic Transducers – Converts 4-20 ma or 2-10 Volt input signal to a 0-15 psig output. Output shall be linear to the input signal. Honeywell RP7517B or pre-approved equal.
    c. Pneumatic to Electric Switches: Must have adjustable setpoint with scale and adjustable differential. Voltage and amperage ratings of the contacts must not be exceeded.
11. Power Supplies and Noise Suppression Devices

a. 24 Volt DC Power Supply:

1) Size Power supply a minimum of 33 percent larger than the total connected load to allow for expansion. Fuse the supply circuit at 150 percent of full load capacity of the power supply.
2) The output of the Power supply shall provide short-circuit protection.

b. Noise Suppressors:

1) All microprocessor based controllers shall be powered from a 120 VAC circuit protected by a noise suppression device. The device shall provide common mode noise reduction of 150 dB and normal mode noise reduction of 65 dB, minimum, at 100 kHz. Must provide overload capacity of 600 percent for 1 cycle and 300 percent 30 cycles. Total harmonic distortion must be less than 1 percent.
2) MGE Ultra-Isolator Noise Suppressor or pre-approved equal.

12. Relays and Switches

a. Mount all relays and power supplies in a NEMA 12 enclosure beside the DDC panel or controlled device and clearly label their functions.

b. Control Relays: All Digital inputs shall use Potter-Brumfield Gold Contact Relays models KHAU 17A16-120 or KHAU 17A16-24, or pre-approved equal. All digital outputs shall use Potter-Brumfield models KUP 14A15-120 or KUP 14A15-24, or pre-approved equal.

c. Current Switches: Digital device rated for amperage load of motor or device with split core design, adjustable high and low trip points, 600 VAC rms isolation, and LED indicator lamps. For example, the device shall be capable of sensing overloading, belt-loss, and power failure with a single signal. Veris Industries Hawkeye 908 Series or pre-approved equal.

d. Current Transmitters: Analog device rated for amperage load and appropriate range of motor or device with split core design, adjustable high and low trip points, 4-20 mA output directly related to current, compatible to VFD control, 600 VAC rms isolation, adjustable span, powered by loop. For example, the device shall be capable of sensing overloading, belt-loss, and power failure with a single signal. Veris Industries Hawkeye 921 Series.

e. High or Low Pressure Switch: Differential pressure switch with double-pole, double-throw snap switch and enclosure.

1) Rated for pressure specified in sequence of control for fan system. (-5.5 to 5.5 inch WC for most AHU’s).
2) Electrical rating shall be 15 amps at 120-480 volts.
3) Setpoint adjustment shall be screw type located inside enclosure.
4) Provide optional manual reset for overpressure protection with all tubing, brackets, and adapters.
5) Device shall be mounted in a locked control panel.
6) Acceptable Manufacturer: Dwyer 1900-X-MR.

f. Coordinate voltage and ampacity of all contacts, relays, and terminal connections of equipment being monitored or controlled. Voltage and ampacity shall be compatible with equipment voltage and be rated for fully ampacity of wiring or overcurrent protection of circuit controlled.

13. Condensate Flow Transmitter (Turbine Type)
   a. Material: 2” Brass Tee.
   b. Rating: 3-200 GPM.
   c. Accuracy: +/- 1.0% of flow rate.
   d. Protection: Maximum 600 psig, temperature 300 deg.F.
   e. Output: Pulsed with local display.
   f. In lieu of Turbine meter provide Mag meter to same criteria.
   g. Manufacturer:
      1) Kele SDI Series
      2) Badger
      3) Approved equal.

14. Lab Exhaust Static Pressure
   a. Material: Variable capacitance
   b. Mounting: Duct mounted
   c. Range: 0-6.0” WC
   d. Accuracy: 0.50% FS
   e. Protection: 16 psi proof, 25 psi burst.
   f. Output: 4-20 mA
   g. Manufacturer: Ashcroft XLdp

15. Lab Exhaust Static Pick-Up
   a. Material: 304 Stainless Steel
   b. Mounting: Duct insertion
   c. Manufacturer: Kele 160 Series

16. Water Differential Pressure Switch
   a. Materials: Brass bellows
   b. Mounting: Pipe mounted
   c. Range: 2 – 26 PSI, 1.2 PSI fixed differential
   d. Protection: 120 PSI Differential overpressure, 180 PSI static pressure.
   e. Output: Form C contacts, 50 VA
17. Current Transducer
   a. Mounting: Field Mounted
   b. Range: 60 Hz nominal
   c. Accuracy: +/- 2% full scale
   d. Protection: 250 A max current
   e. Output: 4-20mA

18. Differential Pressure Transducer
   a. Rating: NEMA 1
   b. Mounting: Duct Insertion, Pipe Insertion
   c. Range: 0-25 in. water column unidirectional, 0- +/- 5 in. water column bidirectional
   d. Accuracy: +/- 1% full scale
   e. Protection: 10 PSIG
   f. Output: 4-20 mA, 0-5 VDC, 0-10 VDC

19. Gas Flow Monitoring
   a. Style: Insertion.
   c. Max Pressure Rating: 500 psig.
   d. Turndown: 50:1.
   e. Accuracy: ± 1%.
   f. Input Power: 24 VDC, ± 10%, 0.75 amp standard.
   g. Output: Two isolated 4 to 20mA (1 for flow and 1 for temperature).
   h. Manufacturers:
      1) Fox Thermal Instruments.
      2) Sage Metering.

20. Steam Flow Monitoring
   a. Rating: NEMA 4X
   b. Mounting: Pipe Insertion
   c. Range: 3-80 in. water column
   d. Accuracy: +/- 1.5% full scale
   e. Protection: 2000 PSI, 500 degrees F
   f. Output: 4-20 mA

   a. Description: Pitot tube flow meter.
   b. Construction: 316 stainless steel, “Y” Type brass 1/8” FNPT head.
   c. Accuracy: +/- 3/4% uncalibrated, 2% @ 1 to 20 ft./sec.
d. Mounting: 2” to 24” pipe diameters
e. Maximum Temperature/Pressure: 250°F/400 psig
f. Output: Based on required transmitter
g. Special: Hot tap assembly
h. Manufacturers:

1) Preso Flow Metering Equipment

22. Humidity Transmitter - Outdoor

b. Rating: NEMA 4 Housing
c. Mounting: Outdoor Wall or Pole
d. Range: 0-100% RH, Temperature: -40 to 140 degrees F
e. Accuracy: RH: +/-3% at 68 degrees F, Temperature: +/-0.55 degrees F at 77 degrees F
f. Output: 0 to 10 VDC and 0 to 1 VDC or 4 to 20 mA
g. Special: Provide shield

23. Occupancy Sensor - Lighting Switch

a. Materials: Plastic, Sensor is Infrared (IR)
b. Rating: UL and CUL
c. Mounting: Wall
d. Sensitivity Control: Adjustable 20 to 100% of Max. Sensitivity
e. Output Load:

1) 120 VAC, 60 Hz: 25-800 Watts (40-800 Florescent)
2) 277 VA, 60 Hz: 40 to 1200 Watts Florescent
3) 347 VAC, 60 Hz: 40 to 1500 Watts Fluorescent

f. Special: LED Indicator, Field of View 180 degrees

24. Thermostat - Line Voltage

a. Materials: Cold Rolled Steel, Beige Thermoplastic, Sensing Element-Liquid
b. Contact Rating:

1) 6 Ampere Running/ 36 Amps. Locked Rotor at 120 VAC
2) 3.5 Amps. Running/ 21 Amps Locked Rotor at 208 VAC
3) 3.0 Amps. Running/ 8 Amps Locked Rotor at 240 VAC

c. Fan and System Switch Rating:

1) 12 Amps. Running/ 34.8 Amps. Locked Rotor at 120 VAC
2) 6.9 Amps. Running/19.1 Amp. Locked Rotor at 208 VAC
3) 6.0 Amps. Running/17.4 Amps Locked Rotor at 240 VAC
25. Air Flow Differential Pressure Sensor

   a. Rating: NEMA 1
   b. Mounting: Duct Insertion
   c. Range: 0.05" to 5.0" WC,
   d. Protection: Overpressure to 1 PSIG
   e. Output: 0-10vDC, 4-20mA
   f. Provide complete installation kit including static pressure tips, tubing, fittings, and air filters.

26. Electronic Room Thermostat

   a. Analog electronic controller wall mounted and designed to control heating and/or cooling valves or dampers utilizing two proportional outputs with face mounted thermometer.

      1) Setpoint dial or digital scale 65° - 82° F or 12 to 28° C.
      2) Separate reverse acting/direct acting output, 0-10 VDC or 4-20 mA with adjustable dead band.
      3) 24 volt AC operating voltage.

   b. Manufacturers:

      1) Siemens, Model RCU61U

27. Water Flow Measurement (Electro Magnetic)

   a. Description: Insertion electromagnetic flow meter
   b. Material: 316 stainless steel
   c. Mounting: 3" minimum pipe diameter to 72" maximum
   d. Range: 200:1 turndown, 0.1 ft./sec to 20 ft./sec.
   e. Accuracy: +/-1% at 2 to 20 ft./sec
   f. Maximum Pressure/Temperature: 400psi at 15-250 degrees F
   g. Output: 0-10vDC, 4-20mA
   h. Special: Hot Tap Assembly
   i. Manufacturer:

      1) Onicon Incorporated.
      2) Siemens.
28. KW Transducer
   a. Materials: Encased copper
   b. Rating: 600vAC
   c. Mounting: Split Core
   d. Range: Up to 2400amps
   e. Accuracy: +/- 1%
   f. Output: 4-20mA

29. Carbon Monoxide Sensors (CO)
   a. Materials: Metal Oxide Semiconductor
   b. Rating: 5000 sq feet
   c. Mounting: Duct and wall mount
   d. Range: 0 to 200ppm
   e. Accuracy:
   f. Protection:
   g. Output: 0-10vDC, 4-20mA

30. Carbon Dioxide Sensors (CO2)
   a. Materials: Molded plastic enclosure
   b. Rating: 0 to 5000ppm
   c. Mounting: Duct or Wall
   d. Range: 0 to 2000ppm / 0-5000 User selectable
   e. Accuracy: +/- 50ppm
   f. Output: 0-10vDC, 4-20mA

B. Pneumatic Devices

1. Air Compressor - Pneumatic Air Supply
   a. General: Assembly shall be a duplex type complete with ASME tank, automatic tank drain trap, belt guards, gauges, low resistance intake air filter and silencer, safety valve, and all necessary accessories, including automatic start-stop pressure switch. Furnish necessary reducing valves to reduce pressure to that required for automatic control purposes with integral relief valve. Mount compressor on a single air storage tank or base mounted compressors with a separate tank as shown or as required.
   b. Sizing: Compressor shall provide sufficient supply air to the entire control system while operating no more than 1/3 of the time with a maximum of six starts per hour.
   c. Electrical: Motor shall be 480 volt, 3 phase, provided with magnetic starter, fusible disconnect and proper overload protection. Provide an automatic alternator which shall switch the lead compressor after each running cycle. It shall be capable of bringing on both compressors if one cannot handle the load, and either shall continue to function on failure of the other.
d. Drier: Refrigerated air drier assembly shall be complete with pressure regulator (single or dual), filter station, 3 way bypass valve, automatic drain, power-on status light, high temperature alarm light, and safety pressure relief. Air capacity shall match the total system requirements. Drier shall have a hot gas bypass control to maintain continuous operation and constant dew-point control. Outlet dew-point shall be +13 degrees F at 18 PSI main pressure. Filter assembly shall be housed in clear plastic and be of the replaceable element type. Filter rating shall remove 99 percent of total oil present, 100 percent of solid particle .6 micron or large, 98 percent of solid particles .4 micron or larger.

C. Controlled Devices

1. Electric Damper Actuators
   a. Rating: NEMA 2 Enclosure
   b. Mounting: Direct mount
   c. Stroke: 90 seconds end to end full stroke, 15 seconds return to normal for spring return
   d. Protection: Electronic stall protection
   e. Control Input:
      1) Floating: 20 to 30 VAC @ 50/60 Hz or 24 VDC
      2) On/Off: 20 to 30 VAC @ 50/60 Hz or 24 VDC
      3) Proportional: Field selectable 0 to 10 VDC, 6 to 9 VDC, or 4-20 mA
   f. Power: 20 to 30 VAC @ 50/60 Hz or 24 VDC
   g. Torque: Size for minimum 150% of required duty
   h. Duty cycle: rated for 65,000 cycles
   i. Special: Output position feedback, manual override, field selectable rotational / spring return direction, field adjustable zero and span.
   j. Operating Temperature: -4 to 122 degrees F.

2. Electric Valve Actuators
   a. Rating: NEMA 1 Enclosure
   b. Mounting: Direct mount
   c. Control Input: Continuous 0-10 VDC or 0-20 mADC
   d. Power: Nominal 24 VAC
   e. Protection: Stall protection
   f. Torque: Size for minimum 150% of required duty
   g. Special: Output position feedback, manual override, field selectable direction, field adjustable zero and span. For spring return provide field selectable spring return direction.
3. Pneumatic Valve and Damper Actuators
   a. Pneumatic spring return actuators shall be capable of providing smooth proportioning control under operating conditions normal to the system.
   b. Equip dampers with actuators sufficient power to control dampers without flutter or hunting through the entire operating range at air velocities at least 20% greater than maximum velocity encountered in design operation. Damper actuators rated torque shall be 200% of the torque required to operate the dampers. Furnish operators with sufficient power on close off providing a tight seal against a differential pressure equal to the pump shut-down head for valves, or scheduled fan static pressure for dampers.
   c. Provide positioners where two or more actuators are controlled from the same controller and where indicated. Positioners shall be mounted directly on the driven device. Feedback from the stem or rod shall be through a pilot spring. Starting point shall be adjustable from 2 to 12 psi. Operating span shall be adjustable from 5 to 13 psi.
   d. Actuators operating in sequence with other operators shall have adjustable operating ranges and setpoints. Actuators shall cause operating device to fail to position indicated.

4. Characterized Ball Valve, 1/2 through 1-1/2 in. NPT, Electrically Operated, Spring Return with End Switches
   a. Materials:
      1) Body - Forged Brass
      2) Ball - 300 Series Stainless Steel
      3) Stem - 300 Series Stainless Steel
      4) Stem Seals - EPDM Double O-Rings
      5) Seats - Graphite-Reinforced PTFE with EPDM O-Ring Backing
   b. Rating: Valve Body 600 psi at 320 degrees F, fluid temp:35 to 250 degrees F
   c. Output Flow Maximum: 0.4 through 143.4 Cv Two-Way; 3.7 through 35.4 Cv Three-Way
   d. Manufacturers:
      1) Siemens
      2) Belimo
      3) Delta

5. Globe Valve, Cast Iron Flanged, Pneumatic Actuated, 2-1/2 through 6 in.
   a. Materials:
      1) Body - Cast Iron with Black Lacquered Finish
      2) Plug - Brass
3) Stem - 316 Stainless Steel
4) Packing - Ethylene Propylene Terpolymer Ring Packs

b. Rating: ANSI 16.1, Class 125, fluid temp: 35 to 281 degrees F
c. Mounting: ANSI 125/150 Flanged Pipe
d. Actuator Control Type: Pneumatic, Spring Return
e. Output Flow Maximum: 0.51 through 344 Cv

6. Globe Valve, Bronze Control Valve with Stainless Steel Trim, Pneumatic Actuated, 1/2 through 2 in.

a. Materials:
   1) Body - Cast Bronze
   2) Plug - Stainless Steel
   3) Seat - Stainless Steel
   4) Stem - Stainless Steel
   5) Packing - PTFE and Elastomer V-Rings

b. Rating: ANSI Class 250, fluid temp: 35 to 338 degrees F
c. Actuator Control Type: Pneumatic, Spring Return
d. Output Flow Maximum: 0.73 through 46.2 Cv

7. Quarter-Turn Valves for Steam Applications:

a. Modulating V-Notch Ball Segment Valves:
   2) Carbon steel or ductile iron body with flanged connections, stainless steel V-notch ball segment, stainless steel shaft, upper and lower shaft bearings, adjustable packing.
   3) Stainless steel, PEEK or “Extreme” seat.
   4) Rated for 170 PSIG working pressure at 500 Deg.F.
   5) ANSI Class IV shut-off rating.
   6) Performance Characteristic: Equal percentage.
   7) Provide an actuator, positioner and filter regulator with isolation valve. All components shall be premounted, prepiped and prewired at the valve manufacturer’s or supplier’s facility and warranted as a complete unit. (Isolation valve may be field installed to prevent damage during shipment.)

b. Modulating V-Notch Ball Segment Valve Accessories:
   1) Actuators:
      a) Pneumatic piston/spring return type.
      b) Sized for 80 PSIG maximum supply air pressure.
c) Sized for 150% of absolute design supply pressure. For example, for 10 PSIG steam supply pressure, size for 22.4 PSIG (10 PSIG = 24.7 PSIA, 150% of 24.7 PSIA = 3.1 PSIA – 22.4 PSIG).
d) Carbon steel or steel alloy pinion/shaft, rather than aluminum alloy.
e) Externally adjustable bi-directional travel stops that act upon the actuator shaft mechanism, rather than the pistons.
f) ISO valve mounting flange and NAMUR mounting pads for all controls.
g) Double rack and pinion type for lower torque applications – Approved manufacturers: Fisher model 1032, Hytork series XL.
h) Scotch yoke type for higher torque applications – Approved manufacturers: Bettis G series, Automax HD series, Rotorq P series.
i) Drive pinion adapters shall be standard products designed for the specific valve/actuator combination rather than custom fabricated components. Pinned adapters are not allowed. Any “free-play” that results from standard manufacturing tolerances shall be eliminated by insertion of shims.
j) Also approved for lower torque applications - Neles/Jamesbury Quadra-Powr spring/diaphragm type, rated for 100 PSIG supply air working pressure, complying with the requirements of paragraphs b, c and g above.

2) Positioners:
   a) Pneumatic, 3-15 PSIG input, 60-80 PSIG supply.
   b) 0.4 SCFM maximum steady state air consumption at 80 PSIG.
   c) Instrument, supply and output pressure gauges.

3) Filter-Regulators:
   a) Approved Manufacturers: ASCO, Bellofram, Control-Air, Fisher, Parker.

4) Isolation Valves:
   a) Line-size full-port ball valve.
   b) Piped to filter-regulator inlet connection with union fitting (or equivalent) to allow convenient removal of filter-regulator / positioner without shutting down supply air source.
   c) Back-bleed feature; vents downstream air pressure when valve is closed.
   a. Materials:
      1) Body - Carbon Steel
      2) Disc - Stainless Steel
      3) Stem - Stainless Steel
      4) Valve Seat Material – Butyl Rubber (Check Compatibility w/Fluid)
   b. Rating: Maximum Fluid Temperature 500 degrees F
   c. Mounting: ANSI 150 Class Flanged Pipe, or ANSI 300 Class Flanged Pipe
   d. Actuator Control Type: Pneumatic positioner for modulating service, or 24 or 120 VAC solenoid for two- position service
   e. Output Flow, Maximum: 160 to 9,800 Cv
   f. Approved Manufacturer: Keystone, Jamesbury, Dezurik.

9. Actuator - Non-Spring and Spring Return Double Piston (6” and Larger)
   a. Mounting: Direct Mount
   b. Direction of Action: Field-selectable direct/reverse
   c. Control Inputs:
      1) On/Off: 20 to 30 VAC at 50/60 Hz
      2) Proportional: Field-selectable 0(2) to 10 VDC or 0(4) to 20 mA
      3) Valve mounted switching solenoid.
   d. Power: 20 to 30 VAC at 50/60 Hz, 80-125 psig compressed air.
   e. Stall Protection: Magnetic Clutch or Electronic
   f. Audible Noise Rating: 30 dBA to 45 dBA
   g. Operating Temperature w/ Cover: -4 to 125 degrees F (-20 to 52 degrees C)
   h. Enclosure Rating: NEMA 2
   j. Rotation Time:
      1) Fixed: 60, 90, 120, 205 seconds
      2) Field-Adjustable: 1, 1.5, 2, 5.5, or 11 minutes
   k. Rotation Range: Field-adjustable 30 to 90 degrees
   l. Life Rating:
      1) Full Stroke Cycles: 60,000 to 100,000
      2) Reposition Cycles: 2,500,000
   m. Position Feedback:
   n. Proportional: 0(2) to 10 VDC
   o. Auxiliary Switches: 2 SPDT, 24 VAC
p. Spring return actuators sized to close/open against system head pressure. Refer to control drawings for fail position.
q. Approved Manufacturer: Morin, Siemens.

10. Actuator - Spring Return Diaphragm Actuated (2”-4”)
   a. Actuator control type, 2” – 4” valves: Pneumatic actuator with current to pneumatic transducer, with spring return or 24 to 120 VAC factory installed electric solenoid for two position service.
   b. Supply Pressure: 20 psig

11. Power Operated Dampers (5 square ft or less)
   a. Multiblade type, with parallel blades for two position service and opposed blade design for modulating service. Provide interconnecting linkage between two damper assemblies which are operated by a single damper operator. Face or bypass dampers shall each be capable of passing 10% of unit rated cfm with pressure drops approximately the same in either extreme position when pressure drop includes coil and bypass components.
   b. Provide blades with nonferrous pivot pins or nonferrous-sleeved pivot pins, and flanged brass sleeve or 1/8 inch wall flanged steel sleeve, with flanged oil-impregnated oilite bushing or graphite impregnated nylon bushing. Provide brass washers between damper blades and oilite bushing flange. Linkages shall be provided with machined nonferrous moving contact surfaces with provisions for oiling. All other linkage connections shall be rigid.
   c. Provide blade edges and ends with seals for quiet operation and tight closure. Maximum seal leakage for outside air dampers shall be 1% at 1” WG when fully closed. Calk frames into ductwork to prevent bypass leakage.
   d. Provide dampers with either a baked enamel finish, a zinc-rich paint finish, or galvanized. Nonferrous surfaces shall not be painted. Frames may be galvanized instead of painted, however, outside air exhaust and return damper frames shall be galvanized after fabrication.
   e. Manufacturers:
      1) Louvers & Dampers, Inc.
      2) Ruskin
      3) Siemens
      4) American Warming & Ventilation
      5) Air Balance, Inc.
      6) Airguide Corp.

12. Power Operated Dampers Extra Heavy Duty (More than 5 Square Ft.)
   a. Performance: Test leakage and pressure drop per AMCA 500.
   b. Opposed style modulation blades shall be used for volume and pressure control for fresh air, return air and relief air control. Parallel blade style of construction shall be used for exhaust air applications. Actuators and pilot-positioners shall be mounted out of the air stream.
c. Bearings, bearing pins (axles), jamb seals or side seals, and damper linkages shall be stainless steel. The damper blade drive shaft shall be zinc plated.

d. Leakage rates shall not exceed 7 cfm per sq.ft. at 1-inch w.c. and shall not exceed 15 cfm at 4 in. w.c. for applications using entering air temperature that can fall below 55 degrees F db but not below 40 degrees F db.

e. Ultra Low Leakage Dampers shall be used for applications where entering air temperature can fall below 40 F. Leakage rates for these dampers shall not exceed 3 cfm per sq.ft. at 1-inch w.c. and shall not exceed 7 cfm at 4 in. w.c.

f. Maximum individual blade height shall be 8 inches.

g. All damper blades and drive components shall sue 16 gauge or heavier galvanized steel unless specified otherwise. Each damper frame shall be 12 gauge or heavier galvanized steel. Multiple damper motors shall be used for multiple damper installations, jackshafts are not allowed. Note: Damper linkage is to be exposed in the air stream for maintenance purpose.

h. A maximum damper area of 16-sq.ft. shall be for each pneumatic damper actuator. Individual blade length shall be limited to 48 inches.

i. Seals shall be mechanically attached blade edge seals. Blade edge seals shall be extruded vinyl for standard temperature applications, silicon for high temperature applications (e.g. steam coil face and bypass dampers). Stainless steel jamb seals.

j. Linkage: Located exposed in the airstream. All linkage shall be stainless steel.

k. Axles shall be zinc plated steel, ¾” diameter. Extended through damper frame as required for operator (unless noted otherwise).

l. Modulating control dampers shall be sized to provide appropriate damper authority. Opposed blade dampers shall be selected to achieve a damper authority of 10-15%. Parallel blade dampers shall be selected to achieve a damper authority of 30-50%. They should not necessarily be duct size.

m. Maximum air velocity shall be such that air velocity through the damper shall not exceed 2/3 of the manufacturer’s published maximum for the make and module used.

n. Branch duct balancing volume control dampers in branch ducts larger than 18” in any direction shall be of multiple, opposed blade pattern.

o. Manufacturers:

1) Ruskin CD30VG2
2) American Warming & Ventilation
3) Greenheck

13. Control Panels

a. NEMA Construction: Provide control panels of NEMA type indicated on the drawings or as required by these specifications. Control panels mounted outdoors shall be NEMA 4.

b. Construction: Conduit, pipe and tubing shall enter the panel thru the top or the bottom of the panel. The top of the panel shall be waterproof. Panel doors shall be equipped with a keyed latch lock and be no greater than 36 inches in width. Panels requiring doors greater than 36 inches in width shall be equipped with multiple doors. Control panels greater than 42 inches in height shall be equipped with legs and be suitable for floor mounting.
c. Layout: Control panels shall be laid out with all similar equipment grouped together and with a barrier between; pneumatic, electric, and electronic equipment. Panels containing electronic equipment shall be provided with filtered louvers and circulating fans to maintain interior temperatures below 85% of the manufacturer’s maximum recommended operating temperature of the housed electronic equipment. All wiring shall be terminated on terminal strips with wire tags. Wire between panel mounted devices and door mounted devices thru a panel mounted terminal strip. All terminal strips shall have a minimum of 20% unused terminals. Flexible connections between the panel and the hinged door shall be neatly fastened along the hinge side and protected against abrasion. Multiple wiring and pneumatic tubing shall be routed within the panel in a raceway. A complete set of wiring and piping diagrams shall be provided within the panel in a protective binder.

d. Control Panel Electrical Section: Electrical equipment shall conform to governing codes and referenced standards. Group electrical equipment together with a barrier separation from pneumatic and electronic sections. Provide a flange mounted disconnect switch where control power is obtained form a line voltage power supply and associated transformers. Electrical control devices shall be supplied by a single manufacturer, to the extent possible. In panels containing more than five electrical control devices provide a square duct for routing wiring. Initial duct fill shall not exceed 50%. Provide all enclosures with a ground lug. Provide all pilot lights with a push to test feature.

e. Control Panel Electronic Equipment: Group electronic together with a barrier separation from pneumatic and electrical sections. Electronic cables shall all terminate on terminal strips with ground terminal provisions, except thermocouple and RTD’s. Protect electronic cables from AC Voltage cables with flexible metal conduit or other approved means.

f. Finish: The control panel exterior and interior shall be painted.

g. Identification: Label control equipment mounted within and on the face of the control panel with engraved plastic laminate equipment tags in accordance with requirements of Section 15190 Mechanical Identification.

h. Control Panel Pneumatic Equipment: Panel mounted air headers shall include two spare valved taps. Provide ½ inch diameter pressure gauges at each device to indicate input and output pressures.

PART 3 - PERFORMANCE / EXECUTION

3.1 INSTALLATION PRACTICES

A. Wiring

1. Provide all conduit, wiring, accessories and wiring connections required for the installation of the Building Management System, as herein specified. All wiring shall comply with the requirements of applicable portions of Division 26 and all local and national electric codes, unless specified otherwise in this section.

2. Class 2 Wiring
a. All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.

3. Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5’ from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines. All wiring shall be installed in accordance with local code requirements. Class 2 signal wiring and 24VAC power can be run in the same conduit. Power wiring 120VAC and greater cannot share the same conduit with Class 2 signal wiring.

4. Perform circuit tests using qualified personnel only. Provide necessary instruments and equipment to demonstrate that:
   a. All circuits are continuous and free from short circuits and grounds.
   b. All circuits are free from unspecified grounds; that resistance to ground of all circuits is no less than 50 mega ohms.
   c. All circuits are free from induced voltages.

5. Provide complete testing for all cables used under this Contract. Provide all equipment, tools, and personnel as necessary to conduct these tests.

6. Provide for complete grounding of all signal and communications cables, panels and equipment so as to ensure system integrity of operation. Ground cabling and conduit at the panel terminations. Avoid grounding loops.

B. Raceway

1. All wiring shall be installed in conduit or raceway except as noted elsewhere in this specification. Minimum control wiring conduit size 1/2”.

2. All conduits and raceways shall be installed level, plumb, at right angles to the building lines and shall follow the contours of the surface to which they are attached.

3. Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls. Flexible Metal Conduit shall be UL listed.

C. Penetrations

1. Provide firestopping for all penetrations used by dedicated BAS conduits and raceways. All other project firestopping to be by other trade.

2. All openings in fire proofed or fire stopped components shall be closed by using approved fire resistive sealant.

3. All wiring passing through penetrations, including walls, shall be in conduit or enclosed raceway.

4. Penetrations of floor slabs shall be by core drilling. All penetrations shall be plumb, true, and square.

5. No penetrations in structural elements shall be made before receipt of written approval from the architect.
D. Identification Standards

1. DDC Identification. All Controllers shall be identified by a permanent label fastened to the outside of the enclosure. Labels shall be suitable for the controller location.
2. Wire Identification. All low and line voltage BAS wiring shall be identified by a number, as referenced to the associated shop drawing and as-built drawing, at each end of the conductor or cable. Identification number shall be permanently secured to the conductor or cable and shall be typed.

E. Controller Installation

1. The control panels and cabinets shall be located as indicated at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer’s recommendations.
2. The control contractor shall be responsible for coordinating panel locations with other trades and electrical and mechanical contractors.

F. Input Devices

1. All Input devices shall be installed per the manufacturer recommendation.
2. Locate components of the control system in accessible local control panels wherever possible.

G. Line Voltage Power Source

1. 120-volt AC circuits used for the system shall be taken from panelboards and circuit breakers as denoted on Drawings.
2. Circuits used shall be dedicated to the control system and shall not be used for any other purposes.

H. DDC terminal unit controllers may use 120-volt AC power from motor power circuits. HVAC Input Devices - General

1. All Input devices shall be installed per the manufacturer recommendation.
2. Locate components of the BAS in accessible local control panels wherever possible.
3. Coordinate installation of all in-line devices such as temperature wells, pressure taps, duct smoke detectors, airflow stations, etc.
5. Outside Air Sensors
   a. Sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air conditions accurately.
   b. Sensors shall be installed with a rain proof, perforated cover (sun shield).
6. Water Differential Pressure Sensors
   a. Differential pressure transmitters used for flow measurement shall be sized to the flow-sensing device.
   b. Differential pressure transmitters shall be supplied with tee fittings and shut-off valves in the high and low sensing pick-up lines.
   c. The transmitters shall be installed in an accessible location.
   d. Medium to High Differential Water Pressure Applications (Over 21" w.c.):
   e. Air bleeds units, bypass valves and compression fittings shall be provided.

7. Building Differential Air Pressure Applications (-1" to +1" w.c.):
   a. Transmitters exterior sensing tip shall be installed with a shielded static air probe to reduce pressure fluctuations caused by wind.
   b. The interior tip shall be inconspicuous and located as shown on the drawings.

8. Air Flow Measuring Station:
   a. Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct.
   b. Station flanges shall be two inch to three inch to facilitate matching connecting ductwork.

9. Duct Temperature Sensors:
   a. Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.
   b. The sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate.
   c. For ductwork greater in any dimension than 48 inches or where air temperature stratification exists such as a mixed air plenum, utilize an averaging sensor.
   d. The sensor shall be mounted to suitable supports using factory approved element holders.

10. Space Sensors:
    a. Shall be mounted per ADA requirements.
    b. Provide lockable tamper-proof covers in public areas and/or where indicated on the plans.

11. Low Temperature Limit Switches:
    a. Install sensing element on the discharge side of the first water or steam coil in the air stream.
    b. Mount element horizontally across duct in a serpentine pattern insuring each square foot of coil is protected by 1 foot of sensor.
c. For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.

12. Air Differential Pressure Status Switches:
   a. Install with static pressure tips, tubing, fittings, and air filter.

13. Water Differential Pressure Status Switches
   a. Install with shut off valves for isolation.

I. HVAC Output Devices

1. All output devices shall be installed per the manufacturer’s recommendation. Coordinate the installation of all in-line devices such as control valves, dampers, etc.

2. Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the entire stroke. When any pneumatic actuator is sequenced with another device, pilot positioners shall be installed to allow for proper sequencing.

3. Control Dampers: Shall be opposed blade for modulating control of airflow. Parallel blade dampers shall be installed for two position applications.

4. Control Valve Sizing: The contractor shall determine the size and shut-off pressure requirements for control valves based on the following criteria:
      1) Determine supply line pressure at the point of valve installation in systems. Take 25% of that pressure H1. Determine pressure drop across coil, manual valve, etc. for H2 value. Compare the value of H2 to H1 and select the larger of the two. This value will be the valve pressure drop used in control valve selection.
   b. Controlled Medium: Steam
      1) Determine the steam supply line pressure at the point of valve installation in system. Calculate H3 and H4 as shown below. Compare the value of H3 and H4 and select the smaller of the two. This value will be the valve pressure drop used in control valve selection.
      2) H3 = 0.80 (PS(supply)-PR(return)) PR = normally 0 psig for fully condensing coils
      3) H4 = critical press drop = 0.50 (PS absolute).
   c. Select water and glycol valves and actuators with a close-off and dynamic rating equal to or greater than 150% of the pump design operating head.
5. Electronic Signal Isolation Transducers: Whenever an analog output signal from the Building Management System is to be connected to an external control system as an input (such as a chiller control panel), or is to receive as an input a signal from a remote system, provide a signal isolation transducer. Signal isolation transducer shall provide ground plane isolation between systems. Signals shall provide optical isolation between systems.

J. Air Piping Installation

1. General Installation Practices
   a. Number-coded tubing shall be used throughout with coding readily identifiable at points of control and equipment, coding of each line to a controller or equipment shall be different.
   b. Tubing shall be installed so that it can be removed without damage or alterations to the building structure.
   c. Connections to instruments shall be made so that disconnect and removal of each individual instrument can be made without distortion of tubing.
   d. Instrument piping and tubing shall be installed so that there is sufficient space around the equipment for servicing and adjustment.
   e. Branch airlines from high-pressure air headers shall be valved at the point of connection to the air header.
   f. Air piping shall be run horizontally level and vertically plumb and parallel to building lines.
   g. Care should be exercised in the installation of pipe, tubing, and fittings to see that no dirt or foreign matter is present in the system.
   h. No airlines shall be concealed under or within duct insulation or acoustic lining. The use of wire or tape to support air piping will not be permitted.
   i. Air tubing in finished areas shall be run concealed.
   j. Test metallic air piping at 150 psig air pressure, and nonmetallic air tubing at 40-psig air pressure, sustained for 4 hours.
   k. Conceal pneumatic tubing in all areas except when other piping is exposed.
   l. Make penetrations through concrete and concrete block surfaces with a 1 inch diameter, copper sleeve. Extend sleeve a minimum of 6 inches above floors. Provide fire stopping between copper tubing and sleeve. Use plastic tubing only; above ceilings, where concealed within walls, and in control panel cabinets.

2. Plastic Tubing Installation Practices
   a. Polyethylene tubing bundles shall be installed in covered aluminum raceways or shall be supported on galvanized steel hangers not more than 4 feet on centers. At each support point at a hanger or trapeze, the tube bundle shall be protected by a 180 degree by 8-inch long galvanized steel shield.
   b. Individual plastic tubing shall be run in thin wall electric conduit or raceway and supported by galvanized hangers on 4-foot centers, when installed in exposed areas.
c. Conduit or raceway shall not exceed 50 percent fill.
d. Raceway shall be terminated not more than 12 inches from terminal devices and this last section may be made with nonmetallic tubing run exposed.
e. Nonmetallic tubing, except terminal ends, shall be installed with a minimum clearance of one foot to any surface, which may exceed 120°F.

3. Copper Tubing Installation Practices

a. Copper tubing shall be fastened and rigidly supported at regular intervals to prevent sagging, using straps, trapezes and pipe hangers as approved.
b. Only tool-made bends in copper tubing will be acceptable.
c. Install valved drip pocket at low points of mains and users.
d. Copper Tubing: Cut tubing square and remove burrs. Clean the mating surfaces of the tubing and fittings before assembly at solder fittings. Use hard drawn tubing in exposed areas, as required by code, and either hard or annealed tubing where concealed. Tubing embedded in concrete shall be annealed and routed in metallic conduit.

3.2 CHECK TEST AND STARTUP

A. Check, test and start-up all aspects of the Building Management System work.

B. Complete the check sheet for all items and functions of the BAS and initial each entry with time/date as record of having fully calibrated and tested the BAS. Submit to Architect.

C. Provide all necessary specialist labor, materials and tools to demonstrate to the Owner that the BAS has been commissioned and is operating in compliance with the contract. Prepare a list of noted deficiencies signed by both the Owner and the BAS Contractor.

D. Promptly rectify all listed deficiencies and submit to the Owner that this has been done.

E. The Owner will retest the deficiencies in conjunction with the BAS Contractor.

F. VAV Box Performance Verification and Documentation

1. Controls Provider shall test each VAV box for where the dampers in one half of a group of boxes are stepped towards full open while the other half are stepped towards full closed. At each step, after a settling time, box air flows and damper positions will be sampled. Following the cycle, a pass/fail report indicating results shall be produced. Possible results are Pass, No change in flow between full open and full close, Reverse operation or Maximum flow not achieved. The report shall be submitted as documentation of the installation.

2. The Controls Provider shall issue a report based on a sampling of the VAV calculated loop performance metrics. The report shall indicate performance criteria, include the count of conforming and non-conforming boxes, list the non-conforming boxes along with their performance data, and shall also include graphical representations of performance. The sampling shall take place after completion of Test and Balance, when
design cooling and heating media have been available and occupied conditions approximated for five consecutive days.

3.3 POINTS LIST

A. Refer to Drawings for Points List.

END OF SECTION
CEW
SECTION 230947 - INSTRUMENTATION AND CONTROL - LABORATORY AIRFLOW CONTROL SYSTEM

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.

B. Division 15 Specification Sections apply to the Work of this Section.

1.2 SUMMARY

A. Provide and install a laboratory airflow control system (LACS) to maintain laboratory airflow, offset between lab and corridor, temperature and fume hood average face velocity. Room pressurization control shall utilize airflow tracking to vary the volume of supply air into the room and general exhaust air from the room to maintain both minimum ventilation and airflow balance. The room offset control system shall also maintain laboratory temperature. The exhaust air volume of laboratory fume hoods shall be controlled by a stand alone fume hood controller that is, seamlessly, incorporated into the room ventilation control system.

B. The system shall include room controllers, fume hood controllers, supply and exhaust air flow control devices, reheat coils and all reheat coil control valves and actuators for laboratories shall be furnished and installed by the Building Automation and Control System Contractor including all associated control wiring, and all necessary accessories to implement an integrated system as specified herein.

C. System verification and documentation as specified under the commissioning section shall also be included.

D. Extent of laboratory airflow control system is indicated on Drawings, and by the requirements of this Section.

E. All laboratory airflow control system components shall be products of a single manufacturer and be the responsibility of that manufacturer. Subject to compliance with requirements, provide laboratory airflow control system of one of the following:

1. Siemens Building Technologies.
1.3 QUALITY ASSURANCE

A. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of LACS systems and shall be the manufacturer’s latest standard design that complies with the specification requirements.

B. Supplier shall have an in-place support facility within 120 miles of the site with technical staff, spare parts inventory, and all necessary test and diagnostic equipment.

C. Installation as well as the startup, checkout and commissioning of the LACS shall be by full time employees of the control system manufacturer and shall be fully trained by the system manufacturer.

D. Codes and Standards:

1. UL and NEMA Compliance: Provide electrical motors and electrical components required as part of Laboratory Airflow Control System, which have been listed and labeled by UL and comply with NEMA standards.

2. NEC Compliance: Install Laboratory Airflow Control System in accordance with NFPA 70 “National Electrical Code.”

1.4 SUBMITTALS

A. Submittals shall include:

1. Manufacturer’s product data including all equipment components such as fume hood monitors, controllers, terminal devices, etc., including dimensions and required clearances.

2. Shop drawings shall include system wiring diagrams with sequences of operation, schedule of air terminal devices, a system configuration diagram showing all controller types and locations, and control panel face details.

3. Discharge and radiated sound power level data for all air terminal devices. The data shall be in accordance with the test procedure in ARI 880-89 Standard for Air Terminals, and all data shall be obtained in a qualified, accredited and ARI approved testing laboratory.

PART 2 - PRODUCTS

2.1 LABORATORY AIR CONTROL VALVE DESIGNATIONS

A. LS: Variable Volume Lab Supply Valve
1. Butterfly Type Control Surface Airfoil Modulation Type Air Valve.
2. Galvanized Steel Construction

B. LE: Variable Volume Lab Exhaust Valve

1. Butterfly Type Control Surface Airfoil Modulation Type Air Valve.
2. Type 304 Stainless Steel/ Construction
3. For use in Fume Hood Exhaust Applications.

C. GE: Variable Volume General Exhaust Valve

1. Butterfly Type Control Surface Airfoil Modulation Type Air Valve.
2. Galvanized Construction
3. For use in General Lab Exhaust Applications.

D. All laboratory air control valves shall be of the same type.

2.2 LABORATORY AIR VALVE OPERATION

A. All valve controls shall be pressure independent. The laboratory control system shall maintain specific airflow, +/- 5% of signal within one second of a change in duct static pressure, regardless of the magnitude of the pressure change, airflow change, or quantity of airflow control devices on the manifold within a 0.1” to 3.0” wc differential pressure.

1. Room and fume hood airflow accuracy and performance shall be guaranteed as specified irrespective of field conditions.

2.3 LABORATORY FUME HOOD EXHAUST SASH SENSING SYSTEM

A. A variable volume fume hood control system shall be provided to directly measure the area of the fume hood sash opening. The measured sash opening shall proportionally control the hood’s exhaust airflow. Hood airflow shall thus be varied to maintain an “average” constant face velocity to +/-5% tolerance within 3 seconds of a change in sash position.

B. Actuators for Laboratory Air Terminals shall be maintenance free high speed actuators capable of 1.0 second from minimum flow to 90% of maximum flow. The actuators shall have a fail-safe position based on the Sequence of Operation. The actuators shall be capable of accepting either 4-20mA or 0-10 Vdc signal. The AFV shall return to specified velocity -0/+5 fpm within 5 seconds of a sash monument as specified in ASHRAE 110.
2.4 LABORATORY ROOM CONTROLLER

A. Each supply and associated exhaust terminal shall be controlled to maintain a CFM airflow differential between total room exhaust and supply air, to meet space pressurization requirements. Offset volumes will be adjustable and initially set at the CFM listed on the plans.

B. Each laboratory room shall have its own controller and shall be specifically designed for fume hood control, pressurization control, temperature control, humidity control (where applicable), occupancy control modes, and emergency control modes. Each controller shall be a microprocessor-based, multi-tasking, real-time digital control processor. Control sequences shall be included as part of the factory supplied software. These sequences shall be field customized by adjusting parameters such as control loop algorithm gains, temperature setpoint, alarm limits, air flow differential setpoint, and pressurization mode.

C. Controller shall include all inputs and outputs necessary to perform all specified control sequences. Refer to Control Drawings for output points required by Building Management System (BAS).

D. Each controller shall operate stand-alone, performing its specified control responsibilities independently.

E. Calibrate the PID loops for each lab controller serving variable volume valves and their associated heating control valves. The supply air controller controls the reheat coil based on the discharge air temperature set point reset by the room temperature transmitter in a 2:1 (adj.) ratio. For every +/- 1 degree change in room temperature the discharge temperature changes +/- 2 degrees point.

F. All databases and programs shall be stored in non-volatile memory, or a minimum of 72-hour battery backup shall be provided. All controllers shall return to full normal operation without any need for manual intervention after a power failure of unlimited duration.

G. In case of power failure or operational failure within the controller, the terminal unit damper shall fail open, unless otherwise specifically noted.

2.5 FUME HOOD FACE VELOCITY CONTROLLER

A. An operator display panel shall be provided for each fume hood to comply with laboratory safety standards. The digital operator display panel shall provide the following functionality:

1. Calculate, display, and control the fume hood face velocity. It shall provide access to menu driven programming through a keypad or hand held service tool.

2. The factory fabricated display case controller shall mount to the bracket attached to a single gang electrical box on the front of a fume hood.
3. Have an alpha-numeric digital display indicating the measured face velocity in feet/minute (ft./min.). The display shall have a range of 0-250 ft./min. With a resolution of 1 ft./min. and shall be updated every one half second.

4. Have a smooth, spill-proof membrane switch keypad to operate menu-driven programming.

5. Have four indicator lights which shall be shown on the front of the controller indicating the following conditions:
   a. Red ALARM light
   b. Red EMERGENCY purge light
   c. Green NORMAL light
   d. Yellow light for standby or marginal operation.
   e. MUTE OR SILENCE BUTTON (Light Optional)

6. Have an audible alarm that sounds when the hood is in an alarm condition.

7. Have alarm contacts for no-flow, low, and high alarms which shall be SPST (N.C.). The contacts shall close in alarm conditions and loss of power.

8. Have a user selected 0-10 VDC or 4-20 mA linear analog output that corresponds to a face velocity of 0-1000 ft./min.

9. Have a setback key and setback input contact, either of which shall initiate control at the setback setpoint.

10. Have a red emergency key and an emergency input contact, either of which shall open the damper full open for maximum exhaust.

11. The operator display panel shall have an RS-485 communications port, and shall reside on the manufacturer’s standard communication network with lab room controller.

12. Be wired to the face velocity controller via terminal strips which plug into the back of the controller for easy installation.

13. Refer to the Drawings for specific requirements for Fume Hoods.

2.6 SPACE TEMPERATURE SENSOR

A. The space temperature sensor shall be a 10,000 ohm thermistor. The sensor shall have a occupied/unoccupied override switch. Transmitter temperature set point shall not be adjustable at transmitter.

2.7 POWER SUPPLIES

A. Provide all power and low voltage power supplies as required.
PART 3 - EXECUTION

3.1 INSPECTION
A. Examine areas and conditions under which laboratory airflow control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Install the control equipment, and operator display panels on fume hoods. Install and terminate all low voltage control wiring between each controller and all control and sensing devices, and provide 24 VAC power where required by the controllers and control devices.
B. Provide 120 volt power circuits in the panel board for appropriate connections to the laboratory control equipment.

3.3 SYSTEM STARTUP
A. System startup shall be provided by factory certified and trained employees of the LACS manufacturer. Start up shall include the following:
1. Determine when the HVAC equipment and physical space is ready for operational testing.
2. Set up fume hood face velocity controls, and verify face velocity and air flow measurement accuracy.
3. Verify room supply system performance.
5. Verify room airflow tracking performance.
B. All steps of system startup shall be formally recorded when performed and provided to the Owner as part of the as-built documentation.

3.4 TRAINING
A. Provide competent instructors to give complete and specific on site instruction to Owner designated personnel in the adjustment, operation and maintenance of the installed system, in lieu of a general training course. Instructors shall be thoroughly familiar with all aspects of the subject matter and the installed system. All training shall be held on weekdays during the normal work hours of 8:00 a.m. to 4:30 p.m.
B. Training shall consist of not less than 16 hours for owner designated operating personnel. Training shall include:

1. Explanation of as built drawings, overall system operation and user required maintenance.
2. A thorough walk-through of the job to locate control components.
3. Laboratory and fume hood controller specific operation and functions.
4. Explanation of adjustment, calibration and replacement procedures

3.5 BUILDING AUTOMATION SYSTEM INTERFACE

A. The following laboratory environment information shall be provided to the building management system.

1. Fume hood exhaust airflow (cfm).
2. Laboratory room supply airflow (cfm) and temperature
3. Laboratory room exhaust airflow (cfm) for each valve.
4. Fume hood sash position.
5. Alarms.
6. Laboratory room airflow totals.
7. Laboratory room temperature and set point.
8. Hot water heating valve position.

B. Information may be transmitted electronically through protocol translators, seamless LAN connection, or through a direct connection (hard wire). If the direct connection approach is used, provide all wiring and any additional building management and LACS control panels required. If the electronic approach is used, provide all network wiring and any protocol translators required by the LACS.

C. The LACS shall accept control inputs (as a minimum) from the building automation system as follows.

1. Laboratory room temperature setpoint adjustment.
2. Occupied state of Laboratory room controls.

END OF SECTION
CEW
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.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 23 Section “Expansion Fittings and Loops for HVAC Piping”.
2. Division 23 Section “Sleeves and Sleeve Seals for HVAC Piping”.
3. Division 23 Section “Escutcheons for HVAC Piping”.
4. Division 23 Section “Meters and Gages for HVAC Piping”.
5. Division 23 Section “General-Duty Valves for HVAC Piping”.
6. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment”.
7. Division 23 Section “Vibration Controls for HVAC Piping and Equipment”.
8. Division 23 Section “Identification for HVAC Piping and Equipment”.
9. Division 23 Section “Testing, Adjusting, and Balancing for HVAC”.
10. Division 23 Section “HVAC Insulation”.
11. Division 23 Section “Commissioning of HVAC”.
12. Division 23 Section “Instrumentation and Control Systems”.
13. Division 23 Section “Hydronic Pumps”.
14. Division 23 Section “HVAC Water Treatment”.
15. Division 23 Section “Air Terminal Units”.
16. Division 23 Section “Condensing Boilers”.
17. Division 23 Section “Heat Exchangers for HVAC”.
18. Division 23 Section “Air-Cooled Dry Fluid Coolers”.
19. Division 23 Section “Rotary-Screw Water Chillers”.
20. Division 23 Section “Custom Air-Handling Units”.
21. Division 23 Section “Air Coils”.
22. Division 23 Section “Fan Coil Units”.
23. Division 23 Section “Propeller Unit Heaters”.
24. Division 23 Section “Radiators”.
25. Division 23 Section “Chilled Beams”.

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. Glycol water piping.
4. Makeup-water piping.
5. Condensate-drain piping.
7. Air-vent piping.

1.3 DEFINITIONS

A. PTFE: Polytetrafluoroethylene.

1.4 SUBMITTALS

A. General:

1. Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Section.

B. 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.
4. Hydronic specialties.

C. Shop Drawings: None required.

D. Welding certificates.

1. Submit welder’s certificates certifying that welders meet the quality requirements specified in Quality Assurance below.

E. Certifications:

1. Submit certification of compliance with ASTM and ANSI manufacturing requirements for pipe, fittings, and specialties.

F. Qualification Data: For Installer.

G. Field quality-control test reports.
H. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. 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.

C. 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.


1.6 EXTRA MATERIALS

A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate the size and location of concrete equipment pads. Coordinate the placement of anchor bolt inserts. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate the installation of pipe sleeves for foundation wall penetrations.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L (ASTM B 88M, Type B).

B. DWV Copper Tubing: ASTM B 306, Type DWV.

C. Wrought-Copper Fittings: ASME B16.22.
D. Wrought-Copper Unions: ASME B16.22.

E. Copper or Bronze Pressure-Seal Fittings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Stadler-Viega.
      b. Elkhart Products “Xpress”.
   2. Housing: Copper.
   3. O-Rings and Pipe Stops: EPDM.
   4. Tools: Manufacturer's special tools.
   5. Minimum 200-psig (1379-kPa) working-pressure rating at 250 deg F (121 deg C).
   6. ASTM B16.18 or ASME B16.22.

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, Schedule 40, seamless or electric resistance welded, 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 as indicated in Part 3 "Piping Applications" Article, raised ground face, bolt holes spot faced.


E. Wrought-Steel Fittings: ASTM A 234/A 234M, seamless or welded, for welded joints, wall thickness to match adjoining pipe.

F. 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:
   2. End Connections: Butt welding.
   3. Facings: Raised face.

G. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.
H. Grooved Mechanical-Joint Fittings and Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Grinnel.
   b. Victaulic Company.

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. Sizes through 12”:
   a. Rigid Type: Housing shall be cast iron in accordance with ANSI B31.1 and B31.9 [Vicatulic Style 07].
   b. Flexible Type: For use in locations where vibration attenuation and stress relief are required. [Vicatulic Style 77].
   c. Flange Adapter: Flat face, for direct connection to ANSI Class 125 or 150 flanged components. [Vicatulic Style 741].

5. 14” through 24”:
   a. Rigid Type: In accordance with ANSI B31.1 and B31.9. [Vicatulic Style W07].
   b. Flexible Type: Housing key shall fit into the wedge shaped AGS groove and allow for linear and angular pipe movement. [Vicatulic Style W77].
   c. Flange Adapter: Raised face, ASTM A105 slip-on flange, Class 150, with AGS grooved end pipe spool. [Vicatulic W45R].

2.3 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (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.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
C. Solder Filler Metals: ASTM B 32, Type E, lead-free alloys. Include water-flushable flux according to ASTM B 813.


E. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

F. Grooved Joint Materials: Gaskets shall comply with ASTM D2000, and be suited to the intended service. Lubricate gaskets in accordance with the manufacturer’s recommendations with lubricant supplied by the coupling manufacturer that is suitable for the gasket elastomer and system media (Victaulic “Vic-Lube”).

2.4 DIELECTRIC FITTINGS

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Epco.
   b. Perfection Corp.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   b. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
   c. End Connections: Solder-joint copper alloy and threaded ferrous.

3. Dielectric Unions: Threaded or soldered end connections for the pipe materials in which installed; constructed to isolate dissimilar metals, prevent galvanic action, and prevent corrosion.

4. Dielectric Waterway Fittings: Threaded, grooved, or plain end connections for the pipe materials in which installed; constructed for an cast ductile iron or steel housing with inert thermoplastic lining to isolate dissimilar metals; prevent galvanic action, and prevent corrosion. [Victaulic Style 47.]

5. Flexible Connectors: Refer to Division 23 “Vibration and Seismic Controls for HVAC Piping” Section.
a. Three (Victaulic Style 77) couplings may be used in lieu of a flexible connector for vibration attenuation and stress relief at locations other than pump flexible couplings. The couplings shall be placed in close proximity to the source of the vibration.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. EPCO.
   b. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
   b. Factory-fabricated, bolted, companion-flange assembly.
   c. Pressure Rating: 125 psig (860 kPa) minimum at 180 deg F (82 deg C).
   d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Central Plastics Company.
   d. Pipeline Seal and Insulator, Inc.

2. Description:
   a. Nonconducting materials for field assembly of companion flanges.
   b. Pressure Rating: 150 psig (1035 kPa).
   c. Gasket: Neoprene or phenolic.
   d. Bolt Sleeves: Phenolic or polyethylene.
   e. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Grinnell Mechanical Products.
   b. Victaulic Company.
2. Description:
   a. Standard: IAPMO PS 66
   b. Electroplated steel nipple, complying with ASTM F 1545.
   c. Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
   d. End Connections: Male threaded or grooved.
   e. Lining: Inert and noncorrosive, propylene.

2.5 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 (1/2 Inch to 2 Inch Size):
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Bell & Gossett Domestic Pump; a division of ITT Industries.
      b. Flow Design Inc.
      c. Taco.
      d. Victaulic Company of America, T.A. Hydrondics Division.
   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.
   8. Handle Style: Lever, with memory stop to retain set position.
   10. Maximum Operating Temperature: 250 deg F (121 deg C).
   11. Each readout valve shall be fitted with internal EPT insert and check valve designed to minimize system fluid loss during monitoring process. Valve shall have integral pointer, calibrated nameplate and memory stop feature to allow valve to be closed for service and re-opened to set point without disturbing the balance position. Valve bodies shall have ¼ inch NTP tapped drain/purge port. Valves shall have accuracy throughout the entire flow range of plus/minus 5%. Valves 2 inch and smaller shall have threaded or press-fit connections and be leak-tight at full working pressure.
D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Bell & Gossett Domestic Pump; a division of ITT Industries.
   b. Flow Design Inc.
   c. Taco.
   d. Tour & Andersson; available through Victaulic Company.

2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
5. Disc: Replaceable bronze disk.
6. Seat: Bronze or ductile iron.
7. End Connections: Flanged or grooved.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum 300 psig.
12. Valve shall have readout valves, calibrated nameplate and be leak-tight.
13. Valve shall have accuracy throughout the entire flow range of plus/minus 5%.

E. Diaphragm-Operated, Pressure-Reducing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett Domestic Pump; a division of ITT Industries.
   d. Conbraco Industries, Inc.
   e. Taco.

2. Body: Cast-iron or brass.
3. Disc: Glass and carbon-filled PTFE.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: Removable without system shutdown.
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. Amtrol, Inc.
   b. Bell & Gossett Domestic Pump; a division of ITT Industries.
   c. Conbraco Industries, Inc.
   d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   e. Spirax Sarco.

2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
8. Inlet Strainer: Removable without system shutdown.
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.
11. 125 psig working pressure and 250 degrees F. maximum operating temperature.

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. Cimberio.

2. Body:
   a. Valves 2 inch and Smaller: Forged brass body with bronze trim, y-pattern body with integral brass-body ball valve.
   b. Valves 2-1/2 Inch and Larger: Ductile iron body and wafer-style body.

3. Piston and Spring Assembly: Self-contained spring loaded perforated cartridge, non-corrosive metal (316 stainless steel and nickel plated brass); removable to allow replacement with higher or lower flow rate cartridges. Cartridges for valves 2 inch and under shall be removable without removing the valve body or disturbing the line piping in any way.
4. Identification Tag (with Chain) for Each Valve: Marked with zone identification, valve number, flow rate and differential pressure range.
5. Size: Same as pipe in which installed.
6. Performance: Maintain constant flow, plus/minus 5 percent over system pressure fluctuations.

7. Minimum CWP Rating:
   a. Valves 2 Inch and Under: 300 psig.
   b. Valves 2-1/2 Inch and Larger: 500 psig.

8. Maximum Operating Temperature: 250 deg F.

9. Each automatic flow control valve shall be provided with pressure tappings with quick disconnect fittings suitable for use with the portable measuring instrument specified, to verify pressure differential access flow control orifice.

2.6 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. Taco.
5. Hoffman Specialty ITT; Fluid Handling Div.

B. Manual Air Vents:

1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Screwdriver or thumbscrew.
4. Inlet Connection: NPS 1/2 (DN 15).
5. Discharge Connection: NPS 1/8 (DN 6).
6. CWP Rating: 150 psig (1035 kPa).

C. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. All Internal Parts: Nonferrous and compatible with propylene glycol.
4. Inlet Connection: NPS 1/2 (DN 15).
5. Discharge Connection: NPS 1/4 (DN 8).
6. CWP Rating: 150 psig (1035 kPa).
D. Bladder-Type Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett ITT; Fluid Handling Div.
   d. Taco.

2. Tank: Welded steel, rated for 125-psig (860-kPa) working pressure and 375 deg F (191 deg C) maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

3. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.


E. Tangential-Type Air Separators:

1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
   a. Amtrol, Inc.
   b. Armstrong Pumps, Inc.
   c. Bell & Gossett ITT; Fluid Handling Div.
   d. Taco.

2. Tank: Welded black steel; ASME constructed and labeled for 125-psig (860-kPa) minimum working pressure and 375 deg F (191 deg C) maximum operating temperature.

3. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.

4. Tangential Inlet and Outlet Connections: Threaded for NPS 2 (DN 50) and smaller; flanged connections for NPS 2-1/2 (DN 65) and larger.

5. Blowdown Connection: Threaded.


2.7 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
b. Hoffman Specialty ITT; Fluid Handling Div.
c. Metraflex Co.
d. Spirax Sarco.
e. Trane Co.
f. Victaulic Co. of America.
g. Watts Regulator Co.
h. Mueller.
i. Spence Engineering Co.
j. Conbraco Industries/Apollo Valves.

2. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
3. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
4. Strainer Screen: 40-mesh startup strainer, and perforated 304 stainless-steel basket with 50 percent free area.
5. CWP Rating: 125 psig (860 kPa).

B. Expansion fittings are specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

2.8 CENTRIFUGAL SOLIDS SEPARATORS (FULL-STREAM AND SIDE-STREAM)

A. Provide a solids from liquids, centrifugal, vertical mounted separator.

B. The separators shall be fabricated of carbon steel. All flanges shall be 150 lb., A.N.S.I., Raised Face. The Separator shall remove 98%, by weight, of separable solids 200 mesh (74 microns) and larger.

C. The separator shall be designed with tangential entry into the acceptance chamber. Upon tangential entry, the liquid/solids are drawn through internal tangential slots and accelerated into the reduced diameter separation cylinder. The solids heavier than the carrying liquid are centrifugally spiraled down the perimeter of the separation cylinder past the deflector stool and allowed to accumulate in the separator's collection changer. The liquid (free of separable solids) will follow the vortex created and centered on the deflector stool up through the interior of the separation cylinder and into the vortex finder which becomes the separator outlet.

D. The separator shall also incorporate a pressure relief line from the collection chamber to the venturi located in the tangential inlet to enhance separation by facilitating quiescent solids sedimentation in the collection chamber. Quiescent solids accumulation shall also be facilitated by the baffle spin arrestor below the deflector stool in the collection chamber.

E. Separation and collection of solids shall not promote excessive wear nor require a continuous "involuntary" underflow.

F. Timer actuated purge valve and liquid recovery system.
G. The purged liquid recovery system shall have a solids collection capacity of 25 pounds and a maximum operating pressure of 125 psi. It shall be comprised of a carbon steel retention vessel with lid, stainless steel internal basket with stainless steel screen, polyester-felt collection bag-50 minimum rating, and an air relief valve. The recovery system shall have a differential pressure operated indicator signifying the collection base is full.

H. Approved Manufacturer: Lakos, Griswold, Puroflux.

2.9 GLYCOL FLUID SYSTEMS

A. Glycol Fill Station:

1. Provide glycol fill station for pressurization, fill and drain of chilled glycol water piping systems. The fill station shall be a single piece of equipment and include 100 gallon polyethylene tank; 1/3 horsepower, 15 gpm, 15 psig, close coupled pump; 120 V, 1 phase; fill funnel; gauge glass; discharge check valve; electric starter; factory mounted control panel and isolation valves all pre-piped and mounted on a skid. Pump shall be capable of dead head operation to maintain pressure with no damage.

B. Approved Manufacturers:

1. Wessels Company (313-875-5000).

C. Premixed Heat Transfer Fluid:

1. Provide propylene glycol pre-mixed heat transfer fluid for systems indicated on drawings and schedules. The solution shall contain propylene glycol, corrosion inhibitors, buffers, and an anti-foam agent. The initial fill concentration of propylene glycol shall be at least 5% greater than the indicated concentration to account for water not completely drained out of the system after flushing. Commercial automobile antifreeze solutions un inhibited glycols, or field inhibited glycol, are not acceptable.

D. Approved Manufacturers:

1. Dynalene, Inc. – Dynalene PG.
2. Dow Chemical – Dowfrost.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Hot-water heating piping, aboveground, shall be any of the following:
1. **Type L (B), NPS 4 and smaller, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure sealed joints.**

2. **Schedule 40 steel pipe NPS 2 ½ (DN 65) and smaller; Class 125, cast-iron fittings; Class 150 malleable-iron unions; and threaded joints.**

3. **Schedule 40 steel pipe, NPS 3 (DN 80) and larger, 125 lb. wrought-steel fittings and 150 lb. wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.**

**B. Chilled-water and chilled glycol-water piping, aboveground shall be the following:**

1. **Schedule 40 steel pipe, NPS 2 (DN 50) and smaller; Class 150, malleable-iron fittings; threaded joints.**

2. **Schedule 40 steel pipe, NPS 2-1/2 (DN 65) and larger, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.**

3. **Type L (B), NPS 4 and smaller, drawn-temper copper tubing, wrought-copper fittings, and soldered or pressure sealed joints.**

4. **Schedule 40 steel pipe, NPS 2 (DN 50) and smaller; steel, pressure-seal couplings and fittings; and pressure-seal joints.**

5. **Schedule 40 steel pipe NPS 2-1/2 (DN 65) and larger; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.**

**C. Makeup-water piping installed aboveground shall be the following:**

1. **Type L (B), drawn-temper copper tubing, wrought-copper fittings, and soldered joints.**

**D. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.**

**E. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.**

**F. Air-Vent Piping:**

1. **Inlet: Same as service where installed.**

2. **Outlet: Type K (A), annealed-temper copper tubing with soldered or flared joints.**

**G. 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.**

### 3.2 VALVE APPLICATIONS

**A.** Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.

**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 silent 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.

G. Install calibrated balance valves on the outlet of each heating or cooling element and elsewhere as required to facilitate system balancing.


3.3 PIPING INSTALLATIONS

A. 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.

B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.
K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) ball valve, and short NPS 3/4 (DN 20) threaded nipple with chained cap, at low points in piping system mains and elsewhere as required for system drainage.

M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."

Q. Install unions in piping, NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 (DN 65) and larger, at final connections of equipment and elsewhere as indicated.

S. 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 with chained cap 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).

T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

U. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."
3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. 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.

C. 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).
   8. NPS 6 (DN 150): Maximum span, 17 feet (5.2 m); minimum rod size, 1/2 inch (13 mm).
   9. NPS 8 (DN 200): Maximum span, 19 feet (5.8 m); minimum rod size, 5/8 inch (16 mm).
  10. NPS 10 (DN 250): Maximum span, 20 feet (6.1 m); minimum rod size, 3/4 inch (19 mm).
  11. NPS 12 (DN 300): Maximum span, 23 feet (7 m); minimum rod size, 7/8 inch (22 mm).

D. 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).

E. 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. 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 Teflon-based 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. Flanged Joints: Align flanges surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

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 piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

D. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.

1. Install pump suction diffusers on pump suction inlet, adjust foot support to carry weight of suction piping. Install nipple and ball valve in blowdown connection.
E. Install bladder-type 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.

F. Install solid blow down from liquid centrifugal separator as indicated on Drawings to manufacturer written instructions.

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 bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.

D. 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. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
6. Provide all valving and cross-connections required for flushing and cleaning the piping. Valves and cross-connections shall be adequately sized to provide a minimum velocity of 6.0 fps in the piping system.

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. distributor's representative is not considered qualified to conduct the training or jobsite visit(s.)

3.9 ADJUSTING AND CLEANING

A. Coordinate flushing and cleaning of hydronic piping systems with the chemical treatment vendor. All flushing and cleaning shall be done under direct supervision of the chemical treatment vendor.

B. For each independent flushing and cleaning cycle, circulate system for a minimum of twenty-four (24) hours or longer if directed by the chemical treatment vendor.

C. Verify with equipment manufacturers if it is acceptable to flush and circulate pipe cleaning water through chillers, boilers, and other equipment. If equipment manufacturer recommends against circulating through equipment, provide temporary bypass at equipment connection to exclude equipment from the pipe cleaning operations.

D. As far as practical, circulate cleaning water using permanent system pumps. Sized temporary bypass(es) to prevent damage to pumps and allow adequate flow and velocity for thorough cleaning.

E. After completion of pipe cleaning as verified by chemical treatment vendor, fill system with reverse osmosis water and add initial chemical treatment and maintain water quality in ranges recommended by water treatment vendor for the first year of operation.

F. Submit a letter report documenting the above, including chemical analysis of the water in the system after flushing is completed.

G. Remove temporary bypass piping and cap connections to permanent piping.

3.10 START-UP

A. Fill system and perform initial chemical treatment.
1. Chemical Treatment: Provide a water analysis prepared by the chemical treatment supplier to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing.

B. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.

C. Before operating the system perform these steps:

1. Open valves to full open position. Close coil bypass valves.
2. Remove and clean strainers.
3. Check pump for proper direction and correct improper wiring.
4. Set automatic fill valves for required system pressure.
5. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type). Operate manual air vents to bleed air completely.
6. Set temperature controls so all coils are calling for full flow.
7. Check operation of automatic bypass valves.
8. Check and set operating temperatures of boilers, chillers, and cooling towers to design requirements.

3.11 EXTRA STOCK

A. Furnish spare containers of premixed glycol heat transfer fluid equal to system capacity for maintenance replacement.

END OF SECTION 232113
CEW
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.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 23 Section “Vibration Controls for HVAC Piping and Equipment”.
2. Division 23 Section “Identification for HVAC Piping and Equipment”.
3. Division 23 Section “Testing, Adjusting, and Balancing for HVAC”.
4. Division 23 Section “HVAC Insulation”.
5. Division 23 Section “Commissioning of HVAC”.
6. Division 23 Section “Instrumentation and Control Systems”.
7. Division 23 Section “HVAC Water Treatment”.
8. Division 23 Section “HVAC Casings”.
9. Division 23 Section “Air Duct Accessories”.
10. Division 23 Section “HVAC Power Ventilators”.
11. Division 23 Section “Air Terminal Units”.
12. Division 23 Section “Diffusers, Registers, and Grilles”.
13. Division 23 Section “HVAC Gravity Ventilators”.
14. Division 23 Section “Gas-Phase Filtration”.
15. Division 23 Section “Custom Air-Handling Units”.
16. Division 23 Section “Fan Coil Units”.

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
4. Sealants and gaskets.
5. Hangers and supports.

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.

B. 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. Adhesives.
   2. Sealants and gaskets.

B. LEED Submittals:
   1. Product Data for Prerequisite EQ 1: Documentation indicating that duct systems comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
   2. Product Data for Prerequisite EA 2: Documentation indicating that duct systems comply with ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."
   3. Leakage Test Report for Prerequisite EA 2: Documentation of work performed for compliance with ASHRAE/IESNA 90.1, Section 6.4.4.2.2 - "Duct Leakage Tests."
   4. Duct-Cleaning Test Report for Prerequisite EQ 1: Documentation of work performed for compliance with ASHRAE 62.1, Section 7.2.4 - "Ventilation System Start-Up."
   5. Product Data for Credit EQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.

C. 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, 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.

D. Delegated-Design Submittal:
1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.

E. 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.
   g. Perforated metal ceilings.

F. Welding certificates.

G. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of metal ductwork products of types, materials, and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. SMACNA Standards: Comply with the 1985 edition of SMACNA's "HVAC Duct Construction Standards, Metal and Flexible" for fabrication and installation of metal ductwork.
2. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" and/or NFPA 90B "Standard for the Installation of Warm Air Heating and Air Conditioning Systems".

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."
D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

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


1.6 DELIVERY, STORAGE, AND HANDLING

A. Protection: Protect shop-fabricated and factory-fabricated ductwork, accessories and purchased products from damage during shipping, storage and handling. Prevent end damage and prevent dirt and moisture from entering ducts and fittings.

B. Storage: Where possible, store ductwork inside and protect from weather. Where necessary to store outside, store above grade and enclose with waterproof wrapping.

1.7 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of Contract Documents.

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Contractor Option:

1. At Contractor's option, Ductmate Industries "25" duct connector may be provided in lieu of any SMACNA joint "F" or lighter class joint; and Ductmate Industries "35" duct connector may be provided in lieu of any SMACNA "J" or lighter class joint. All joints and seams of all ductwork shall be sealed.

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Eastern Sheet Metal
   b. Lindab Inc.
   c. McGill AirFlow LLC.
   d. SEMCO Incorporated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches (1524 mm) in Diameter: Flanged.

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.

D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials...
involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 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.

2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. 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.

D. Factory- or Shop-Applied Epoxy Coated Galvanized Sheet Steel: Comply with ASTM A653/A653M:

1. Apply to the surface of sheet metal that will form the interior surface of the duct. An untreated clear coating shall be applied to the exterior surface.
2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

E. 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.

F. 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).

2.4 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. General: Seal all seams, joints, ductwall penetrations, and fitting connections shall be sealed.
C. Indoor Galvanized Duct Sealant: Hardcast Iron Grip 601 vinyl acrylic, water based, brush-on duct sealant or hardcast gypsum impregnated #DT tape with #FTA 20 activator/adhesive, water based; applied according to manufacturer's direction.

D. Outdoor Galvanized Duct Sealant: Hardcast Versa-Grip 102 polyester/synthetic resin, brush-on duct sealant or Hardcast gypsum impregnated #DT tape with #RTA50 activator/adhesive; applied according to manufacturer's directions.

E. Indoor stainless steel, aluminum and/or copper duct sealant (if joints are not soldered or welded: Hardcast Foil Grip 1402P-3 sealant tape.

F. All sealants shall be U.L. rated and shall conform with NFPA 90A.

G. Round Duct Joint O-Ring Seals:
   1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa) and shall be rated for 10-inch wg (2500-Pa) static-pressure class, positive or negative.
   2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
   3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.5 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. 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."

C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

D. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

E. 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.

F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

G. Trapeze and Riser Supports:
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. Refer to Drawings M7-Series, for duct construction and application schedule.

C. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

D. Install round ducts in maximum practical lengths.

E. Install ducts with fewest possible joints.

F. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

G. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

I. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.

J. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

K. 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).

L. 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.

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 to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class B.
4. Outdoor, Return-Air Ducts: Seal Class B.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class B.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class B.
8. Unconditioned Space, Return-Air Ducts: Seal Class B.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class B.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class B.

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 (100 mm) thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) 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; install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.

1. Friction clamps shall be permitted on low pressure ductwork up to 12 inches wide and 12 inches high only.
2. "C" clamps with retainer clip and lock nut shall be permitted on low pressure ductwork up to 36 inches wide and 20 inches high only.
3. Low pressure ductwork 37 inches wide and larger shall be concentric beam clamps. No friction or "C" clamps will be permitted.
4. For both rectangular and round medium and high pressure ductwork, friction clamp and/or "C" clamp upper attachment devices shall not be permitted.

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 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.
3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:
   2. Test the following systems:
      a. Ducts with a Pressure Class Higher Than 3-Inch wg (750 Pa): Test representative duct sections, selected by Architect from sections installed, totaling no less than 25 percent of total installed duct area for each designated pressure class.
   3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
   4. Test for leaks before applying external insulation.
   5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
   6. Give seven days' advance notice for testing.

C. Duct System Cleanliness Tests:
   1. Visually inspect duct system to ensure that no visible contaminants are present.
   2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
      a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.8 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

B. Use service openings for entry and inspection.
   1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.
   2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.
3.9 START UP

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.10 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

B. Intermediate Reinforcement:
   2. Epoxy-Coated Ducts:
      a. Exposed to Airstream: Match duct material.
      b. Not Exposed to Airstream: Match duct material.

B. Intermediate Reinforcement:
   2. Epoxy-Coated Ducts:
      a. Exposed to Airstream: Match duct material.
      b. Not Exposed to Airstream: Match duct material.

C. 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 0.5 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 0.5 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. 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.

D. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."

   a. Rectangular Main to Rectangular Branch: 45-degree entry.

   b. Rectangular Main to Round Branch: Spin in.

2. Round Duct: 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."

   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 m/s) or Higher: 45-degree lateral.
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.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 23 Section “Identification for HVAC Piping and Equipment”.
2. Division 23 Section “Testing, Adjusting, and Balancing for HVAC”.
3. Division 23 Section “HVAC Insulation”.
4. Division 23 Section “Commissioning of HVAC”.
5. Division 23 Section “Instrumentation and Control Systems”.
6. Division 23 Section “Metal Ducts”.
7. Division 23 Section “HVAC Casings”.
8. Division 23 Section “Centrifugal HVAC Fans”.
9. Division 23 Section “HVAC Power Ventilators”.
10. Division 23 Section “Air Terminal Units”.
11. Division 23 Section “Diffusers, Registers, and Grilles”.
12. Division 23 Section “HVAC Gravity Ventilators”.
13. Division 23 Section “Custom Air-Handling Units”.
14. Division 23 Section “Fan Coil Units”.

1.2 SUMMARY

A. Section Includes:

2. Fire dampers.
3. Smoke dampers.
4. Combination fire and smoke dampers.
5. Flange connectors.
6. Turning vanes.
7. Remote damper operators.
8. Duct-mounted access doors.
10. Flexible ducts.
11. Duct accessory hardware.
B. Refer to Divisions 23, 26 and 28 for the following work; not work of this Section.

1. Power supply wiring to smoke dampers and combination fire/smoke dampers.
2. Interlock wiring between smoke dampers, combination fire/smoke dampers and related mechanical equipment and fire alarm system.
4. Section 283111 "Digital, Addressable Fire-Alarm System" for duct-mounted fire and smoke detectors.

1.3 ACTION SUBMITTALS

A. General:

1. Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.

B. Product Data: For each type of product.

1. Submit manufacturer's technical product data for each type of ductwork accessory, including dimensions, capacities, and materials of construction; and installation instructions.
2. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

C. LEED Submittals:

1. Product Data for Prerequisite IEQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."
2. Product Data for Prerequisite EA 2: Documentation indicating that duct insulation R-values comply with tables in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air Conditioning."

D. 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, method of fastening or support, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
   a. Special fittings.
   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.

1.4 INFORMATIONAL SUBMITTALS
A. 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.

B. Source quality-control reports.

1.5 CLOSEOUT SUBMITTALS
A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.
2. Submit manufacturer's maintenance data including parts lists for each type of duct accessory. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of Division 01.

1.7 QUALITY ASSURANCE
A. Codes and Standards:

1. SMACNA Compliance: Comply with applicable portions of SMACNA "HVAC Duct Construction Standards, Metal and Flexible".
2. Industry Standards: Comply with ASHRAE recommendations pertaining to construction of ductwork accessories, except as otherwise indicated.
3. UL Compliance: Construct, test, and label fire dampers in accordance with UL Standard 555 "Fire Dampers and Ceiling Dampers".
PART 2 - PRODUCTS

2.1 ASSEMBLY DESCRIPTION


B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.2 MATERIALS

A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
   2. Exposed-Surface Finish: Mill phosphatized.

B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

D. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.3 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:
   1. Manufacturers: Subject to compliance with requirements, provide products by the following:
      a. Air Balance, Inc.
      b. Airguide Corp.
      c. American Warming & Ventilating, Inc.
      d. Arrow Louver and Damper; Div. of Arrow United Industries, Inc.
      e. Louvers & Dampers, Inc.
      f. Penn Ventilator Co.
      g. Ruskin Mfg. Co.
2. General: Factory fabricated with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

3. Single Blade Round Volume Dampers: SMACNA construction not less than two (2) gauges heavier than duct with continuous 3/8” diameter shaft with dual pivots, non-ferrous bearings, and quadrant lock. All materials other than bearings shall be galvanized steel.

4. Rectangular Volume Dampers: Provide multiple opposed-blade design with standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications. SMACNA construction not less than two (2) gauges heavier than duct with continuous 3/8” diameter shaft with dual pivots, non-ferrous bearings, and quadrant lock. All materials other than bearings shall be galvanized steel.

5. Standard leakage rating, with linkage outside airstream.

6. Suitable for horizontal or vertical applications.

7. Frames:
   a. Frame: Hat-shaped, 0.094-inch- (2.4-mm-) thick, galvanized sheet steel.
   b. Mitered and welded corners.
   c. Flanges for attaching to walls and flangeless frames for installing in ducts.

8. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized-steel, 0.064 inch (1.62 mm) thick.


10. Bearings:
    a. Oil-impregnated bronze or molded synthetic.
    b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

11. Tie Bars and Brackets: Galvanized steel.

B. 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.
2.4 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Air Balance, Inc.
2. American Warming & Ventilating Inc.
4. Louvers and Dampers, Inc.
6. Nailor
7. Greenheck

B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class and minimum 2000-fpm (10-m/s) velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Style "C" for rectangular ductwork with blades out of airstream; fabricated with roll formed, 20 gauge galvanized steel with 24 gauge, 2 ½" long galvanized steel duct collars and airtight casing.

F. Frame: Style "CR" for round ductwork with blades out of airstream; fabricated with roll formed, 20 gauge galvanized steel with 24 gauge, 2 ½" long galvanized steel duct collars and airtight casing.

G. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: Minimum Thickness: Conform to code minimum requirements. Where any part of the fire damper frame falls outside the plane of the wall or floor when installed, sleeve shall be minimum 10 gauge.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
3. Retaining members shall be minimum 1/8" thick with shape, length, and width as detailed on Drawings.

H. Mounting Orientation: Vertical or horizontal as indicated.

I. Blades: Roll-formed, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.

J. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

K. Heat-Responsive Device: Replaceable 165°F (74°C) rated, fusible links.
2.5 SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Greenheck.
3. Louvers and Dampers Inc.

B. General: Smoke dampers meeting the following specifications shall be furnished and installed where shown on plans and/or as described in schedules. Dampers shall meet the requirements of the latest edition of NFPA 90A, 92A and 92B.

C. Dampers shall be tested, rated and labeled in accordance with the latest edition of UL Standards 555S. Dampers shall be UL labeled for use in dynamic systems. The damper shall have a dynamic closure airflow rating equal to or greater than the airflow at the damper’s installed location and a dynamic closure pressure rating of 4 in. WC at 3000 FPM.

D. Dampers shall have a UL555S Leakage rating of Class I and a Temperature rating of 350°F. Dampers shall have a UL555S operational airflow rating equal to or greater than the airflow at its installed location and an operational pressure rating of 4 in. WC at 3000 FPM. Damper actuators shall be factory mounted and qualified for use with the damper in accordance with UL555S. Provide actuator with auxiliary switch to indicatedamper position. Damper actuators shall be electric type for 120 volt operation, or pneumatic, as indicated on the drawings. Manufacturer’s submittal data shall indicate actuator space requirements around the damper. Damper and actuator shall be supplied as single entity, which meets all applicable UL555S qualifications for both dampers and actuators.

E. All UL555S Dynamic Closure Ratings, Operational Ratings and Leakage Ratings shall be qualified for airflow and pressure in either direction through the damper. UL ratings shall allow four mounting damper vertically (with blades running horizontal).

F. The Damper Manufacturer’s submittal data shall certify all air performance pressure drop data is licensed in accordance with the AMCA Certified Ratings Program for Test Figures 5.2, 5.3 and 5.5. Damper air performance data shall be developed in accordance with the latest edition of AMCA Standard 500-D.

G. Damper blades shall be airfoil shaped single piece construction with 13 GA galvanized steel. Blades shall be completely symmetrical relative to their axle pivot point, presenting identical resistance to airflow and operation in either direction through the damper (blades that are non-symmetrical relative to their axle pivot point or utilize blade stops larger than 0.5 in. are unacceptable). Bearings shall be stainless steel sleeve turning in an extruded hole in the damper frame.

H. Damper frames shall be a minimum 16 GA. galvanized steel formed into a structural hat channel shape to 13 GA, channel frame with reinforced corners. Bearings shall be stainless steel sleeve turning in an extruded hole in the damper frame. Blade edge seals shall be silicone rubber and galvanized steel mechanically locked into blade edge. Jamb seals shall be stainless steel compression type.
I. Provide actuator with indicating switch package for remote mounting.
   1. Keyswitch.
   2. Alarm status light.

2.6 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Greenheck.
   3. Louvers and Dampers Inc.

B. General: Labeled to UL 555S. Combination fire and smoke dampers shall be labeled for one-and-one-half-hour rating to UL 555.

C. Resettable Electric Heat Switch: Replaceable, 165 deg F. rated or as indicated on the drawings.

D. Frame and Blades: 16 gauge galvanized sheet steel, airfoil shaped.

E. Mounting Sleeve: Factory or field installed galvanized sheet steel.
   1. Minimum Thickness: Conform to Code minimum requirements. Where any part of the combination fire smoke damper frame falls outside the plane of the wall or floor sleeve shall be minimum 10 gauge.
   2. Retaining members shall be minimum 1/8" thick of shape, length and width as detailed on Drawings.

F. Blade Seals:
   1. Blade edge smoke seal; silicone rubber rated for 450 deg. F.
   2. Blade edge flame seal: Galvanized steel rated for 1900 deg. F.

G. Linkage: Galvanized steel concealed in frame.

H. Axles: Minimum ½ inch plated steel hex.

I. Bearings: Stainless steel sleeve type.
J. Damper Motors: Provide for modulating or two-position action.
   1. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
   2. Outdoor Motors and Motors in Outside-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
   3. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lb and breakaway torque rating of 300 in. x lb.
   4. Two-Position Motor: 115 V, single phase, 60 Hz.
   5. Damper and actuator shall be supplied as single entity, which meets all applicable UL555S qualifications for both dampers and actuators. Provide actuator with auxiliary switch to indicate damper position.

K. Provide actuator with indicating switch package for remote mounting.
   1. Keyswitch.
   2. Alarm status light.

2.7 TURNING VANES
A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Aero Dyne Co.
   2. Airsan Corp.
   3. Anemostat Products Div.; Dynamics Corp. of America
   4. Duro-Dyne

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

2.8 REMOTE DAMPER OPERATORS
A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Pottorff.
   2. Ventfabrics, Inc.
   3. Young Regulator Company.
   4. MAT.

B. Description: Cable system designed for remote manual damper adjustment.

C. Tubing: Aluminum.
D. Cable: Stainless steel.

E. Wall-Box Mounting: Recessed.

F. Wall-Box Cover-Plate Material: Stainless steel.

2.9 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Air Balance Inc.
2. Air Filter Co.
3. Duro Dyne Corp.
5. Ventfabrics Inc.


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: Continuous and two sash locks.
   c. Access Doors up to 24 by 48 Inches (600 by 1200 mm): Continuous and two compression latches with outside and inside handles.
   d. Access Doors Larger Than 24 by 48 Inches (600 by 1200 mm): Continuous and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:

1. Door and Frame Material: Galvanized sheet steel.
2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.
3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch-(25-mm-) thick, fibrous-glass or polystyrene-foam board.

2.10 DUCT ACCESS PANEL ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Air Balance Inc.
   2. Air Filter Co.
   3. Duro Dyne Corp.
   5. Ventfabrics Inc.

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0428-inch (1.1-mm) stainless steel.

D. Fasteners: Stainless 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.

G. Insulation: 1-inch thick, fibrous-glass or polystyrene-foam board.

2.11 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   2. Duro Dyne Corp.
   3. Flexaust (The) Co.
   4. Ventfabrics

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 5-3/4 inches (146 mm) wide attached to two 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.

   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).

   1. Minimum Weight: 14 oz./sq. yd. (474 g/sq. m).
   2. Tensile Strength: 450 lbf/inch (79 N/mm) in the warp and 340 lbf/inch (60 N/mm) in the filling.
   3. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).

G. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
   1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
   2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
   7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch (6-mm) movement at start and stop.

2.12 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Flexmaster U.S.A., Inc.
   2. McGill AirFlow LLC.
B. Flexible Duct Connectors:
   1. Clamps: Nylon strap in sizes 3 through 18 inches (75 through 460 mm), to suit duct size.

2.13 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.

2.14 DUCT PRESSURE RELIEF PANEL
   A. At location(s) indicated on plans, provide spring controlled pressure relief panel to open inward (negative relief) or outward (positive pressure relief) as system dictates. Panel shall be of 12 ga. (galvanized) construction for frame and door. Polyurethane foam around door perimeter shall provide positive seal. Relief spring settings shall be adjustable from 3" to 10" wg. static pressure. Door size shall be minimum (18" x 18") (24" x 12"). Panel shall carry an AMCA rating.
   B. Manufacturer: Subject to compliance with requirements, provide pressure relief panel of one of the following:
      1. Ruskin PRD18

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.
   B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ducts, and stainless-steel accessories in stainless-steel ducts.
   C. Install turning vanes in all square 90 degree elbows, except in supply air ductwork downstream of air terminals.
   D. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
E. Install volume dampers where indicated on Drawings. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.

F. Set dampers to fully open position before testing, adjusting, and balancing.

G. Install test holes at fan inlets and outlets and elsewhere as indicated.

H. Install fire and smoke dampers according to UL listing.

I. Install damper indicating switch package in an accessible location in ceiling or wall surface coordinate location with Owner and Architect. Provide all necessary wiring.

J. Provide duct access doors at all locations where access is required for maintenance and inspection including but not limited to fire dampers, control dampers, duct mounted equipment, reheat coils, air filters, humidifiers, sound traps, turning vanes, air extractors, etc.

K. Duct access doors shall be installed in the vertical duct wall which is most accessible.

L. Install access doors with swing against duct static pressure.

M. Duct access door size shall be 24" x 18" wherever possible, minimum door size shall be 18" x (duct height minus 2 inches).

N. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

O. Install flexible connectors to connect ducts to equipment.

P. 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.

Q. Connect terminal units to supply ducts directly. Do not use flexible ducts.

R. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch (1500-mm) lengths of flexible duct clamped or strapped in place.

S. Connect flexible ducts to metal ducts with draw bands or adhesive plus sheet metal screws.

T. Install duct test holes where required for testing and balancing purposes.

U. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch (6-mm) movement during start and stop of fans.
V. Install double wall louver blank-off panels with cadmium plated fasteners. Inside and outside panels shall be minimum 20 gauge with stiffeners and bracing as required. Provide galvanized channel bracing and/or stiffeners to maintain rigidity. Seal around entire perimeter with silicone caulk.

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.

3.3 ADJUSTING AND CLEANING

A. Adjusting: Adjust ductwork accessories for proper settings, install fusible links in fire dampers and adjust for proper action.

1. Label access doors in accordance with Division-23 Section "Identification for HVAC Piping and Equipment".
2. Final positioning of manual dampers is specified in Division-23 Section "Testing, Adjusting, and Balancing".

B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 233300
CEW
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.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 23 Section “Expansion Fittings and Loops for HVAC Piping”.
2. Division 23 Section “Meters and Gages for HVAC Piping”.
3. Division 23 Section “General-Duty Valves for HVAC Piping”.
4. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment”.
5. Division 23 Section “Vibration Controls for HVAC Piping and Equipment”.
6. Division 23 Section “Identification for HVAC Piping and Equipment”.
7. Division 23 Section “Testing, Adjusting, and Balancing for HVAC”.
8. Division 23 Section “HVAC Insulation”.
9. Division 23 Section “Commissioning of HVAC”.
10. Division 23 Section “Instrumentation and Control Systems”.
11. Division 23 Section “Hydronic Piping”.
12. Division 23 Section “HVAC Water Treatment”.
13. Division 23 Section “Metal Ducts”.

1.2 SUMMARY

A. Section Includes:

1. Shutoff, single-duct air terminal units.

1.3 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.
2. Liners and adhesives.
3. Sealants and gaskets.
B. LEED Submittals:

1. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."

C. 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.

D. Coordination Drawings: Reflected ceiling 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. Ceiling suspension assembly members.
2. Size and location of initial access modules for acoustic tile.
3. Ceiling-mounted items including lighting fixtures, cable tray, diffusers, grilles, speakers, sprinklers, fire alarm devices, access panels, and special moldings.

E. Field quality-control reports.

F. 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.

1.4 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: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

C. Codes and Standards:

1. ARI Compliance: Provide air terminals which have been tested and rated in accordance with ARI 880 "Industry Standard for Air Terminals: and bear ARI certification seal.
2. NFPA Compliance: Construct air terminals using acoustical and thermal insulations complying with NFPA 90A "Air Conditioning and Ventilating Systems".
3. All electrical work and electrical components shall comply with requirements of Division 26.

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. Krueger Manufacturing Co.
2. Titus.
5. Siemens.

B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Casing: Minimum 22 gauge galvanized steel, single wall.

D. Casing Lining: All air terminals shall have a non-porous sealed lining system. Liner and insulation shall meet requirements of UL 181 and NFPA 90A, including bacteriological standards of ASTM C665. All seams and cut edges shall be sealed from the airstream using metal brackets; use of adhesive-backed tape is unacceptable. Insulation shall be 4 lb/ft³ density with an R-Value of 3.5.

   1. Lining shall have 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 for duct attachment.
3. Air Outlet: S-slip and drive connections.
4. Access: Removable panels for access to diverting damper, reheat coil and other 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.
6. Casing leakage shall not exceed 2% of scheduled design flow at 3” s.p.

E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

   1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 6-inch wg (1500-Pa) inlet static pressure.
F. The damper shall have a built-in stop to prevent overstroking and shall seal against a closed-cell foam gasket, to limit close-off leakage to the maximum values shown in the following table:

<table>
<thead>
<tr>
<th>Inlet Size</th>
<th>Damper Leakage CFM 1.5 WC</th>
<th>3.0&quot; WC</th>
<th>6.0&quot; WC</th>
</tr>
</thead>
<tbody>
<tr>
<td>4, 5 &amp; 6</td>
<td>4</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>7, 8</td>
<td>4</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>9, 10</td>
<td>4</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>12</td>
<td>4</td>
<td>5</td>
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<td>14</td>
<td>4</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>16</td>
<td>5</td>
<td>7</td>
<td>9</td>
</tr>
</tbody>
</table>

G. Attenuator Section: 0.034-inch (0.85-mm) steel sheet.

1. Lining: Adhesive attached, 1-inch- (25-mm-) thick, coated, fibrous-glass duct liner complying with ASTM C 1071, 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.

   a. Cover liner with nonporous foil.

2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

H. 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 hose end drain valve with cap.

I. Direct Digital Controls: Single-package unitary controller, space temperature sensor and actuator specified in Division 23 Section "Instrumentation and Control for HVAC."

2.2 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Steel Cables: Galvanized steel complying with ASTM A 603.

C. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

D. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
E. 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.

2.4 TERMINAL UNIT INSTALLATION MATRIX (SEE NOTES A, B, C, D, E, F, AND G)

<table>
<thead>
<tr>
<th>Item</th>
<th>Furnished By</th>
<th>Mounted By</th>
<th>Connected By</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminal Unit</td>
<td>Unit Supplier</td>
<td>Contractor</td>
<td>Contractor (A)</td>
</tr>
<tr>
<td>Damper Actuator</td>
<td>Control Supplier</td>
<td>Unit Supplier (B)</td>
<td>Unit Supplier (B)</td>
</tr>
<tr>
<td>Air-Flow Pickup</td>
<td>Unit Supplier</td>
<td>Unit Supplier (B)</td>
<td>Unit Supplier (B)</td>
</tr>
<tr>
<td>Hot Water Coil Control Valve</td>
<td>Unit Supplier</td>
<td>Unit Supplier (B)</td>
<td>Contractor</td>
</tr>
<tr>
<td>Valve Actuator</td>
<td>Control Supplier</td>
<td>Contractor</td>
<td>Contractor</td>
</tr>
<tr>
<td>Room Sensor</td>
<td>Control Supplier</td>
<td>Contractor</td>
<td>Contractor</td>
</tr>
<tr>
<td>24-Volt Transformer (D)</td>
<td>Unit Supplier</td>
<td>Unit Supplier (B)</td>
<td>Unit Supplier (B)</td>
</tr>
<tr>
<td>Low Voltage Side Wiring (E)</td>
<td>Unit Supplier</td>
<td>Unit Supplier (B)</td>
<td>Unit Supplier (B)</td>
</tr>
<tr>
<td>Line Voltage Side Wiring (F)</td>
<td>Unit Supplier</td>
<td>Unit Supplier (B)</td>
<td>Unit Supplier (B)</td>
</tr>
<tr>
<td>Disconnect Switch</td>
<td>Unit Supplier</td>
<td>Unit Supplier (B)</td>
<td>Contractor</td>
</tr>
<tr>
<td>Air-Flow Transducer</td>
<td>Control Supplier</td>
<td>Unit Supplier (B)</td>
<td>Unit Supplier (B)</td>
</tr>
<tr>
<td>Digital Controller</td>
<td>Control Supplier</td>
<td>Unit Supplier (B)</td>
<td>Contractor (E)</td>
</tr>
<tr>
<td>All Other Components</td>
<td>Contractor</td>
<td>Contractor</td>
<td>Contractor</td>
</tr>
</tbody>
</table>

A. Ductwork and piping connections.

B. At the terminal unit factory.

C. If not integral to control valve.
D. If the terminal has no fan, the 24-hour power source should be furnished, mounted and connected by the control supplier.

E. Connection to room temperature transmitter, heating coil control valve actuator, other digital controllers and the BMS.

F. Connection to the air flow pick-up, the damper actuator, the fan relay and the 24-volt transformer.

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 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 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: Galvanized 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 union or flange, balancing valve and shutoff valve.

C. Connect ducts to air terminal units according to Division 23 Section "Metal Ducts."

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. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. 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.

D. Air terminal unit will be considered defective if it does not pass tests and inspections.

E. 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
CEW
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.
   B. Related Sections: The following Sections contain requirements that relate to this Section:
      1. Division 23 Section “Testing, Adjusting, and Balancing for HVAC”.
      2. Division 23 Section “Metal Ducts”.
      3. Division 23 Section “Air Duct Accessories”.

1.2 SUMMARY
   A. Section Includes:
      1. Rectangular and square ceiling diffusers.
      2. Perforated diffusers.
      3. Linear bar diffusers.
      4. Adjustable blade registers and grilles.

1.3 QUALITY ASSURANCE
   A. ASHRAE Compliance: Rate air outlets and inlets in accordance with ASHRAE 70 “Method of
      Testing for Rating the Air Flow Performance of Outlets and Inlets”.

1.4 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. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color
      finishes.
   C. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes
      to verify color selected.
D. Coordination Drawings: Reflected ceiling 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. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
5. Duct access panels.

E. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Rectangular and Square Ceiling Diffusers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Krueger.
   b. Nailor Industries Inc.
   c. Price Industries.
   d. Titus.

2. Devices shall be specifically designed for variable-air-volume flows.
5. Face Size: 24 by 24 inches (600 by 600 mm) or 12 by 12 inches (300 by 300 mm).
6. Face Style: Plaque or perforated as indicated on Drawings.
7. Mounting: Surface or T-bar as indicated on Drawings.
9. Accessories:
   a. Equalizing grid.
   b. Sectorizing baffles.

B. Perforated Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Krueger.
   b. Nailor Industries Inc.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Steel or aluminum (where indicated) backpan and pattern controllers, with stainless steel or aluminum face where indicated.
4. Finish: Baked enamel, white.
5. Face Size: 12 by 12 inches (300 by 300 mm), 24 by 12 inches (600 by 300 mm), 48 by 12 inches (1200 by 300 mm), 24 by 24 inches (600 by 600 mm), and 48 by 12 inches (1200 by 300 mm).
6. Duct Inlet: Round.
7. Face Style: Flush.
9. Pattern Controller: None.
10. Accessories:
   a. Equalizing grid.
   b. Safety chain.

2.2 FLOOR DIFFUSERS

A. Linear Bar Diffusers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Krueger.
      b. Nailor Industries Inc.
      c. Price Industries.
      d. Titus.
   3. Finish: Aluminum.
   5. Components:
      a. Aluminum diffuser core.
      b. Diffuser frame.
      c. Plenum, 0.034-inch (0.85-mm) steel.

2.3 REGISTERS AND GRILLES

A. Adjustable Blade Grille:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2.4 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.

3.4 SPARE PARTS

A. Furnish to Owner with receipt, three (3) operating keys for each type of air outlet and inlet that requires them.

END OF SECTION 233713
CEW
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.
B. Related Sections: The following Sections contain requirements that relate to this Section:
   1. Division 23 Section “Custom Air-Handling Units”.

1.2 SUMMARY
A. Extent of heating and cooling coil work required by this Section is indicated on drawings and schedules, and by requirements of this Section.
B. This Section includes the following types of air coils that are not an integral part of air-handling units:
   1. Heating Coils (Hot Water)
   2. Cooling Coils (Chilled Water)

1.3 SUBMITTALS
A. Product Data: Submit for each type of product indicated. Include construction details, performance data, material descriptions, dimensions and weights of individual components and profiles, and finishes for each air coil. Include rated capacity and pressure drop for each air coil. Include installation data.
B. Operation and Maintenance Data: Submit operation and maintenance manuals. Include parts list.

1.4 QUALITY ASSURANCE
A. ASHRAE Compliance:
   1. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
   2. Comply with applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

WAYNE STATE UNIVERSITY
IBIO RADIO CHEMISTRY FACILITY

PROJECT NO.: 2016-01118-000
WSU PROJECT NO.: 211-277899

AIR COILS
238216 - 1
1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Handle coils carefully to prevent damage, breaking, denting, and scoring. Do not install damaged units or components; replace with new.

B. Store coils in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

C. Comply with manufacturer's rigging and installation instructions for unloading coils and moving them to final location.

PART 2 - PRODUCTS

2.1 WATER COILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Aerofin Corporation.
3. McQuay.
4. Trane.
5. York/JCI.

2.2 HEATING AND COOLING COILS

A. Heating Coils (Hot Water):

1. Provide continuous tube water coils with capacities and arrangements as indicated in Contract Documents.
2. Primary surface tubes shall be minimum 1/2" O.D. seamless de-oxidized copper tubing. The copper tubing to steel supply and return header connection shall be brazed with silver solder.
3. Secondary surface shall consist of aluminum fins. The fins shall be continuous plate type or smooth taper helically wound.
4. Casing shall be constructed of galvanized sheet steel having provisions for bolting to ductwork on top and bottom channels and both ends.
5. Coils shall have drain and vent connections at each end.
6. Testing: Each coil shall be proof tested at 300 psi and leak tested at 200 psig (air pressure under water); and be suitable for working pressures and temperatures up to and including, 200 psig and 380 degrees F.
B. Cooling Coils (Chilled Water):

1. Provide ARI certified drainable continuous tube water coils with capacities and arrangements as indicated in Contract Documents.
2. Primary surface tubes shall be minimum 1/2" O.D. seamless deoxidized Type L copper tubing. The copper tubing to steel supply and return header connection shall be brazed with silver solder.
3. Secondary surface shall consist of aluminum fins. The fins shall be continuous plate type.
4. The casing shall be constructed of stainless steel sheet steel having provisions for bolting to ductwork on top and bottom channels and both ends.
5. Headers shall be copper and have vent and drain connections at each end.
6. Testing: Coils shall be proof tested at 300 psig and shall be leak tested at 200 psig (air pressure under water); and be suitable for working pressures and temperatures up to and including 200 psig and 220 degrees F.

C. Air Vents:

1. Provide air vents for all coils.

D. Pressure Taps:

1. Provide pressure taps across each coil that does not have pressure gauges detailed in the Contract Documents. Pressure taps shall be located in the inlet and outlet pipe at each coil and shall consist of a 1/8" MPT inlet x 1/8" MPT outlet tight shut-off needle valve Anderson Brass Company No. VIHI-J. Provide 1/8" cap on outlet of each valve. Valve shall be rated for 500 psig pressure and 250 degrees F. water.

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 coils level and plumb, and in accordance with manufacturer's installation instructions.
B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

C. Mount coils on supports to form banks or stacks as indicated, brace, secure to air intake chamber. Place in location to permit installation of bypass damper if required, provide steel baffles where required to prevent bypassing of air.

D. Pitch coil casings for drainage, not less than 1/8" toward return connections, except where drainage feature is included in coil design.

E. Provide for each bank of cooling coils, stainless steel drain pan under each coil supported off of floor of sufficient height to allow installation of condensate trap to allow drainage of condensate from pan when installed on suction side of fan.

F. Maintain a minimum of 48 inches clear downstream of all integral face and by-pass heating coils in order to minimize the potential for air temperature stratification.

G. Install stainless-steel drain pan under each cooling coil.
   1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1.
   2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
   3. Extend drain pan upstream and downstream from coil face.
   4. Extend drain pan under coil headers and exposed supply piping.

H. Install moisture eliminators for cooling coils. Extend drain pan under moisture eliminator.

I. Straighten bent fins on air coils.

J. 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, shutoff valves, automatic temperature regulating valve, and balance valve 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. Insulate the supply header, return header and all connecting piping, exposed to the air stream, on all steam and hot water coils.

END OF SECTION 238216
CEW
SECTION 260500 - GENERAL REQUIREMENTS, ELECTRICAL WORK

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. Extent of work by this Section is applicable to all subsequent Sections of Division 26, 27 and 28.

B. Provide all labor, material, equipment and services and perform all operations required for the complete electrical installation and all related Work as required by the Contract Documents.

C. The Contract Drawings indicate the general design and extent of the electrical system. The Contract Drawings are schematic and diagrammatic and are not intended to indicate complete construction details and exact wiring routing, unless specifically indicated. The Project Manual (Specifications) establishes minimum performance, product and installation requirements. In addition to the specified and indicated performance and quality requirements, furnish products and perform installation work consistent with the design intent and necessary for the provision of complete operating electrical systems.

D. The following brief description under this heading generally outlines the principal items of work, material and equipment and is not intended to limit the amount of Work. Perform all Work as shown on Drawings and as specified in the Specifications. Items include:

1. Complete support systems and hangers for electrical devices, luminaires and raceways.
2. Perform work in existing panelboards as required, to effect renovation indicated on Drawings.
3. Branch power and lighting circuits.
5. Branch circuit conduit and wiring.
6. Circuit identification and labeling, and identification for electrical systems.
7. Lighting control devices.
8. Conduit and wiring systems for security and access control devices in the area of renovation.
9. Luminaires and lamps.
10. Receptacles, power outlets and plates.
11. Panelboards.
12. Feeder conduit and wiring.
13. Cable support systems and j-hooks.
14. Raceway systems, boxes and fittings.
15. Fire alarm system devices. Modify existing fire alarm system as required, to effect renovation indicated on Drawings.
16. Complete conduit, wiring and connection of Owner furnished equipment as defined in the Drawings and Specifications.
17. Coordination with work of other trades.
18. Control devices and wiring for the electrical interlocking of mechanical and electrical equipment.
19. Connect all line voltage electrically operated devices furnished in place by the Mechanical and Architectural Trades.
20. Complete testing of all systems and equipment.
21. Conduit, conduit fittings, outlet boxes, supports, fuses, circuit breakers, wire, cables, connectors, insulating bushings, solder, tape, etc. required for a complete electrical installation.
22. Work, equipment and materials as shown on the Drawings, mentioned in the Specifications, and as required to make a complete satisfactory job, complete with all code requirements.

1.3 RELATED WORK SPECIFIED IN OTHER DIVISIONS

A. Providing motors, except for electrical connections, unless otherwise specified or shown.
B. Providing starters and integral controls on packaged, self-contained equipment. Make all required branch circuit field wiring connections, unless otherwise specified or shown.
C. Providing certain control devices, such as thermostats, which are connected to mechanical piping or duct work. Make all required field wiring connections, unless otherwise specified or shown.
D. Providing electrical door operators complete with control devices. Provide circuit for door operators if so indicated on the Drawings.
E. Providing and installing controls and control devices for mechanical equipment, such as for heating, ventilation and air conditioning.
F. Painting, except as otherwise specified.

1.4 QUALITY ASSURANCE

A. Codes:

1. Install all materials and equipment in strict accordance with the latest edition of the National Electrical Code, the National Safety Code, the National Fire Protection Association, and all governing national, state, and local codes and authorities. When Contract Documents indicate higher quality materials or method than the minimum required by the regulatory agencies, comply with the required Contract Documents.
B. Materials:

1. Provide all materials in the Electrical Work herein specified unless otherwise specified, and suited to the use intended; listed by the Underwriters Laboratories, Inc., meeting their requirements, and bearing their label whenever standards have been established and label service is regularly furnished by that agency. Provide all materials of the types of makes hereinafter specified, except that substitutions will only be considered in accordance with General Conditions of the Contract. Provide products for which quantities of two or more are to be furnished, from the same manufacturer and of the same product or model series.

2. In all cases where the capacity or rating of the equipment being provided, e.g., motor starters and switches, is based on the rating of equipment, confirm such capacities or ratings with the suppliers before purchase of the equipment.

C. Rules Of Authority Having Jurisdiction:

1. Before submitting a bid, check with each authority having jurisdiction over the Project, and determine from them all standards and other methods of construction which they will require to be incorporated in this installation, and include the cost of the same in the bid. No extra payments will be made for the installation of such items, except in cases where the requirements of the governing codes may change after the bid has been submitted.

1.5 SUBMITTALS

A. Submittal Procedures: Comply with requirements of Division 01, and General Conditions of Contract.

B. Items Required: For specific submittals of Shop Drawings, Product Data, Wiring Diagrams, Riser Diagrams, Manuals, Instructions, Complete Parts Lists and Spare Parts List, refer to appropriate Division 26, 27 and 28 Sections.

1.6 PROJECT RECORD DOCUMENTS

A. Refer to Division 01 and General Conditions of Contract for requirements regarding form and submittal of Project Record Documents.

B. Using the Layout Drawings, keep an accurate record during construction of all concealed conduit and all deviations and/or construction changes in the Electrical Work.

C. The Project Record Documents shall show, but not be limited to, the following information:

1. The location of all equipment, outlets, luminaires, junction boxes, etc., as installed.
2. Conduit runs shown in their relative locations, with size and number of wires within.
3. Complete detailed riser diagrams for power, lighting, fire alarm, voice/data, grounding, security, and any special system.
4. Luminaire schedule including catalog number and manufacturer.
5. Provide separate drawings for lighting, power and all other electrical, fire alarm and security systems. Indicate all conduit locations.
6. Miscellaneous wiring diagrams for all special systems and equipment.

1.7 LAYOUT DRAWINGS

A. Prepare Layout Drawings prior to fabrication and installation of items noted herein. Layout Drawings shall be drawn to scale showing the intended method of installation and construction. Use Contract Drawings and Specifications, which are schematic representations of the Architect’s design intent, as a guide in preparing the Layout Drawings. The Layout Drawings shall not be a repetition or direct copy of the Contract Drawings. The Layout Drawings shall reflect the full intent of the Architect’s Contract Drawings. Type, quantity, and location of equipment shall not be compromised. During preparation of the Layout Drawings, Contractor shall coordinate the Layout Drawings specified in this Section with Layout Drawings of all other trades involved in the Project.

B. Dimension and show electrical equipment locations, elevations, space requirements, mounting details, circuiting and conduit size. Indicate wire size and number of wires for each conduit run. Runs include, but are not limited to: branch circuits, and auxiliary systems. Distinguish between conduit in floor, conduit in ceiling, and exposed conduit. Show elevation and routing of raceways, sizes and rating of electrical equipment, and all other pertinent information for systems as shown on the Drawings and/or specified.

1. Provide separate Layout Drawings for lighting, power, and signal/telecommunications systems.

C. Prepare the Layout Drawings on a reproducible medium. Drawing size shall be uniform for each set prepared. Size of drawing shall match the size of the Contract Drawings.

1. Layout Drawings are not required to be submitted to the Architect.
2. Layout Drawings are not Coordination Drawings as noted in Division 01, “Construction Progress Documentation” and “Submittal Procedures”.

D. Keep a current set of Layout Drawings prints on site and protect from deterioration and loss.

1. Provide the Architect access to the Layout Drawings for reference during normal working hours.
2. Maintain and file in a chronological and numerical order.
3. Post changes and modifications as they occur.
4. Use the final Layout Drawings in preparing “Record Drawings” as called for in Division 01.

1.8 CERTIFICATION

A. Where shown in Sections of Division 26, 27 and 28, provide required certification statements or labels, from the manufacturers and/or installers, attesting that the materials and equipment meet
the Specification requirements. Submit certification, in triplicate, prior to product delivery to the Project site.

B. Certified equipment shall have been regularly manufactured by the manufacturer for a minimum period of two years prior to the date of issuance of the Bidding Documents for the Project.

1.9 RECEIPTS AND MISCELLANEOUS ITEMS

A. Refer to General Conditions of Contract regarding receipts for portable and detachable parts, and operation and maintenance information.

B. Retain until the completion of the Work, all portable and detachable portions of the installation such as tool kits, instruction books, wiring diagrams and service manuals, keys, etc.

C. Transfer all items to the Owner when the work has been approved and accepted, and obtain an itemized receipt.

D. Identify keys, wiring diagrams, instruction books, and service manuals clearly as to which piece of equipment they apply and the equipment location.

E. Return to the Owner, in good condition, all tools and tool kits supplied by manufacturers for installation or adjustment of their equipment. Replace any missing parts; clearly identify special tools supplied for pieces of equipment with that equipment.

F. Attach copies of all receipts obtained for the return or delivery of articles to the request for final adjustment and payments.

1.10 ELECTRICAL CHARACTERISTICS

A. Secondary service for power: 480/277 volts, 3 phase, 4 wire, 60 Hz, solidly grounded neutral except where shown otherwise.

B. Secondary service for lighting: 480/277 volts, 3 phase, 4 wire, 60 Hz, solidly grounded neutral except where shown otherwise.

C. Secondary service for receptacles: 208/120 volts, 3 phase, 4 wire, 60 Hz, solidly grounded neutral.

1.11 EQUIPMENT PHYSICAL SIZING

A. Equipment to be furnished shall fit in the space allocated, with sufficient access space to allow proper operation, service of the equipment and to meet all code requirements. If equipment does not have adequate space for service or meet code required clearances, the Contractor shall replace equipment with units that meet the space allocated.
1.12 PROTECTION AND HANDLING OF EQUIPMENT AND MATERIALS
   A. Protect all materials and equipment after delivery, and before and after installation. Protect against pilferage, dampness and damage from all causes until the work is accepted by the Owner.

1.13 TEMPORARY PLUGS AND COVERINGS
   A. Protect equipment outlets and conduit openings with temporary plugs, caps or burlap.

1.14 MANDATORY SITE VISIT
   A. Carefully examine the spaces to be renovated prior to contract award, ascertain the extent of labor and material needed to finish the space to effect its completion under this project; as no allowance will be made thereafter for failure to make such examination. Examine existing panelboards from which branch circuits supplying the laboratory area to be renovated originate, and all associated raceway systems, wireways and pull boxes.
   B. Examine the site before submitting a Bid in accordance with General Conditions of Contract. Ascertain and check all conditions which may affect the Work, including:
      1. Location of existing building construction and services, existing ground elevations, floor elevations, conditions in existing building where work is to be performed, including utilities, structural and physical clearances, and the like. No allowance will subsequently be made for extra expense due to failure or neglect to make such examination.
   C. Examine all areas where new raceway systems and electrical equipment are required to be installed.
   D. Check existing equipment which must be connected to verify voltage and other items which may affect the Work. Verify that space provided for new equipment is adequate for equipment to be provided under the Contract.

1.15 COOPERATION WITH OTHER TRADES
   A. Prior to proceeding with installation of the Work, check with other trades and the Project Drawings to avoid interference. In case of interference, consult with the Architect or Resident Engineer who will decide which trades may occupy each space.

1.16 PERMITS
   A. Comply with applicable requirements of the Contract Conditions.
1.17 INSPECTIONS

A. Arrange for all necessary inspections by local or state laws, and pay all fees and expenses in connection therewith.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR TEMPORARY USE DURING CONSTRUCTION

A. Receptacles: Duplex, 20A, 120 volt AC, ground fault interrupter type, weatherproof, with test and reset buttons, and pilot light for connection of power tools and equipment.

B. Power Cords: Grounded extension cords; use “hard-service” cords where exposed to abrasion and traffic. Provide waterproof connectors to connect separate lengths of electric cords, if single lengths will not reach areas where construction activities are in progress.

C. Lamps and Luminaires: General service incandescent lamps of wattage required for adequate illumination. Provide guard cages or tempered glass enclosures, where lamps are exposed to breakage. Provide weatherproof exterior luminaires where exposed to moisture.

2.2 ACCESS DOORS

A. Furnish access doors where required, for items requiring service. Where access doors are required, their exact size, appearance, location and method of installation shall be coordinated with Architect.

B. Where items are within easy reach of operator through the access door, door shall be 12 inch (305 mm) x 12 inch (305 mm) minimum size.

C. When operator must pass through opening in order to reach the item, door shall be 24 inch (610 mm) x 24 inch (610 mm) minimum size.

D. For description of access doors, refer to Division 08, “Access Doors and Frames”.

E. Access doors will be installed as part of the work of Division 08, “Access Doors and Frames”.

PART 3 - EXECUTION

3.1 GENERAL

A. Consult Drawings, field layouts of other trades as appropriate and all related shop drawings and install the electrical system complete so that its component parts function together as a workable system with all accessories necessary for its operation.
3.2 EQUIPMENT CONNECTIONS

A. Make connections to equipment, fixtures, etc., in accordance with the wiring diagrams, shop drawings and rough-in measurements furnished by the manufacturers of particular equipment provided. Total number of services required may vary slightly above or below number shown on Drawings, but install such services as part of the project at no additional cost. Any and all additional connections not shown on the Drawings, but called for by the equipment manufacturer wiring diagrams, or required for the successful operation of the particular equipment shall be installed by the contractor as part of the Contract with no additional cost.

B. Make final connections to Owner-furnished equipment requiring hard-wired connections.

3.3 EQUIPMENT BY OWNER AND OTHERS

A. Certain items of equipment will be purchased by the Owner or others but set and installed in place with conduit, wiring and all connections provided as part of the Work of Division 26, 27 and 28. Coordinate equipment locations and verify actual electrical hook-up requirements prior to installation. Notify the General Contractor, Construction Manager and Architect/Engineer of any discrepancies before proceeding with the work.

B. Provide all labor and material required to receive, unload, uncrate, handle, assemble, install and connect the Owner’s or others furnished equipment. Protect the equipment during storage and be responsible for any breakage or pilferage from the time of receipt.

C. Do not store equipment outdoors or in locations where it may be subject to damage from construction or other operations. Protect the equipment at all times against water and dust, and provide heating, if required, to protect the equipment against moisture. Comply with special methods of protection as may be required by the equipment manufacturer as noted in the equipment manufacturer’s literature.

3.4 MOUNTING HEIGHTS

A. Mount outlet boxes and equipment as shown below, unless otherwise indicated on Drawings. Mounting heights shown, in general, are above finished floor to centerline of outlet boxes or equipment unless otherwise noted.

1. Switches: 46 inch (1168 mm).
2. Receptacles - Finished Areas: 18 inch (457 mm).
4. Safety Switches: 48 inch (1219 mm).
5. Motor Starters: 46 inch (1168 mm).
7. Fire Alarm Combination Audible/Visual Notification Appliance: Mount such that the entire lens is not less than 80 inches (2.0 m) and not greater than 96 inches (2.4 m) above the finished floor.
8. Fire Alarm Visual Notification Appliance: Mount such that the entire lens is not less than 80 inches (2.0 m) and not greater than 96 inches (2.4 m) above the finished floor.
9. Panel Cabinets: 6 ft. – 8 inch (2.0 m) to the top, providing bottom of cabinet is not less than 12 inch (305 mm) above floor.

B. Refer to Architectural, Mechanical and Structural Drawings before installing any of the above outlets or equipment for interference, and adjust heights to avoid interferences that would occur. If deviations are required, first receive the approval of the Architect.

3.5 CUTTING AND PATCHING

A. Comply with applicable requirements of Division 01, “Cutting and Patching” for cutting, punching, and drilling of structural members.

B. Engage workmen skilled in the trade involved for all cutting and patching in connection with the Electrical Work. Patch and restore areas to the satisfaction of the Architect, consistent with the conditions of the surfaces prior to the cutting and patching.

C. Any and all required cutting, punching and drilling of structural members shall be coordinated with Architect to starting Work.

3.6 DAMAGE TO ADJACENT WORK

A. Repair damaged surfaces caused as a result of construction operations. Repairs shall be performed by workmen skilled in each trade involved.

3.7 CLEANING

A. Comply with cleaning requirements specified herein, and General Conditions of Contract.

B. Thoroughly brush galvanized surfaces and wipe with clean rags and solvent to remove all dirt, oil and grease.

C. Clean and polish factory finished equipment. Repair any surfaces which have been damaged.

D. Clean and polish luminaires including lens, reflectors and trim.

E. Upon completion, thoroughly clean the entire installation and remove all rubbish.

3.8 EQUIPMENT LOCATIONS

A. Where exact locations and arrangements of equipment are not shown in full detail on the Drawings, obtain such information from the Architect. Remove and relocate equipment to the proper location. Repair or replace damaged materials and equipment and construction due to failure to obtain such information. Repair or replacement of damaged equipment and
construction shall be to the full satisfaction of the Architect. Removal, relocation, replacement, and repairs shall be at no cost to the Owner.

B. Immediately notify Architect in writing of all interferences occurring during the construction period that were unforeseeable in correlation and coordination meetings.

3.9 COORDINATION BETWEEN ELECTRICAL TRADES AND MECHANICAL TRADES WORK

A. In general, “packaged” equipment will be furnished complete with starters and individually fused 120 volt (unless otherwise noted on drawings) AC control power transformers as part of the work of Division 21, 22 and 23. Safety switches for these starters shall be provided in accordance with Code requirements. Coordinate safety switch requirements for packaged equipment with Mechanical trades.

B. Provide all power wiring and final connections to starters, safety switches, motors and packaged mechanical equipment. Verify that electrical wiring is installed in accordance with manufacturer’s submittals. Coordinate installation with Mechanical Trades to ensure that motor rotation is in the direction intended for proper performance.

C. PROVIDE AND CONNECT ALL 120 VOLT AC CONTROL WIRING REQUIRED FOR THE PROPER OPERATION OF THE MECHANICAL SYSTEMS, EXCEPT WHERE SPECIFICALLY SHOWN OTHERWISE ON THE DRAWINGS OR SPECIFIED. REFER TO MECHANICAL DRAWING CONTROL DIAGRAMS AND MECHANICAL EQUIPMENT SHOP DRAWINGS.

D. Connect all thermostats provided under Division 21, 22 and 23.

3.10 COORDINATION BETWEEN ELECTRICAL TRADES AND OTHERS

A. Unless otherwise specified, laboratory casework, laboratory equipment, and other specifically noted equipment will be furnished, assembled and set in place by others. Such equipment will be furnished and installed with switches, receptacles, control devices, etc. that are required for installation. Coordinate all power wiring and final connection requirements.

B. The equipment will be furnished with roughing-in drawings and detailed instructions as required.

C. Provide all power wiring and final connections to packaged equipment. Coordinate motor starter and motor control requirements with equipment manufacturer and/or installer.

D. Connect all movable equipment such as casework, with flexible, liquid-tight conduit. Provide extra length of flexible liquid tight conduit to permit removal of movable equipment for cleaning.

E. Connect all vibrating equipment such as transformers with flexible, liquid-tight conduit.
F. Coordinate all power wiring and final connection requirements with telecommunication, data and/or multimedia suppliers.

3.11 PAINTING

A. Prime coat all racks, sheet metal guards and framework, exposed conduit, miscellaneous iron work, wireways, multi-outlet raceways, plug strips, pull boxes, junction boxes and other exposed electrical items which are to be finish painted. Comply with applicable Sections of Division 09.

B. Finish painting shall comply with applicable Sections of Division 09.

C. Touch up factory finished equipment, such as panelboards, luminaires, and other similar items, which are chipped or defaced due to handling, installation or construction work. Touch up shall provide surface and finish that does not look like a “patched” item, otherwise Architect may require refinishing or replacing the entire piece.

3.12 STRUCTURAL INTERFERENCES

A. Should any structural interferences or location and arrangement of Owner’s equipment prevent the installation of outlets, setting of cabinets, running conduit, etc., at points shown on Drawings, the necessary deviations there from, as determined, must be made without additional cost.

3.13 TEMPORARY LIGHT AND POWER

A. Provide temporary lighting and temporary power distribution as required, for construction operations. Electricity for temporary light and power may originate from temporary wiring extended from existing building power distribution equipment. Temporary electric light and power shall be as specified herein.

B. Temporary Electric Power:

1. Verify with Owner, designated panels, if any, to which connection may be permitted to the existing building power distribution system. Origin of power used for construction shall be coordinated with Owner.

   a. Provide all transformers or other accessories, necessary to convert the above power to characteristics required for operation of power tools, temporary lighting and other requirements under the Contract.

   b. Where power is available and has been coordinated with Owner, it will be provided without charge to the Contractor unless this privilege is abused. Items such as leaving lighting on, unnecessarily, during off-shift hours, overloading of circuits, damage to power panels, wiring, etc., will be considered as abuse, and will lead to cancellation of this arrangement with the Contractor being required to
provide an alternative supply at its own expense. Any damage to the existing power system components shall be repaired at the Contractor’s expense and to the satisfaction of the Owner’s Representative. If existing system has insufficient power for construction operations, or Owner will not permit connection of construction equipment to the existing system, contractor shall provide an alternate supply at its own expense.

C. Temporary Power Distribution:

1. Install wiring where least exposed to damage. Where permitted, wiring circuits not exceeding 125 volts AC, 20 ampere rating, and lighting circuits, may be nonmetallic sheathed cable where overhead and exposed, or hard service extension cords.
2. Provide a minimum of one duplex, 20 ampere, 120 volt AC ground fault receptacle spaced not more than 50 ft. (15.2 m) on center. Provide a minimum of one duplex, ground fault receptacle in any area enclosed by permanent walls.
3. Branch circuit wiring shall be a minimum of #12 AWG (3.31 mm²) with no more than four (4) duplex receptacles installed per circuit. Provide, in each branch circuit, additional conductor to be used throughout as equipment ground.
4. Any party requiring necessary grounded portable cords, lamps and switches from the aforesaid outlets to points of use shall pay for same.
5. Any party requiring service of capacity or characteristics other than the foregoing shall provide and pay for their own service.
6. Electrical service and lighting facilities incidental to the temporary construction of the various trades and of other parties shall be furnished, removed, disposed of and paid for by the parties concerned to suit their individual requirements.

D. Temporary Lighting:

1. Install and operate temporary lighting that will fulfill security and protection requirements, without operating the entire system, and will provide adequate illumination for construction operations and traffic conditions, but not less than:
   a. One 200-watt incandescent lamp per 1000 square feet (93 square meters), uniformly distributed, for general lighting, or equivalent illumination.
   b. Minimum of one 200-watt incandescent lamp in any area enclosed by permanent walls.
   c. One 100-watt incandescent lamp every 50 linear feet (15.2 m) in traffic areas.

3.14 REVISIONS TO ELECTRICAL FACILITIES IN EXISTING STRUCTURE

A. Refer to General Conditions of Contract, regarding modification work and examination of premises.

B. All demolition work shall be sequenced, scheduled and coordinated with the Owner and other trades.
C. Remove or relocate existing electrical equipment and luminaires interfering with new construction and where shown. Remove existing, exposed conduit abandoned as part of the work. Close all unused openings in junction or pull boxes and device boxes with a suitable stainless steel or other approved cover or plug.

D. Existing abandoned electrical equipment, conduit and wiring, J-hooks and low voltage wiring within the construction area shall be removed. Provide firestopping material where conduits, and/or low voltage wiring are removed from penetrations in fire rated walls which remain.

E. The Contractor shall thoroughly investigate all existing electrical services (power feeders, branch circuits, fire alarm wiring, evacuation wiring, control wiring, telecommunication cabling, etc.) transversing in, out or through construction areas prior to removal of services or equipment. The Contractor shall provide permanent or temporary services as required for any electrical service being removed in the construction area but serving area outside the construction area. The Contractor shall relocate any existing electrical services, feeders and equipment which are to remain but interferes with new construction.

F. Remove the “home-run” wire in abandoned branch circuits back to their respective power source (distribution panel, power panel, lighting panel, receptacle panel, motor control device, etc.), and clearly mark circuit positions “SPARE” on the panel directory.

G. The Owner shall be granted the right of first refusal on all equipment to be removed. Any equipment waived by the Owner shall be legally disposed of off-site by the Contractor.

H. Relocate as may be necessary and/or as shown on the drawings all existing electrical equipment, switches, starters, conduit, wire, controls, etc., interfering with the new construction, but not being abandoned as part of the Work.

I. Provide new wiring in existing conduit to provide electrical service to devices to remain and extend new wiring to new devices.

J. Provide new conduit and wiring to replace existing conduit and wiring abandoned or removed as part of the Work where required.

K. Extend the existing conduit system or provide new conduit and wire to provide electrical service to new devices or existing devices where required.

L. Conceal all conduits in existing finished areas in either the ceiling space above or by channeling the existing walls, unless otherwise noted or indicated.

M. The Contractor shall provide supports for the electrical equipment for following existing site conditions where required:

1. Existing conduit and wiring (to remain) which relies on the existing ceiling system or is otherwise improperly supported.
2. Existing low voltage wiring (to remain) which relies on the existing ceiling system or is otherwise improperly supported.
3. Luminaires or other ceiling mounted electrical devices (to remain) which relies on the existing ceiling system or is otherwise improperly supported.

N. Upon completion of the Work, remove all materials, scrap, and debris, relative to the installation and leave the premises in an orderly condition.

3.15 INTERRUPTION OF SERVICE

A. Perform any interruption of service at a time approved in advance by the Owner’s Engineer so as not to interfere with the present building operations. Contractor shall notify the Owner’s Engineer of the electrical systems involved, area affected and duration of outage.

B. Some areas may not be shut down except for temporary and new service tie-ins. Coordinate all shutdowns with the Owner’s Representative. If any service serving any area is severed or disconnected unintentionally, the Contractor shall immediately notify the Owner’s Representative and work continuously until the service is restored. It is the Contractor’s responsibility, prior to bid, to thoroughly investigate all areas affected by work and have a complete understanding of all the systems which are required to keep the area in service.

C. Plan work to minimize duration and quantity of power interruptions.

3.16 FINAL OCCUPANCY INSPECTION

A. Final electrical inspection is required by the local inspection authority. Forward a copy of the final approval to the Fire Marshal Division, local field office as directed by Owner. Coordinate all inspection and approval activities with Owner. Meet jointly with Owner to plan and coordinate inspection and approvals.

3.17 FINAL CLEANING AND ADJUSTMENTS

A. Perform final cleaning of electrical and similar work and leave the equipment in proper adjustment and operating condition.

B. Permanently installed luminaires used for temporary lighting during construction shall be cleaned and relamped at completion of project.

END OF SECTION

BEN
SECTION 260519 - WIRES AND CABLES (600 VOLTS AND LESS)

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. Extent of wires and cables work is indicated by Drawings and by requirements of this Section.
   B. Provide wire and cable systems as required, and all material and equipment, including wire, cable, connectors and lugs, splices, fittings, and wire and cable identification, as indicated or specified.

1.3 RELATED WORK SPECIFIED ELSEWHERE
   A. Comply with applicable requirements of Section 260553, “Identification for Electrical Systems”.

1.4 ABBREVIATIONS AND DEFINITIONS
   C. AWG: American Wire Gauge.
   D. EMT: Electrical Metallic Tubing.
   E. IPCEA: Insulated Power Cable Engineers Association.
   I. PVC: Polyvinyl Chloride.
   J. UL: Underwriters Laboratories.
1.5 QUALITY ASSURANCE

A. UL Compliance: Provide wire, cable and connector products which are UL-listed and labeled.

B. Source Quality Control: Furnish wire and cable on which standard factory tests established by ASTM, ANSI, IPCEA and NEMA have been performed.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver all wire and cable to the site on reels or in coils, plainly marked for complete identification, including the wire or cable size, the number of conductors, type of wire or cable, length, weight, thickness and character of the insulation and the name of the manufacturer. Furnish 600 volt AC wires and cables on coils and reels carrying original date perforated inspection labels of the Underwriters Laboratories showing the number of feet and type of wire contained.

B. Store wire and cable in clean dry space. Protect products from weather, damaging fumes, construction debris and traffic.

C. Handle wire and cable carefully to avoid abrading, puncturing, and tearing wire and cable insulation and sheathing. Ensure that the dielectric resistance integrity of wires/cables is maintained throughout the storage period.

1.7 COORDINATION

A. Coordinate layout and installation of wiring and raceway systems with other installations and trades.

1.8 WARRANTY

A. Manufacturer shall warranty equipment to be free from defects in material and workmanship for one (1) year from date of Owner’s acceptance.

B. Installation contractor shall warranty installation to be free from defects in material and workmanship for one (1) year from date of Owner’s acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Wire and Cable: Subject to compliance with requirements, provide products by one of the following:

1. Aetna Insulated Wire (www.aetnawire.com).
4. General Cable Corporation (www.generalcable.com).
5. Okonite (www.okonite.com).

2.2 WIRE AND CABLE

A. General: Wire and cable shall be per standard specifications established for such material and construction by ASTM, ANSI, IPCEA and NEMA, where applicable. All conductors furnished shall be copper of 98% conductivity, unless otherwise specified. All conductors furnished shall be not less than #12 AWG (3.31 mm$^2$), except control conductors which may be #14 AWG (2.08 mm$^2$). Provide conductor sizes as indicated. Provide solid conductors for sizes #14 AWG (2.08 mm$^2$) and smaller, and stranded conductors for sizes #12 AWG (3.31 mm$^2$) and larger.

B. Wire for Use in Luminaire Wiring Channels: Stranded copper, NEC Type “RHH”, “THHN”, or “XHHW”, rated 90 deg C (194 deg F), 600 volt AC. Fixture shall be approved for through wiring, when utilized as such.

C. Wire for General Interior Work or Exterior Above-Grade Work: Single conductor, annealed copper, rated 600 volt AC as follows:

1. NEC Type “THHN”, rated 90 deg C (194 deg F), dry and damp location.
2. NEC Type “XHHW”, rated 90 deg C (194 deg F), dry and damp location and 75 deg C (167 deg F), wet location.
3. NEC Type “XHHW-2”, rated 90 deg C (194 deg F), dry and wet location.

D. Low Voltage Power and Control Wiring, General Purpose (Class 1, Class 2 and Class 3 Remote-Control, Signaling and Power-Limited Circuits):

1. Low voltage wiring shall be UL listed and labeled for the application in which it will be used, and shall be rated for 30 volt service.
2. Where low voltage wiring is not installed in conduit, it shall be rated for use in plenum spaces.

2.3 CONNECTORS FOR SPlicing COPPER CONDUCTORS

A. Connectors for Straight Splicing Conductors Up To and Including #10 AWG (5.261 mm$^2$): Solderless compression type.

B. Twist-On Connectors for Pigtail Splicing Up to and Including #10 AWG (5.261 mm²): Metal wire spring pressure type connector with thermoplastic insulated cover with positive grip design having a temperature rating of 105 deg C (221 deg F) and a voltage rating of 600 volt AC.

1. 3M “Scotchlok” (www.3m.com).

C. Crimp Connectors for Pigtail Splicing Conductors Up To and Including #10 AWG (5.261 mm²): Solderless type with a metallic insert crimp connector within a plastic insulating cover having a temperature rating of 105 deg C (221 deg F), 600 volt AC.

1. Buchanan #2011S (crimp connector) and #2014 (splice cap insulator) (www.idealindustries.com).
2. Ideal #411 (crimp connector) and #417 (wrap cap insulator) (www.idealindustries.com).

D. Connectors for Straight Splicing Conductors #8 AWG (8.37 mm²) and Larger: Solderless compression 2-way type.

3. ILSCO CT or CTL (www.ilsco.com).

2.4 LUGS FOR TERMINATING COPPER CONDUCTORS

A. Lugs for Terminating Power Conductors Up To and Including #8 AWG (8.37 mm²): Tin plated, solderless type, manufacturer’s standard, unless otherwise specified.

B. Lugs for Terminating Power Conductors #6 AWG (13.30 mm²) and Larger: High conductive wrought copper, tin plated, solderless compression type, one hole, single indent for #6 AWG (13.30 mm²) through #4/0 AWG (107.2 mm²) inclusive, and two hole, long barrel, double indent for larger sizes, unless otherwise specified. Lugs for #4/0 AWG (107.2 mm²) and larger shall be sized for the specific cable size. Multi-range lugs are not acceptable.

1. Burndy Type YA-L (www.burndy.com).
3. ILSCO CN (www.ilsco.com).
4. 3M Company (www.3m.com).

C. Lugs for Terminating Control and Switchboard Wiring: Solderless compression type with tinned ring tongue.
3. 3M Company (www.3m.com).

2.5 TERMINAL BLOCKS

A. Terminal Blocks for Use in Control Wiring of Control Panels and Terminal Cabinets: Molded barrier type rated 30 amperes, 600 volt AC, with washer head binding screws and white marking strip.


2.6 WIRE LABELS

A. Wire labels for identification of conductors, flame resisting, adhesive type.

2. Gardner Bender (www.gardnerbender.com).
4. 3M Company (www.3m.com).

2.7 INSULATING TAPE

A. General Use Tape:

1. 3M Company, Scotch 33 Plus (www.3m.com).

2.8 MISCELLANEOUS

A. Resin Encapsulated Electrical Splicing Kits:

1. 3M Company, Scotchcast Series 82 (www.3m.com).

B. Lubricating Compound: Lubricating compound shall be UL approved and compatible with the cable’s outer jacket.

1. Ideal (www.idealindustries.com).

C. Aluminum Joint Compound:
2. Thomas & Betts No. 21059 (www.tnb.com).

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Install wiring in accordance with NEC or per any other codes that take precedence.
2. Coordinate the specified work with adjacent construction in clearing equipment and inserts by at least 6 inch (152 mm). If the indicated location of any electrical outlet is concealed or covered by adjacent construction, install the outlet to clear the interference and extend conduit and wiring to the location shown on Drawings.
3. Install wiring in raceway systems, as indicated and as specified, except where exposed wiring is indicated or specified. Install wiring only in completed raceway systems and when systems are protected from the weather.
4. Install conductors continuous, without splices, between equipments, where possible. Where splices are required, make up splices in boxes; do not use fittings for same.
5. Install phase and neutral conductors of each branch or feeder circuit in a single conduit except where paralleling circuits are indicated.
6. Run a separate neutral wire for each single phase load. The neutral wire shall not be shared between phases in 3 phase, 4 wire system, and in the case of 120/240 volt AC system, the neutral shall not be shared between the lines.
7. No more than six (6) current carrying conductors shall be installed in a single conduit. For this project, neutrals are considered current carrying conductors.
8. Run an insulated green ground conductor in all conduits containing branch circuit or feeder wiring.
9. Continuously lubricate cables at the pull-in point of conduit systems with an approved compound compatible with conductor insulation or jacket.
10. Install conductors in such a manner that the bending radius of any wire or cable is not less than the minimum recommended by ICEA and/or the manufacturer. Do not exceed manufacturer’s recommended values for maximum pulling tension applied to any wire or cable.
11. Connect all power wiring to equipment, such that phasing shall be A-B-C-N left to right, top to bottom and front to back, where possible, and permanently identify phasing on the structure or housing adjacent to bus. Phase identification A-B-C is equivalent to transformer phase identification X1-X2-X3 and H1-H2-H3.
12. Connect phasing wiring to all 3 phase receptacles to insure the same phase rotation in all receptacles with interchangeable plugs.
13. For accessories that require special tools for installation, use such special tools recommended by the respective manufacturer, and in accordance with the established practice and the recommendation of the manufacturer.
14. Use manufacturer approved pulling compound or lubricant where necessary. Compound used must not deteriorate conductor or insulation. Do not exceed manufacturer’s recommended maximum pulling tensions and sidewall pressure values.
B. Conductor Color Coding:

1. Provide phase specific color coding on three phase feeders and three phase branch circuits as indicated below.

<table>
<thead>
<tr>
<th></th>
<th>480/277 Volt System</th>
<th>208/120 Volt System</th>
<th>240/120 Volt System</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase A</td>
<td>Brown</td>
<td>Black</td>
<td>Black</td>
</tr>
<tr>
<td>Phase B</td>
<td>Orange</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Phase C</td>
<td>Yellow</td>
<td>Blue</td>
<td>Blue</td>
</tr>
<tr>
<td>Neutral</td>
<td>Gray</td>
<td>White</td>
<td>White</td>
</tr>
<tr>
<td>Ground</td>
<td>Green</td>
<td>Green</td>
<td>Green</td>
</tr>
<tr>
<td>Isolated Ground</td>
<td>Green w/ Yellow Strip or Tape</td>
<td>Green w/ Yellow Strip or Tape</td>
<td>Green w/ Yellow Strip or Tape</td>
</tr>
</tbody>
</table>

2. Single phase feeders and branch circuits shall utilize any of the listed colors for the given voltage class for live or neutral conductors respectively. Single phase line-line feeders and branch circuits shall not utilize the same color.

3. Phase specific color coding shall be either factory applied within the wire insulation or applied with tape to the cables at all accessible locations.

C. Conductor Labeling:

1. Provide unique labeling of all branch circuit conductors and associated neutral conductors. (The conductor labeling should not be panel circuit number specific, to allow balancing of panel loads.) Provide conductor labeling in all terminal cabinets, panelboards, distribution, control and load centers, pull boxes and wherever conduit run is broken. Mark the white marking strip of all control terminal blocks with the same identification as the connecting wire in permanent black ink.

2. All conductors shall be tagged at their point of origin, in all junction and pull boxes and at their point of termination.

3. Include a conductor labeling cross reference chart with each panel schedule to cross reference final circuit numbers to unique conductor labeling.

D. AWG to Metric Conversion:

<table>
<thead>
<tr>
<th></th>
<th>AWG</th>
<th>22</th>
<th>20</th>
<th>18</th>
<th>16</th>
<th>14</th>
<th>12</th>
<th>10</th>
<th>8</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>mm²</td>
<td>0.32</td>
<td>0.52</td>
<td>0.82</td>
<td>1.31</td>
<td>2.08</td>
<td>3.31</td>
<td>5.26</td>
<td>8.37</td>
<td>13.20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1/0</td>
<td>2/0</td>
<td>3/0</td>
<td>4/0</td>
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<td></td>
</tr>
<tr>
<td>mm²</td>
<td>21.2</td>
<td>26.7</td>
<td>33.6</td>
<td>42.4</td>
<td>53.5</td>
<td>67.4</td>
<td>85.0</td>
<td>107</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td></td>
<td>250</td>
<td>300</td>
<td>350</td>
<td>400</td>
<td>500</td>
<td>550</td>
<td>600</td>
<td>700</td>
<td>750</td>
<td></td>
</tr>
<tr>
<td>mm²</td>
<td>126</td>
<td>152</td>
<td>177</td>
<td>202</td>
<td>253</td>
<td>278</td>
<td>304</td>
<td>354</td>
<td>380</td>
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<tr>
<td></td>
<td>900</td>
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<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
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<tr>
<td>mm²</td>
<td>456</td>
<td>506</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
</tbody>
</table>
E. Branch Circuits:

1. Connect lighting fixtures as shown on the Drawings. When the circuitry is not indicated on the Drawings, connect not more than 1200 watts of lighting fixtures to any 20 ampere 120 volt AC branch lighting circuit and not more than 3200 watts of lighting to any 20 ampere 277 volt AC branch lighting circuit. Size wire for branch circuit loading in accordance with allowable voltage drops of the NEC.

2. When the circuitry is not indicated on the Drawings, connect general purpose duplex receptacles with not more than six per any 20 ampere circuit, unless otherwise indicated.

3. Connect receptacles or branch circuits used to supply individual pieces of equipment, like electric water coolers, fans, unit heaters, motors, etc. to one circuit as shown on the Drawings or as required.

4. Individually connect 30 ampere and larger receptacles on one circuit, of the voltage and phases as required, to the panel as shown on the Drawings or as required.

5. Do not connect single phase motor loads to a general purpose or special purpose receptacle circuit. Connect all single or three phase motor loads to independent circuits.

6. Do not connect receptacles to a lighting circuit.

7. Where lighting and receptacle circuits are not shown as to what panels they are to be connected to, divide equally to all panels nearest in the area so that all panels will share an equal portion of the load. Connect circuits to each panel so that each panel is balanced insofar as is possible.

8. Install branch circuit wiring for all exit lights, night and emergency light circuits in separate conduits and connect to the emergency lighting panels, as applicable, and where indicated on Drawings.

9. If the single distance from panelboard to first lighting and receptacle outlet or device on a circuit exceeds 50 ft (15.2 m), provide not less than #10 AWG (5.261 mm²).

10. Branch circuit home runs to panelboards and/or control equipment longer than 50 ft (15.2 m) shall not be less than #10 AWG (5.261 mm²) and shall be sized to allow for voltage drop.

11. When conductor sizes are not shown or specified, provide sizes as required by code and in no case less than 125% of the connected load and/or circuit protection devices.

F. Low Voltage Power and Control Wiring, General Purpose (Class 1, Class 2 and Class 3 Remote-Control, Signaling and Power-Limited Circuits):

1. Install wiring concealed wherever possible. Run without conduit in accessible ceiling spaces, and with conduit in non-accessible concealed ceiling spaces and between walls of partitions. Where wiring is installed in masonry partitions or within walls or architectural enclosures, or in an exposed location, use conduit.

2. Install wiring in accordance with the NEC, and per recommendations and written instructions of the manufacturer of the device or load to which the wiring is connected.

3. Low voltage wiring that is installed exposed shall not be routed across ceilings or in contact with ductwork, piping, etc. Do not attach low voltage wiring to work of other trades. Any and all low voltage wiring that is not installed in conduit, wireway or in cable tray shall be held up against the building structure or against permanent support members with the use of approved J-hooks or tie.wraps. Low voltage wiring shall be installed in such a manner that it does not interfere with the access to or operation of equipment or removal of ceiling tiles. Tie.wraps and J-hooks shall be installed in such a
manner as to bundle conductors neatly, allowing run outs of single conductors or groups to drop down to equipment served. Install grommeting where dropping out of trays or into panels or service columns. Install sleeves with bushings where penetrating partitions. Firestop sleeves with approved material. Do not penetrate firewalls if so indicated on Drawings.

4. Conductors for communications circuits installed within environmental air plenums shall be per NEC and other applicable Codes, with cable marked in accordance with the purpose.

5. Provide plenum rated tie-wraps where plastic straps or other supports, etc., are installed in plenum areas.

6. Low voltage wiring shall not be installed in the same conduit or raceway system as containing branch circuit or feeder wiring.

G. Splices and Terminations:

1. Splice and terminate conductors with connectors and lugs as specified for the specific size and type of conductor. Indent all compression type connectors and lugs with tools as recommended by the connector or lug manufacturer.

2. Thoroughly clean wire ends before connectors or lugs are applied.

3. Whenever copper lugs are terminated on aluminum bus, use a Belleville washer and two tin or cadmium plated washers, one in each side in combination with aluminum joint compound on all contacting surfaces. Tighten bolts until Belleville washer is flat.

4. Insulate all bare surfaces of conductors with a minimum of four layers (half lap in two directions) of electrical insulating tape. Tape joints in outlet and junction boxes in such manner and thickness that the insulating value of the joint or splice will be at least equal to the insulating value of the conductor to which it is applied. On larger splices and terminals, build up connection with electrical insulating putty before applying tape, to eliminate both sharp edges and voids.

5. Terminate all armored cables at equipment with an approved type of armored cable terminator and terminate cable ground conductors on equipment ground bus.

6. Twist-on pigtail connectors shall be used in all locations for #10 AWG (5.261 mm²) and smaller not subject to movement and vibration. They shall not be used for connection to rotating equipment. Crimp pigtail connectors shall be used for #10 AWG (5.261 mm²) and smaller for connections to rotating equipment and where wiring is subject to movement and vibration.

7. Provide junction boxes and reduce conductor sizes to accommodate equipment lugs when wire sizing has been increased to compensate for voltage drop or when using wire taps.

8. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer’s published torque values, or where manufacturer does not indicate torque requirements, per UL 486A.
3.2 TESTING

A. Perform continuity and polarity testing as required throughout installation, to ensure proper connection of wiring, outlets, luminaires and wiring devices.
SECTION 260526 - GROUNDING

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 grounding of electrical systems and equipment. Extent of grounding work is indicated by Drawings and by requirements of this Section.

B. Provide grounding systems as required, and all accessories and associated equipment, as indicated or specified. Equipment ground shall provide a permanent and continuous bonding of conductor enclosures, equipment frames, wireways, raceways, conduits, luminaires, wiring devices, and other non-current carrying parts of the system to form a low impedance path to ground.

C. Types of grounding conductors specified:
   1. For General Use Above Grade: Insulated, unless otherwise specified.
   2. In Conduit with Phase Conductors: Insulated.

D. Types of grounding connections specified:
   1. To Non-Permanently Fixed Equipment: Lugs bolted to the equipment.
   2. To Existing Grounding Electrode System: Lugs bolted to the equipment.

1.3 ABBREVIATIONS AND DEFINITIONS

A. AWG: American Wire Gauge.

B. IEEE: Institute of Electrical and Electronic Engineers.


E. UL: Underwriters Laboratories.
1.4 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC requirements as applicable to materials and installation of electrical grounding systems, associated equipment and wiring.

B. UL Compliance: Comply with applicable requirements of UL Standards No. 467 and 869 pertaining to electrical grounding and bonding. Provide grounding products which are UL listed and labeled.

1.5 SUBMITTALS

A. Product Data: None required.

B. Shop Drawings: None required.

C. Samples: None required.

1.6 WARRANTY

A. Manufacturer shall warranty equipment to be free from defects in material and workmanship for one (1) year from date of Owner’s acceptance.

B. Installation contractor shall warranty installation to be free from defects in material and workmanship for one (1) year from date of Owner’s acceptance.

PART 2 - PRODUCTS

2.1 GROUNDING CONDUCTORS

A. Bare Grounding Conductors: Stranded annealed copper of 98% conductivity.

B. Insulated Grounding Conductors: Stranded annealed copper color coded green insulated conductor to match current carrying conductor insulation as specified in Section 260519, “Wire and Cables (600 Volts and Less)”. Refer to Section 260519 for list of acceptable manufacturers.

2.2 GROUNDING CONNECTIONS

A. Grounding Fittings for Bonding a Ground Conductor to its Own Conduit:

1. Burndy Type GG (www.burndy.com).
2. Penn Union Type GPL (www.penn-union.com).
B. Ground Bonding Straps and Jumpers:

1. Flexible, tinned, pure copper braid with unplated, seamless pure copper ferrules formed into rectangular shapes on each end.
   b. ILSCO Type T (www.ilSCO.com).
   c. T&B Blackburn Type FB (www.tnb.com).

C. Other Grounding Connectors and Lugs:

1. Compression type as specified in Section 260519, “Wires and Cables (600 Volts and Less)”.

PART 3 - EXECUTION

3.1 APPLICATION

A. Use only copper conductors.

B. In raceways, use insulated color coded green copper equipment grounding conductors.

C. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.

D. Secondary Neutral and Transformer Enclosure: Interconnect and ground to grounding conductor.

3.2 EQUIPMENT GROUNDING CONDUCTORS

A. Comply with NEC for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NEC are indicated.

B. Install code color green insulated equipment grounding conductors in all raceways containing feeder or circuit wiring. Equipment grounding shall be established by individual grounding conductors routed with the phase conductors in conduit. Conduit is not an acceptable grounding conductor.

3.3 INSTALLATION

A. Grounding Conductors:

1. Extend ground conductors from the ground system to all wiring devices, transformers, disconnect switches, panelboards, and control panel ground buses or ground bars, and to electrical equipment as indicated.
2. Route along shortest and straightest paths possible, unless otherwise indicated on drawings.
3. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
4. Provide protection for ground conductors subject to physical damage or abuse. Where metallic conduit is used for physical protection of a ground conductor, the conductor shall be bonded to the conduit at both ends.
5. Pack openings around ground conductor penetrations of floor slabs or walls with intumescent non-asbestos fireproof material.
6. Ground cables shall be protected with sleeves where the cable extends through an inside concrete surface. Round inserts shall be used where ground cables extending through the surface would be exposed to damage during or after construction.

B. Bonding Straps and Jumpers: Install so vibration by equipment is not transmitted to rigidly mounted equipment. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

C. Equipment Enclosures: The enclosures of all transformers, switches and equipment shall be grounded by a separate grounding conductor to the ground system.

D. Motors rated 480 volt AC and below shall be securely bonded to the ground system by means of a motor feeder ground conductor.

E. Feeder and Branch Circuits: Provide a separate insulated equipment grounding conductor in all feeder and branch circuits. Terminate each end on a grounding lug, bus or bushing.

F. Flexible Metallic Conduit: Where flexible metallic conduit is used for branch circuit or feeder wiring, a ground conductor shall be run in the conduit, with the phase conductors. The ground conductor shall be connected to a locking type grounding bushing at each end of the conduit.

G. Grounding Electrode Conductors: Do not secure or support grounding electrode conductors to conduit or raceway system. Route grounding electrode conductors through conduit where exposed. Provide bushings at ends of conduit. Protect grounding electrode conductors from physical damage.

H. Outlet Boxes: Grounding of receptacle boxes and receptacles, (as well as lighting switch boxes and switches) shall be installed so that continuity of grounding conductor will not be disrupted when receptacles (or switches) are replaced for maintenance.

I. Air Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices. Bond conductor to each unit and to air duct.

J. Separately Derived AC Systems: For separately derived AC systems, such as transformers, provide insulated grounding electrode conductors to connect the grounded conductor of the derived system to the building structural steel or other applicable portions of the building grounding electrode system.
3.4 CONNECTIONS

A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
6. Thoroughly clean all bonding surfaces of non-conducting materials. Tin and sweat contact surfaces while bolting. Do not use solder type connections.

B. Equipment Grounding Conductor Terminations: For #8 AWG (8.367 mm$^2$) and larger, use pressure-type grounding lugs. For #10 AWG (5.261 mm$^2$) and smaller grounding conductors may be terminated with winged pressure-type connectors.

C. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.

D. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A.

E. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

F. Moisture Protection: For insulated grounding conductors connected to grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.5 FIELD QUALITY CONTROL

A. Inspect grounding and bonding system conductors and connections for tightness and proper installation. Inspect ground paths for equipment grounding. Make corrections as required.
B. Check transformers for loose, weak or missing ground connections. Check transformers, power supplies and components of separately derived AC systems to determine if properly grounded. Make corrections as required.

END OF SECTION
BEN
SECTION 260529 - HANGERS AND SUPPORTS 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. Provide all anchors, hangers and strut channel supports for all electrical components and systems as specified.
   B. Support components or systems specified herein are minimum requirements and are to be used as a guide only.

1.3 RELATED WORK SPECIFIED ELSEWHERE
   A. Comply with the applicable requirements of Section 260500, “General Requirement, Electrical Work”.

1.4 ABBREVIATIONS AND DEFINITIONS
   D. UV: Ultraviolet.

1.5 DELIVERY, STORAGE, AND HANDLING
   A. Store components and fittings in original cartons in a clean dry space. Protect products from weather, damaging fumes, dirt, water, construction traffic and debris.
1.6 WARRANTY

A. Manufacturer shall warranty equipment to be free from defects in material and workmanship for one (1) year from date of Owner’s acceptance.

B. Installation contractor shall warranty installation to be free from defects in material and workmanship for one (1) year from date of Owner’s acceptance.

PART 2 - PRODUCTS

2.1 STRUT CHANNEL SUPPORTS AND COMPONENTS

A. General: Strut shall be 1-5/8 inch (41.3 mm) wide in varying heights and welded combinations as required to meet load capacities and designs indicated on the Drawings.

B. Material and Finish: Material and finish specifications for each type are as follows:

1. Aluminum: Strut shall be manufactured of extruded aluminum alloy 6063-T6. All fittings and hardware shall be zinc plated according to ASTM B633. For outdoor use, all fittings and hardware shall be stainless steel Type 316 or chromium zinc, ASTM F1136 Gr3.

2. Epoxy Painted: Strut shall be made from steel meeting the minimum mechanical properties of ASTM A1011 33,000 PSI min. yield, then painted with water born epoxy applied by a cathodic electro-deposition process. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A1018 33,000 PSI min. yield. The fittings shall have the same epoxy finish as the strut. Threaded hardware shall be zinc plated in accordance with ASTM B633 Service Class 1. Service Class 1 in not an acceptable coating for fittings or components other than threaded hardware.

3. Pre-Galvanized Steel: Strut shall be made from steel meeting the minimum mechanical properties of ASTM A653 33,000 PSI min. yield, mill galvanized coating designation G90. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A1018 33,000 PSI min. yield and zinc plated in accordance with ASTM B633 Service Class 3. Threaded hardware shall be zinc plated in accordance with ASTM B633 Service Class 1. Service Class 1 is not an acceptable coating for fittings or components other than threaded hardware.

4. Hot-Dip Galvanized Steel: Strut shall be made from steel meeting the minimum mechanical properties of ASTM A1011 33,000 PSI min. yield and shall be hot-dip galvanized after fabrication in accordance with ASTM A123. Fittings shall be manufactured from steel meeting the minimum requirements of ASTM A1018 33,000 PSI min. yield, and hot-dip galvanized after fabrication in accordance with ASTM A123. All hardware shall be stainless steel Type 316 or chromium zinc ASTM F1136 Gr3. All
hot-dip galvanized after fabrication products must be returned to point of manufacture after coating for inspection and removal of all sharp burrs.

5. Stainless Steel: All struts, fittings and hardware shall be made of AISI Type 316 stainless steel.

6. Manufactures: Subject to compliance with requirements, provide products by one of the following:
   d. Thomas & Betts Corporation, Superstrut (www.tnb.com).
   e. Unistrut (www.unistrut.com).

2.2 WOOD FASTENERS

A. Prefabricated Wood Fasteners: Galvanized steel connectors engineered for specific application.

   1. Manufactures: Subject to compliance with requirements, provide one of the following:
      a. “Simpson Strong-Tie Connectors”.
      b. “Lumberlock”.

PART 3 - EXECUTION

3.1 GENERAL

   A. Locate hangers to avoid interference with all building components including lights, cable tray, conduits, ducts, pipes and equipment.

   B. Coordinate the location of all support devices cast into concrete.

   C. Coordinate the location of all equipment and material being supported with other trades supporting equipment and material in the same space or area.

   D. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

   E. Install support devices to securely and permanently fasten and support electrical components.

   F. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following, unless other fastening methods are indicated:
Construction

1. Wood: Fasten with wood screws or screw-type nails.
2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on wood masonry units.
3. Steel: Welded threaded studs or spring-tension clamps on steel.
   a. Field Welding: Comply with AWS D1.1.
4. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
5. Light Steel: Sheet-metal screws.
6. Fasteners: Select so the load applied to each fastener does not exceed 25% of its proof-test load.

G. Do not support directly from permanent metal forms or floor deck.
H. Do not attach hangers to steel-deck tabs.
I. Fasten hangers to cast-in-place hanger inserts, cast-in anchors that extend through forms into concrete or post-installed concrete anchors.
J. Do not attach hangers to steel roof deck. Attach hangers to structural members only. If spans are greater than 6.5 ft (2.0 m), provide supplemental framing members to support the electrical equipment. Supplemental steel shall span between building structural members.
K. Structural supports for equipment and systems shall be in accordance with manufacturer's printed instructions, and as may be modified by Contract requirements.

3.2 STRUT CHANNEL SUPPORTS AND COMPONENTS

A. Use the following strut channel support system, unless otherwise noted or indicated on the Drawings.
   1. Indoors:
      a. General areas: Epoxy painted.
      b. Damp areas: Pre-Galvanized. Repair any surfaces which have been damaged.
      c. Wet locations: Hot-dip galvanized. Repair any surfaces which have been damaged.
      d. Special areas as noted: Aluminum.

B. Strength of supports shall be adequate to carry present and future loads, times a safety factor of at least four; minimum loading shall be 200 lb (90 kg) design load per anchor point.

C. Select, furnish and install structural supports, rods, braces, inserts and framing for the proper installation of conduit, wireways, raceways, outlets, pull and junction boxes, panelboards,
luminaires, and starting and control equipment, as well as any other equipment provided as part of the work.

D. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.

E. All nuts and bolts shall be tightened to the following values:

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<thead>
<tr>
<th>Bolt Size</th>
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<th>5/16 -18</th>
<th>3/8 - 16</th>
<th>1/2 - 13</th>
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<tr>
<td>Torque (ft-lbs)</td>
<td>6</td>
<td>11</td>
<td>19</td>
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3.3 SUPPLEMENTAL FRAMING

A. Provide supplemental framing for the following conditions:

1. Where the anchor locations do not align with the structural framing.
2. Where the intended loads exceed the structural framing maximum load carrying capacity.

B. Provide supplemental framing or reinforcing straps, within the joist, to transfer the load to a panel point wherever proposed hanger locations do not align with a steel joist panel point.

3.4 WOOD FASTENERS

A. Installation of fasteners shall be in strict accordance with manufacturer’s written instructions.

3.5 ADJUSTING AND CLEANING

A. Hanger Adjustments: Adjust hangers so as to distribute loads equally on attachments.

END OF SECTION

BEN
SECTION 260533 - RACEWAYS AND FITTINGS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Extent of basic materials and methods work is indicated by Drawings and by requirements of this Section.
B. Provide raceway systems as required, and all equipment and material, including conduit, fittings, support systems, boxes and wireways, as indicated or specified. All materials in each raceway system shall be compatible.

1.3 RELATED WORK SPECIFIED ELSEWHERE
A. Comply with applicable requirements of Section 260500, “General Requirements, Electrical Work”.
B. Comply with applicable requirements of Section 260529, “Hangers and Supports for Electrical Systems”.
C. Comply with applicable requirements of Section 260553, “Identification for Electrical Systems”.
D. Comply with applicable requirements of Section 262726, “Wiring Devices”.

1.4 ABBREVIATIONS AND DEFINITIONS
D. EMT: Electrical Metallic Tubing.

G. PVC: Polyvinyl Chloride.

H. UL: Underwriters Laboratories.

1.5 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC requirements applicable to construction and installation of raceway systems.

B. UL Compliance: Comply with provisions of UL Safety Standards pertaining to electrical raceway systems; and provide raceway materials which have been UL listed and labeled.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store in clean dry space which prevents formation of condensation. Use storage space with uniform temperature and adequate air circulation. Protect materials from dirt, fumes, water and physical damage.

1.7 SUBMITTALS

A. Product Data:
   1. None required.

B. Shop Drawings:
   1. None required.

C. Samples:
   1. None required.

1.8 COORDINATION

A. Coordinate layout and installation of conduits, outlet boxes, pull boxes, and wireways with other construction elements and work of other trades to ensure adequate headroom, working clearance, access, and slab thickness.
1.9 WARRANTY

A. Manufacturer shall warranty equipment to be free from defects in material and workmanship for one (1) year from date of Owner’s acceptance.

B. Installation contractor shall warranty installation to be free from defects in material and workmanship for one (1) year from date of Owner’s acceptance.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit, Elbows, and Couplings: Zinc-coated threaded steel per ANSI C80.1 “Specification for Rigid Steel Conduit, Zinc-coated”. Each length of conduit shall be threaded on both ends.

2. Republic Conduit (www.republicconduit.com).

B. Intermediate Metal Conduit, Elbows and Couplings: Hot-Dipped galvanized per ANSI C80.6 “Intermediate Metal Conduit”. Each length of conduit shall be threaded on both ends.

2. Republic Conduit (www.republicconduit.com).

C. Electrical Metallic Tubing: Zinc-coated steel per ANSI C80.3 “Specification for Electrical Tubing, Zinc-coated”.

2. Republic Conduit (www.republicconduit.com).

D. Flexible Steel Conduit: Full wall, zinc-coated steel per UL-1, “Flexible Metal Conduit”.

1. AFC Cable System. “5400 Product Line” (www.afcweb.com).
2. Electri-Flex, “Type BR” (www.electriflex.com).
3. International Metal Hose, “Type HWS” (www.metalhose.com).

E. Liquid-Tight Flexible Steel Conduit: Per UL-360, “Liquid-tight Flexible Steel Conduit, Electrical”.

1. AFC Cable System, “Amer-Tite, 6200 Product Line” (www.afcweb.com).
2. Alflex, “Ultratite, Type UL” (www.southwire.com).
5. International Metal Hose, “Sealskin, Type UALT” (www.metalhose.com).

2.2 CONDUIT FITTINGS

A. Couplings and Connectors for Rigid Steel or Intermediate Metal Conduit: Cast or malleable iron tapered threaded devices. Compression and or split bolt devices are not approved.

1. Appleton (www.egseg.com).

B. Fittings for Rigid Steel or Intermediate Metal Conduit: Cast or malleable iron bodies, cadmium or zinc-plated, with taper threads, and screw attached cover plates. Provide gaskets when located in areas requiring gaskets as specified in Part 3.

1. Appleton Form 35 (www.egseg.com).

C. Expansion Fittings for Rigid Steel or Intermediate Metal Conduit: Cast or malleable iron bodies, with threaded end caps for receiving fixed and movable conduits, metallic pressure packing and copper bonding jumper assembly, and providing for a minimum of 2 inch (50.8 mm) movement of the conduit in either direction.

1. Appleton Type XJ (www.egseg.com).
2. Crouse-Hinds Type XJG (www.crouse-hinds.com).
3. O-Z/Gedney Type AX (www.o-zgedney.com).

D. Couplings and Connectors for EMT: Zinc-plated steel, compression type.

1. Appleton (www.egseg.com).

E. Rigid Steel Conduit Unions, on Continuous Run:

2. O-Z/Gedney Type UNF (www.o-zgedney.com).
F. Fittings for Flexible Steel Conduit: Malleable iron or steel, zinc or cadmium plated, securing the conduit by clamping action around the periphery of the conduit. Do not furnish fittings that anchor the conduit by means of set screws.

1. Appleton (www.egseg.com).

G. Fittings for Liquid-Tight Flexible Steel Conduit: Designed to maintain the liquid-tight feature of the installation. Fittings shall be specifically approved for use with liquid-tight flexible steel conduit.

3. Thomas & Betts 5331 to 5360 (www.tnb.com).

H. Locknuts for Rigid Steel or Intermediate Metal Conduit: Malleable iron or steel, zinc or cadmium plated.

I. Bushings for 1 Inch (27 mm) and Smaller Rigid Steel Conduits, Intermediate Metal Conduits and Electrical Metallic Tubing: Insulating plastic type of non-burnable thermosetting phenolic, conforming to Underwriters’ Laboratories requirements. Do not furnish non-rigid plastic bushings.

J. Bushings for 1-1/4 Inch (35 mm) and Larger Rigid Steel or Intermediate Metal Conduits, and Electrical Metallic Tubing: Malleable iron or steel, zinc or cadmium plated, with insulating insert of thermosetting plastic as specified for smaller conduit bushings, molded and locked into the bushing ring.

K. Partition and Channel Mounting Boxes: Trim line Type.


2.3 OUTLET BOXES

A. Sheet Steel Boxes: Galvanized stock not less than No. 14 gauge, with knockout openings, single or multiple gang, with extensions, adapters, plaster rings, tile covers, fixture studs and cover plates. Provide accessories with same gauge and finish as specified for boxes, except where special finishes are specified for covers and device plates in Section 262726, “Wiring Devices”. Provide sizes per NEC requirements for wiring space, except where minimum sizes are specified.

1. Appleton (www.egseg.com).

B. Cast or Malleable Iron Boxes: Galvanized or cadmium plated, single or multiple gang, with taper threaded hubs, adapters and cover plates. Provide cast metal, galvanized or cadmium-plated accessories, except where special device plates are specified in Section 2627, “Wiring Devices”. Provide gaskets when located in areas requiring gaskets as specified in Part 3. Provide sizes per NEC requirements for wiring space.

1. Appleton (www.egseg.com).

2.4 PULL AND JUNCTION BOXES

A. Boxes Less Than 5 Inch (127 mm) by 5 Inch (127 mm): Conform to paragraph “Outlet Boxes”.

B. Sheet Metal Boxes: Code gauge, full seam welded with bent-in flanges seam welded at corner joints, screw fastened cover of same gauge as box. Fasten cover with brass machine screws. Galvanize box and cover after fabrication. Provide sizes conforming to NEC requirements for wiring space, except where boxes of larger size are indicated. Provide gaskets when located in areas requiring gaskets as specified in Part 3.


2.5 WIREWAYS

A. Steel Wireway: Painted steel enclosure with screw fastened cover, bends, elbows, tees, crosses, adapters and accessories as required, easily assembled into a complete system. Provide sizes as required per NEC requirements for wiring space, except where larger sizes are indicated. Provide gaskets when located in outdoor areas and in other areas requiring gaskets.

5. Wiremold (www.wiremold.com).
2.6 J-HOOKS FOR SUPPORT OF LOW VOLTAGE (CLASS 1, CLASS 2 & CLASS 3 REMOTE – CONTROL, SIGNALING & POWER-LIMITED CIRCUIT) CABLES

A. General: Provide j-hooks for support of low voltage cabling. J-hooks shall comply with NEC and EIA/TIA requirements for structured cabling systems. J-hook bases shall provide proper support of low voltage cabling, eliminating kinks, bends and cable crimping. J-hooks shall accept a wide variety of cable, including, though not limited to Cat. 5, Cat. 6, fiber-optic and inner duct. J-hooks shall be capable of supporting a minimum of 80 pounds with a safety factor of 2, and shall provide sufficient cross-sectional cable containment area per j-hook manufacturer’s recommendations, with a minimum of 50% spare capacity for future cabling.

B. J-hooks for Support of Low Voltage Cabling: UL listed, galvanized steel finish, to provide smooth cable pull and corrosion resistance. J-hooks shall be protected against corrosion by galvanizing or cadmium plating. Fabricate j-hook products with rounded edges and smooth surfaces to reduce friction and cable compaction. J-hook supports and fasteners shall be as recommended by the j-hook manufacturer. J-hooks shall be capable of attachment to a wide variety of structures and shall incorporate mounting holes for attachment to building structure, wall, and/or support rod. Provide all hardware, supports and fasteners for J-hook installation. Select j-hook design, capacity and size consistent with the structure, mounting provisions and anticipated cable capacity for the location where it will be installed.

1. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
   b. Erico (www.erico.com).
   d. Thomas & Betts (www.tnb.com).

2.7 MISCELLANEOUS

A. Conduit Sleeves: Sleeves for penetration of concrete slabs and concrete or CMU walls shall be galvanized or black enameled rigid steel conduit or schedule 40 black steel pipe. All masonry penetrations shall be grouted. Sleeves for penetration of stud walls shall be EMT. Aluminum conduit shall not be used. The space between conduit and sleeves shall be packed with fiberglass or other approved non-combustible packing material to prevent passage of air or liquid, and shall be at least equal in fire resistance to the construction being penetrated.

B. Trapeze Hangers: Hot-dipped, galvanized cast malleable iron straps or structural steel with hot-dipped galvanized nuts and bolts. Perforated straps are not acceptable.

C. Shielding Paint:
   1. Thomas & Betts “KopR-Shield” (www.tnb.com).

D. Sealant:

E. Fire stops and fire rated sealants:
   3. 3M Company Fire Barrier (www.3m.com).

F. Thread Lubricant:

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Use the following raceway system, unless otherwise noted or indicated on the Drawings:

B. Indoors:
   1. Exposed: Electrical metallic tubing, for all dry locations not subject to damage or vibration.
   2. Provide rigid steel conduit up to 6 ft (1.8 m) above finished floor for utility type areas such as:
      1) Mechanical Equipment Room.
      2) Penthouse.
      3) Slab penetrations.
   3. Concealed in walls or above ceilings in dry locations: Electrical metallic tubing.
   5. Damp or Wet Locations: Rigid steel conduit.

3.2 INSTALLATION

A. Conduit - General:
1. Install conduit sizes as indicated. Where conduit sizes are not indicated, install sizes per NEC requirements, except do not use conduit sizes smaller than 3/4 inch (21 mm), unless otherwise specified or where conduit hubs or knockouts on equipment specified are not available in sizes ¾" or larger. Use 1/2 inch (16 mm) fixture stems optionally, unless otherwise indicated.

2. All conduits shall be installed parallel to or at right angle to walls and in an orderly manner.

3. Where conduit joints occur in concrete slabs, damp or wet locations or exposed to weather, make the joints watertight by applying a coating of thread lubricant to the entire conduit thread area before assembling. Use special care to insure that such joints are tight mechanically and that the lubricant application completely seals them against the entrance of moisture. Coat all field cut threads with thread lubricant.

4. For on-site cutting and threading, cut conduit square with a hack saw. Cut threads clean and true using proper size dies for conduit type being threaded. Thoroughly clean and ream all inside edges of the conduit to remove all burrs or sharp edges.

5. Where inside protective coating has been destroyed by the above operations, apply a suitable protective coating.

6. Conceal all conduits in finished areas either above ceilings or walls. Conduit shall not be installed in floors or in slabs on grade, unless otherwise specified or as indicated on the Drawings.

7. Install conduit in mechanical rooms and similar spaces exposed, unless otherwise specified or indicated.

8. Deliver conduit to the project site in not less than 10 ft (3.0 m) lengths with each length of conduit having approved stamp of Underwriters Laboratory and manufacturer’s name and trademark.

9. Mechanically join together metal conduit, fittings, enclosures and raceways for conductors to form a continuous electrical conductor, and to provide effective electrical continuity and firm mechanical assembly.

10. Install raceways, outlet boxes and electrical equipment which penetrates fire-rated or smoke barriers in a manner which maintains the integrity of the rating of the surface or barrier.

11. Do not install conduit across or perpendicular to duct shafts, pipe shafts or vent duct openings.

12. Conduit installed through a building wall shall have internal and external seals.

13. Install conduit a minimum of 12 inch (305 mm) from hot water or steam pipes and 3 inch (76.2 mm) from other mechanical piping.

14. Secure conduit in place by two locknuts and terminate with a bushing for conduit entering sheet metal enclosures and outlet boxes and not terminated in a threaded hub.

15. Clean conduit thoroughly and dry inner surfaces before conductors are installed. Remove and replace conduit found to be plugged or so exceptionally dirty that they cannot be satisfactorily cleaned. Install an approved type of conduit cap or plug on conduit installed for future use or use by other trades. Cap or plug and properly identify with metal tags empty conduit installed for future use.

16. Install pull boxes no more than 100 ft (30.5 m) apart in long conduit runs.

17. Complete installation of electrical raceways before starting installation of conductors within raceways.
18. Prevent foreign matter from entering raceways by using temporary closure protection.
19. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
20. Do not use wire ties to support conduit. Attach conduits to structure. Do not support conduit by a ceiling suspension system.
21. Make bends and offsets so the inside diameter is not effectively reduced.
22. Install no more than the equivalent of three (3) 90 degree bends in any conduit run before providing an appropriately sized pull box.
23. Raceway systems shall be routed from electrical closets, telecommunication rooms or utility rooms, up and across the ceiling space, and down the wall, service drop or partition as applicable to the supplied load, unless otherwise indicated or required by the specific location of the supplied device.
B. Conduit - Raceway Spacing:

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C. Fittings:

1. Use only compression type fittings on EMT conduit. Set screw fittings are not permitted.
2. Cast body fitting are not permitted.
3. Install fittings compatible with conduit and suitable for use and location.
4. Join conduit system with fittings designed and approved for the purpose to make joints tight.

D. Expansion Fittings:

1. Install a conduit expansion fitting in each conduit run wherever it crosses an expansion joint in the structure to which it is attached. In addition, install an expansion fitting in each conduit run which is mechanically attached to separate structures. Install a bonding jumper or ground clamp to connect the conduits.

E. Raceway Sealing Fittings:

1. Install raceway sealing fittings in accordance with the manufacturer’s written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points and elsewhere as indicated:
a. Where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces.
b. Where required by the NEC and all code regulations.

F. Bushings:
   1. Install insulating bushings on conduit ends before the installation of any conductors.
   2. Grounding bushings shall be installed on all flexible conduit at connections to boxes and/or equipment. Grounding bushings shall be installed on all metallic conduit where bare ground wires or cables are run.

G. Flexible Connections:
   1. Use maximum of 6 ft (1.8 m) of flexible conduit for service to individual recessed fixtures, 1/2 inch (16 mm) minimum size, and for final connection to distribution transformers, motors and other equipment subject to vibration or movement. Install the flexible metallic conduit so that liquids will tend to run off the surface instead of draining toward the fitting.

H. Supports:
   1. Do not support conduit from pipes, hangers, ducts, cable tray, or extension of installation of other trades, unless allowed by the engineer due to ceiling space construction and only if confirmed as acceptable by a structural engineer. Piggy-back suspension systems for conduits, fixtures, etc., are prohibited.
   2. Install supports to securely and permanently fasten conduit system.
   3. Do not support 1-1/2 inch (41 mm) and larger conduit runs above suspended ceiling from ceiling members. Support 1-1/2 inch (41 mm) and larger conduit from ceiling support system.
   4. Install individual and multiple hangers and riser clamps to support conduits. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits. Install clevis type hangers for individual conduit not supported on pipe straps.
   5. Support riser conduit at each floor level by approved clamp hangers.
   6. Support parallel runs of horizontal conduits together on trapeze- or bracket-type hangers.
   7. Size supports for multiple conduit installations so capacity can be increased by a 25% minimum in the future.
   8. Support individual horizontal conduits with separate, malleable-iron pipe hangers or clamps. Limit anchors to support of 1-1/2 inch (41 mm) conduit or smaller.
   9. Support exposed conduit and outlet boxes by approved hangers, clamps or clips fastened by machine screws to expansion sleeves, or expansion anchors. Lead anchors are not approved for use. Support conduit on both sides of bends.
  10. Repair fireproofing damaged or removed in the installation of supports.
  11. Fabricate field supports from structural steel or steel channel. Use hex head bolts with spring lock washers under all nuts.

I. Stub-Up Connections:
1. Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable type of coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; flexible steel conduit may be used 6 inch (152 mm) above the equipment pad or floor. Install screwdriver-operated, threaded flush plugs flush with the equipment pad or floor for future equipment connections.

2. Arrange stub-ups so curved portions of bends are not visible above the finished floor.

J. Concealed Conduit:

1. Install concealed conduit and extensions from exposed conduit systems neatly parallel with or at right angles to the walls of the building. Install horizontal runs as high as practicable, coordinated with work of other trades.

2. Install conduit so as not to damage or run through structural members. Install sleeves where conduit runs through structural walls. Refer to Section 260500, “General Requirements, Electrical Work” for Cutting and Patching.

3. Avoid horizontal or cross runs in building type partitions or side walls.

K. Exposed Conduit:

1. Install exposed conduit and extensions from concealed conduit systems neatly parallel with or at right angles to the walls of the building. Install horizontal runs as high as practicable, coordinated with work of other trades.

2. Install exposed conduit work so as not to interfere with ceiling inserts, ceiling lights or ventilation outlets.

L. Sleeves:

1. Install sleeves where individual conduits penetrate masonry or fire-rated walls and all other fire rated floor and wall assemblies. Where conduits are to pass through floor slabs, and conduit slots are not provided, install rigid steel conduit sleeves of size as required for conduit or as indicated, and securely fasten in the concrete forms to avoid damage or movement of the sleeve at any time.

2. Install rigid steel conduit sleeves with bottom of sleeves flush with slab and top 3 inch (76.2 mm) above finished floor.

3. Close and make watertight all open spaces around installed conduit with oakum and approved mastic. Support conduit at each level. Seal unused pipe sleeves. Provide approved mastic for fire stop and/or fire rated wall/floor penetration system at all floor and wall penetrations.

M. Pull Rope:

1. Install monofilament plastic line having a tensile strength of not less than 200 lbs (90 kg) with wooden blocks fastened to both ends in all empty electrical and telephone conduits. Leave at least 12 inch (305 mm) of slack at each end of pull rope.

N. Outlet Boxes:
1. In general, use outlet boxes not less than 4 inch (102 mm) square, at least 2 inch (50.8 mm) deep and of sufficient size to accommodate the wiring devices to be installed at the outlet location. Equip boxes for ceiling and interior bracket-mounted fixtures with fixture stud in the center of the box. Use boxes with mounting lugs or ears for covers, and knockouts for conduit terminations.

2. Use threaded-hub, cast metal outlets on exposed conduit systems or for weatherproof devices suitable for the wiring devices to be installed. Where exposed metal raceway is used, use outlets of sufficient diameter to seat the fixture canopy.

3. Use standard deep type outlet boxes (concrete rings with appropriate covers) in floor slab construction where concealed conduits enter sides of boxes to clear steel reinforcing rods.

4. Use outlet boxes with plaster covers for wiring devices in finished walls where practicable, to bring box openings flush with finished wall or not more than 1/4 inch (6.4 mm) back of same.

5. Where switches or receptacles occur in walls having thick finishes, use proper size extension rings to bring switches or receptacles out flush with finished wall surface.

6. Obtain the exact location of outlets from the Drawings of interior details, finishes and elevations. Do not install boxes back to back. Stagger boxes to minimize sound transmission.

7. Outlet boxes installed on opposite sides of fire-resistance rated walls shall be separated by a horizontal distance of not less than 24 inches, or by a horizontal distance of not less than the depth of the wall cavity where the wall cavity is filled with cellulose loose-fill or mineral fiber installation, or by solid fire blocking.

8. In locating outlets, make allowance for overhead pipes, ducts, variation in arrangement, thickness of finish, window trim, paneling and other constructions. Correct any inaccuracy in locating outlets without additional expense.

9. Obtain a decision from Architect for any condition that would place an outlet box in an unsuitable location, such as at a molding or at a break in wall finish.

10. Mount outlet boxes for similar equipment at uniform heights within the same or similar areas. Mount outlet as specified or indicated.

11. Where mounting height or location of outlets is not shown or specified, locate the outlet as best suited for the equipment connected thereto or as directed.

12. Securely fasten outlet boxes independent of conduit, and plumb and square with the building. Attach exposed outlet boxes to permanent inserts or expansion anchors with machine screws or threaded rods.

13. Close unused openings in outlet boxes with knockout closers manufactured for the purpose.

14. Use ganged boxes, 2-1/2 inch (63.5 mm) deep, for 120 volt AC and 277 volt AC switches at the same location with isolating partition between 120 volt AC and 277 volt AC switches. Provide a single switch plate to accommodate the number of switches required. Provide isolating partition between 277 volt AC switches.

15. Use 4 inch (102 mm) octagon boxes with 3/8 inch (9.5 mm) fixture stud for lighting fixtures. Individually support boxes for heavy fixtures, from the building structures. Attach fixtures to the outlet box or building structure in such a manner as to prevent accidental detachment.
16. For lighting fixtures for suspended ceiling work install 4 inch (102 mm) octagon boxes with removable backplate where required and with two parallel bars for securing to the cross furring channels.

17. Install cast type outlet boxes with tapered threaded hubs and gaskets and covers for exposed switches and receptacles exposed to wet or damp locations.

18. Provide face openings in the box covers for intended device. Use covers that fit the boxes without overlapping edges or corners.

19. For concealed telephone and signaling systems install 4-11/16 inch (119.5 mm) square type outlet boxes with plaster cover and bushed 3/8 inch (9.5 mm) opening coverplate.

20. Fasten conduits to outlet boxes with locknuts inside and out, and bushings.

O. Pull and Junction Boxes:

1. For junction or pull boxes not over 100 cubic inch (1639 cubic centimeter) in size use 4-11/16 inch (119.5 mm) x 4-11/16 inch (119.5 mm) outlet boxes. For junction or pull boxes over 100 cubic inch (1639 cubic centimeter) in size construct same as cabinets with covers of same gauge metal as boxes and secure by screws or bolts. Use galvanized sheet steel boxes with metal thickness not less than No. 14 gauge. Size and install boxes per the latest edition of the NEC. Use junction boxes 4-11/16 inch (119.5 mm) square by 1-1/2 inch (38.1 mm) deep minimum. Install removable covers for access at all times. Fasten boxes to the structure, independent of the conduit support systems.

2. Install pull or junction boxes so that conduit runs do not exceed three (3) 90 degree bends between boxes.

P. Wireways:

1. Install wireways complete with all required covers, hinges, couplings, end closures etc., as required.

Q. Emergency and Fire Alarm System Pull/Junction Boxes and Enclosures:

1. Paint red all pull/junction boxes and enclosures of emergency and fire alarm system and mark “EMERGENCY”, or “FIRE ALARM”, as applicable.

R. Penetrations Through Fire Resistant Floor and Wall Construction:

1. Penetrations of conduit, sleeves, space between conduit and sleeves, cable tray, etc. through fire resistant floor and wall construction shall be sealed with materials of equivalent fire resistance rating, using materials and methods specified in applicable Sections regarding firestopping.

2. In addition to the requirements of Section “Firestopping”, protection shall be provided that shall meet NFPA Life Safety Code 101 “Penetrations” Sections, as applicable for fire barriers, smoke partitions and smoke barriers. Protection shall also be provided in accordance with NEC Article 300 fire stopping regulations and Standards.

3. Individual cables not enclosed in conduit and penetrating plenum air return areas shall be firestopped.
4. Plenum air return ceiling penetrations for conduit and cables shall be sealed with a system appropriate for the substrate and level of protection required.

5. Horizontal penetrations consisting of conduit, sleeves or chases shall be firestopped on both sides of the penetration.

S. J-hooks for Support of Low Voltage (Class 1, Class 2 & Class 3 Remote-Control, Signaling & Power-Limited Circuit) Cables:

1. Install j-hooks according to manufacturer's written instructions. Mount or support j-hooks to building structure or sub-structure. Do not support j-hooks from ductwork, piping or other equipment hangers.

2. Coordinate location and installation of j-hooks with other trades. Coordinate all low voltage pathway runs and associated j-hook installation with other trades prior to j-hook installation.

3. Properly size slots or openings through walls for low voltage cable routing. After j-hooks are installed and cables pulled and fastened in place seal fire barrier walls, smoke barrier walls and wall openings with fireproof materials and methods as specified in Section “Firestopping”.

4. Provide and install supports, hanger rods, fasteners, etc., required for all j-hooks. Install j-hooks where low voltage cabling will be routed at intervals not greater than 4 feet (1.20 m). Support j-hooks with standard fasteners or hanger rods as required. For rod mounting applications, use 3/8 inch (8.5 mm) diameter hanger rods as a minimum.

5. Provide and maintain sufficient space above j-hooks to permit adequate access for installing and maintaining the cables.

6. Construct j-hook fastening so that bolts or fasteners do not form snagging surfaces and permit cables to be pulled in or laid in without catching on bolt heads or fasteners.

7. Provide separate j-hooks to separate cables of different systems and/or cable insulation voltage ratings.

8. Secure cables at j-hooks with cable clamps every 4 feet (1.2 m) on horizontal runs and every 18 inches (457 mm) on vertical runs. For communication & data cables, use nylon cable ties. Cables installed on j-hooks shall be installed using techniques, practices and methods that are consistent with cable manufacturer’s recommendations.

9. Remove burrs and sharp edges from cable surfaces of j-hooks.

10. Where openings at fire and smoke barriers previously sleeved or capped need to be utilized for routing new cabling, provide firestop-sealed penetrations after new cabling is installed. The firestopping shall be a UL-approved fire stop system meeting applicable local building and fire codes.

11. Tighten electrical connectors according to manufacturer’s published torque-tightening values. If such values are not indicated, use those specified in UL 486A and UL 486B.

12. J-hooks installed on this project shall be reserved for mechanical support of telecommunications and data cabling. Cabling installed on j-hooks shall be UL listed and labeled. J-hooks shall not be permitted for routing of general power distribution or control wiring.

13. At locations not otherwise accessible for installing conduit, fire alarm system wiring shall be permitted to be supported via j-hooks where not exposed to damage.

15. Install j-hooks for low voltage cabling and associated cables a minimum distance from the following systems:

a. 12 inches (305 mm) minimum perpendicular distance from 600 volt cables.
b. 24 inches (610 mm) minimum parallel distance from 600 volt cables.
c. 48 inches (1219 mm) minimum from motors or transformers.
d. 6 inches (152 mm) minimum from lighting fixtures.

3.3 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and boxes are without damage or deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or painted finishes with matching touchup coating recommended by manufacturer.

B. Protect floor boxes and boxes installed in concrete floors from damage at all times, including damage from machinery, such as lift trucks.

END OF SECTION
BEN
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. Extent of identification for electrical system work shall be as specified herein and as indicated on Drawings.
B. Provide all items, articles, materials, operations or methods listed, mentioned or scheduled on drawings and/or herein, including all labor, materials, equipment and incidentals necessary and required for their completion.

1.3 ABBREVIATIONS AND DEFINITIONS
B. NEC: National Electrical Code
C. OSHA: Occupational Safety and Health Administration.
D. UL: Underwriters Laboratories.

1.4 QUALITY ASSURANCE
A. Comply with ANSI A13.1.
B. Comply with NEC.
C. Comply with UL 969, Marking and Labeling Systems.
E. Comply with ANSI Z535.4 for safety signs and labels.
1.5 SUBMITTALS
A. Product Data: None required.
B. Shop Drawings: None Required.
C. Samples: None required.

1.6 COORDINATION
A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer’s wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and OSHA 29 CFR 1910.145. Use consistent designations throughout Project.
B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
C. Coordinate installation of identifying devices with location of access panels and doors.
D. Coordinate installing electrical identifying devices and markings prior to installing acoustical ceilings and similar finishes that conceal such items.

1.7 WARRANTY
A. Manufacturer shall warranty equipment to be free from defects in material and workmanship for one (1) year from date of Owner’s acceptance.
B. Installation contractor shall warranty installation to be free from defects in material and workmanship for one (1) year from date of Owner’s acceptance.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION NAMEPLATES
A. General: Provide nameplates of plastic phenolic laminate white surface and black core. Nameplates shall be approximately 2 inch (50.8 mm) x 3 inch (76.2 mm) in size and be engraved with lettering 1/4 inch (6.4 mm) in height.
B. Emergency Systems and Fire Alarm Systems: Provide nameplates of plastic phenolic laminate red surface and white core. Nameplates shall be approximately 2 inch (50.8 mm) x 3 inch (76.2 mm) in size and be engraved with lettering 1/4 inch (6.4 mm) height.
C. Manufacturer: Signs shall be as manufactured by one of the following:

2.2 WIRE LABELS FOR IDENTIFICATION OF CONDUCTORS

A. General: Provide wire labels as specified herein.

B. Manufacturer: Wire labels shall be as manufactured by one of the following:

2. Gardner Bender (www.gardnerbender.com).
4. 3M Company (www.3m.com).

2.3 WARNING LABELS AND SIGNS


B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: “DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES.”

D. Manufacturer: Signs shall be as manufactured by one of the following:


PART 3 - EXECUTION

3.1 EQUIPMENT IDENTIFICATION NAMEPLATES

A. Identify new panels, control points, receptacles, switches, etc., as approved in accordance with the identification markings shown on the Drawings and/or as directed.

B. Identify equipment with suitably sized engraved plastic laminate phenolic tags/labels.
C. Label equipment after the general painting of the building interiors and other general painting is completed.

D. Identify disconnecting switches, by voltage, number of phases, equipment controlled, and the circuit from which they are fed.

E. Identify power receptacles by voltage, number of phases, and circuit from which they are fed.

F. For each component of equipment, unless otherwise specified, securely attach a plate with manufacturer’s name and catalog number on it or stamp or cast into the body of the items the name and catalog number of the equipment.

3.2 HAZARD IDENTIFICATION FOR EQUIPMENT

A. Provide identification for hazards associated with specific equipment by warning signs.

B. When specific equipment or procedures must be used to effectively discharge stored static voltages, provide warning sign indicating this information.

END OF SECTION

BEN
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. Extent of lighting control devices work is indicated by Drawings and by requirements of this Section.
   B. Provide lighting control devices as required, and all materials and equipment, including, but not limited to the following:
      1. Lighting Switches.
      2. Occupancy Sensors.

1.3 RELATED WORK SPECIFIED ELSEWHERE
   A. Comply with applicable requirement of Section 260500, “General Requirement, Electrical Work”.
   B. Comply with applicable requirements of Section 260519, “Wire and Cables (600 Volts and Less)”.  
   C. Comply with applicable requirements of Section 260529, “Hangers and Supports for Electrical Systems”.
   D. Comply with applicable requirements of Section 260553, “Identification for Electrical Systems”.
   E. Comply with applicable requirements of Section 262726, “Wiring Devices”.
   F. Comply with applicable requirements of Section 265100, “Lighting Systems”.

1.4 ABBREVIATIONS AND DEFINITIONS
B. AWG: American Wire Gauge.

C. IEEE: Institute of Electrical and Electronic Engineers.


F. PDT: Passive Dual Technology (infrared and ultrasonic).

G. UL: Underwriters Laboratories.

1.5 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC as applicable to installation and wiring of electrical wiring devices.

B. UL Compliance: Provide products that are UL listed and labeled for their application and installation conditions and for the environments in which installed. Comply with applicable requirements of:

1. UL 20, “General-Use Snap Switches”.

C. NEMA Compliance: Comply with applicable requirements of:

1. NEMA 250, “Enclosures for Electrical Equipment (1000 Volts Maximum)”.
2. NEMA WD 1, “General Color Requirements for Wiring Devices”.
3. NEMA WD 6, “Wiring Devices, Dimensional Requirements”.

1.6 SUBMITTALS

A. Product Data: None required.

B. Shop Drawings: None required.

1.7 WARRANTY

A. Manufacturer shall warranty equipment to be free from defects in material and workmanship for two (2) years from date of Owner’s acceptance.

B. Installation contractor shall warranty installation to be free from defects in material and workmanship for two (2) years from date of Owner’s acceptance.
PART 2 - PRODUCTS

2.1 GENERAL

A. Provide devices in colors and finishes as indicated in Division 09, “Finish and Color Schedule”, or if not indicated, Contractor shall, prior to submitting bid, obtain requirements from the Architect.

2.2 LIGHTING SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following, unless otherwise indicated:

2. Leviton (www.leviton.com).
5. Cooper (www.cooperwiringdevices.com).

B. Switches for Controlling Lighting Directly on AC Systems in General: Toggle operated, composition based, heavy duty, flush, quiet type, with provision for back and side wiring, and rated 20 ampere at 120/277 volt AC with ground screw.

1. Specification Grade, Standard Toggle:

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<td>4901 thru 4904 Series</td>
<td>PS20AC1 thru PS20AC4 Series</td>
<td>AH1221 thru AH1224 Series</td>
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2.3 OCCUPANCY SENSORS

A. General:

1. All sensors shall be of a standard single manufacturer.

2. Verify product application, coverage, placement, quantities, ratings and wiring requirements with manufacturer prior to purchase and installation.
B. Manufacturer: New occupancy sensors and associated relays, power packs, etc., shall be manufactured by Sensor Switch, for compatibility with existing other occupancy sensors and automatic lighting control devices in the building.

C. SensorSwitch (www.sensorswitch.com):

1. Ceiling Mounted Sensor:
   a. Dual technology, auto adapting, integrated photocell, 24 VDC: Cat #DT – Corner – WV16-PDT-P-LM Series
   b. Dual technology, auto adapting, integrated photocell, 24 VDC: Cat# DT – Ceiling – CM-PDT-9-P Series.
   c. Dual technology, auto adapting, integrated photocell, 120/277 VAC: Cat# DT - Corner - WVR-PDT-P Series.
   d. Dual technology, infrared, auto adapting, integrated photocell, 120/277 VAC: Cat# DT - Ceiling - CMR-PDT-P Series.

2. Low Voltage Occupancy Sensor Power Pack:
   a. For 24 VDC sensors, 120/240/277 VAC: Cat # MP-20 Series.

2.4 DEVICE PLATES

A. Comply with applicable requirements of Section 262726, “Wiring Devices”.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install wiring devices and accessories as indicated, in accordance with manufacturer’s written instructions, applicable requirements of NEC and in accordance with recognized industry practices to fulfill project requirements.

B. Install wiring devices vertically, unless otherwise noted.

C. Install wiring devices only in electrical boxes that have been cleaned of excess building materials, dirt and debris.

D. Install wiring devices after all wall preparation, including painting, is complete.

E. Connect devices to branch circuits using pigtails that are not less than 6 inch (152 mm) in length.

F. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
G. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.

H. Install wiring devices with uniform orientation throughout the project.

I. Install wall switches 6 inch (152 mm) from door frame at strike side of doors, unless indicated otherwise on Drawings. Where glass partitions or other architectural features prevent such locations, switches shall be located for maximum accessibility. Install switches in 4-11/16 inch (119.5 mm) square boxes where possible.

J. Install wall switches, other than 3 or 4-way, with the “Off” position down.

K. Use ganged boxes, 2-1/2 inch (88.9 mm) deep, for 120 and 277 volt AC switches. Provide isolating partition between 120 and 277 volt AC switches. Provide isolating partition between 277 volt AC switches.

L. Install plates on flush mounted outlets with all four edges in continuous contact with finished wall surfaces. Do not use plaster or similar fillings. Install plates vertically, unless otherwise noted, with an alignment tolerance of 1/16 inch (1.6 mm).

M. Install and aim sensors in locations to achieve not less than 90% coverage of areas indicated. Do not exceed coverage limits specified in manufacturer’s written instructions.

N. Connect wiring device grounding terminals to branch circuit equipment grounding conductors.

O. Adjust control devices such as timers, to achieve required operation.

P. Install above-ceiling devices, such as occupancy sensor power supplies and junction boxes, etc., to enable convenient accessibility for maintenance and future wiring operations.

Q. In laboratory areas arrange occupancy sensors to turn luminaires ON automatically when the zone or area of coverage is occupied, and turn OFF automatically, after an adjustable time delay when unoccupied.

R. Install occupancy sensors to act as a master “On–Off” switch for the rooms or areas as designated on drawings. With occupancy detected in a room or area, wall mounted switches shall be automatically enabled, to allow multi-level or individual manual switching as indicated. For laboratory rooms designated on drawings as having occupancy sensors, luminaires in the room, shall automatically turn OFF after an adjustable time delay when unoccupied.

S. Perform all installation, adjustment, alignment, masking and final orientation of occupancy sensors as required, to maximize performance and to eliminate false ON and false OFF operation.

T. Mount lighting control devices according to manufacturer’s written instructions. Install wiring between sensing and control devices according to manufacturer’s written instructions.
U. Install individual control devices, such as relays, in enclosures.

V. Coordinate wiring and installation of control devices such as relays, etc., to provide ON & OFF functions indicated on drawings.

W. Adjust control devices to achieve required operation. Verify proper operation of controlled lighting loads by observing automatic operation in both ON & OFF conditions. Observe and make adjustments for controlled lighting loads. Make adjustments as required to provide specified lighting control.

3.2 IDENTIFICATION

A. Comply with applicable requirements of Section 260553, “Identification for Electrical Systems”.

3.3 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Replace lighting control devices that fail tests and inspections.

B. Perform field tests, inspections and prepare test reports for installed wiring devices.

1. After installing wiring devices and after circuitry has been energized, test for proper polarity, ground continuity and compliance with requirements.

2. Use caution when testing devices having solid-state components. Test solid-state components per manufacturer’s written instructions.

3. Perform operational tests. Set and operate devices, such as occupancy sensors, to demonstrate their functions and capabilities in a manner that simulates or reproduces actual operating functions. Correct operational deficiencies, make necessary adjustments and retest.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting occupancy sensors, to suit occupied conditions. Provide as many as two (2) visits to project during other-than-normal occupancy hours for this purpose.

END OF SECTION
BEN
SECTION 262416 - PANELBOARDS

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. Extent of panelboards work is indicated by Drawings and by requirements of this Section.

B. Provide all labor, material, equipment and services and perform all operations required for the complete installation of the panelboards and related Work as required by the Contract Documents.

C. Provide all labor, material, equipment and services and perform all operations for work in existing panelboards and incidental to renovation work indicated on Drawings, such as removal or addition of branch circuit wiring, field verification of existing wiring and circuiting, circuit breakers, fuses, switches, circuit identification and labeling.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Comply with applicable requirements of Section 260500, “General Requirement, Electrical Work”.

B. Comply with applicable requirements of Section 260529, “Hangers and Supports for Electrical Systems”.

C. Comply with applicable requirements of Section 260553, “Identification for Electrical Systems”.

D. Comply with applicable requirements of Section 262813, “Fuses”.

1.4 ABBREVIATIONS AND DEFINITIONS


B. IEEE: Institute of Electrical and Electronic Engineers.

E. RMS: Root Mean Square.
F. UL: Underwriters Laboratories.

1.5 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC as applicable to installation of panelboards, cabinets, and cutout boxes.
B. UL Compliance: Provide products that are UL listed and labeled. Comply with the latest applicable requirements of:
   1. UL 50, “Enclosures for Electrical Equipment”.
   2. UL 67, “Panelboards”.
   3. UL 486A, “Wire Connectors and Soldering Lugs for Use with Copper Conductors”.
   4. UL 489, “Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures”.
   5. UL 943, “Ground-Fault Circuit-Interrupters”.
   6. UL 1053, “Ground-Fault Sensing and Relaying Equipment”.
C. NEMA Compliance: Comply with applicable requirements of:
   1. NEMA 250, “Enclosures for Electrical Equipment (1000 Volts Maximum)”.
   2. NEMA FU 1, “Low Voltage Cartridge Fuses”.
   3. NEMA KS 1, “Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)”.
   4. NEMA PB 1, “Panelboards”.
   5. NEMA PB 1.1, “General Instruction for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less”.
D. IEEE Compliance: Comply with applicable requirements of:

1.6 SUBMITTALS

A. Product Data: None required.
B. Shop Drawings: None required.
1.7 DELIVERY, STORAGE, AND HANDLING
   A. Handle panelboards carefully to avoid damage to internal components, enclosures, and finishes. Store all equipment in clean, dry place with uniform temperature to prevent condensation. Protect all equipment from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.8 COORDINATION
   A. Coordinate layout and installation of equipment with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.9 WARRANTY
   A. Manufacturer shall warranty equipment to be free from defects in material and workmanship for one (1) year from date of Owner’s acceptance.
   B. Installation contractor shall warranty installation to be free from defects in material and workmanship for one (1) year from date of Owner’s acceptance.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS
   A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:

   2. General Electric (www.geelectrical.com).

2.2 LIGHTING AND RECEPTACLE PANELBOARDS - 208Y/120 VOLT
   A. General: Dead-front safety type lighting and receptacle panelboards consisting of 3 phase, 4 wire with solid neutral and ground bus, all fabricated of 98% conductivity copper sized to limit total temperature rise of 55 deg C (131 deg F) over an ambient of 40 deg C (104 deg F) at rated load, with main circuit breaker as indicated, and branch circuit breakers. All circuit breakers used for switching fluorescent lighting shall be approved for such switching duty and shall be labeled “SWD”.
   B. Panelboard Bracing: Equipment bracing shall be fully rated for 3 cycles (minimum) at the specified rating.
C. Ratings of Panel Bus and Main Lugs or Main Circuit Breaker: As indicated on Drawings.

D. Main, Neutral and Ground Lugs: Lugs shall be copper mechanical type.

E. Branch Lugs: Lugs shall be per manufacturer’s standards.

F. Neutral and Ground Bus Bar: Provide bus bars of sufficient capacity and length to terminate all the branch circuit neutral and ground wires.

G. Isolated Ground Bus Bar: If so indicated on the Drawings, provide bus bars of sufficient capacity and length to terminate all the isolated ground wires.

H. Circuit Breakers: Bolt-on molded case type, thermal magnetic, 1, 2 or 3 poles, quick-make, quick-break with common trip for 2 and 3 pole breakers, trip indication and a minimum short circuit interrupting rating of 22,000 symmetrical RMS amperes at 120 volt AC for single pole breakers and at 240 volt AC for 2 and 3 pole breakers, unless otherwise noted on Drawings. No breaker or device in the panelboard shall be rated less than the available short circuit fault current as indicated on the Drawings. Series rated breakers are not acceptable. Main and branch breakers shall be fixed, standard rated (80%), thermal magnetic molded case type, unless otherwise indicated on the Drawings.

I. Cabinets: Flush or surface mounting type as indicated, with minimum 20 inch (508 mm) box, except column width panel. Provide NEMA 1 enclosure, unless otherwise noted. Fabricate cabinets from code gauge sheet steel. Galvanize or phosphatize, prime and finish paint surfaces with manufacturer’s standard ANSI finish, unless otherwise noted. Galvanize recessed boxes. Provide gutter space to accommodate size of cable used in accordance with NEC.

J. Front Trim: Provide one piece screw on trim with hinged door over the branch circuit breaker area and one to two flush type lockable door latches. Key all locks alike.

K. Spares: Provide spare breakers as indicated on Drawings.

L. Spaces: Equip panel with bussing and accessories required to accept future breakers. Provide a removable blank cover plate over the spaces.

M. Directory: Provide card and card holder mounted inside of door to identify the circuits.

N. Nameplate: Provide nameplate as specified in Section 260553, “Identification for Electrical Systems”.

O. Manufacturers:
2.3 EXISTING PANELBOARDS

A. General: Perform work in existing panelboards as required for work indicated on drawings or incidental to the work, such as the addition or removal of branch circuit or feeder wiring. Provide new circuit breakers or fusible switches as applicable, for all new work. New components installed in existing panelboards shall be of the same manufacture and shall have ratings same as existing like components in the associated panelboard. Provide and install new components in existing panelboards as required for branch circuiting and feeder wiring incidental to the construction project.

B. Circuit breakers: New circuit breakers for installation in existing panelboards shall be bolt-on molded case type, thermal magnetic, 1, 2, or 3 pole, quick-make, quick-break with common trip for 2 and 3 pole breakers, trip indication and minimum interrupting rating of not less than that of existing breakers within the same panelboard. Series rated breakers are not acceptable. Piggy-back and “mini” circuit breakers are not acceptable.

C. Directory: For existing panelboards affected by work in this contract, provide new circuit identification directory as applicable, to identify all existing circuits and those which are made spare or are modified. For each circuit, identify the load served and location. Identify all spare circuit positions.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. General: Install panelboards at locations indicated on the Drawings. Align and mount panelboards per “Mounting Heights” requirements of Section 260500, “General Requirement, Electrical Work”. Install handle locking devices for night lighting, emergency lighting, and other designated circuits.

B. Supports: Securely fasten to walls or columns as indicated, with required inserts, anchors, bolts, and brackets. Do not support from connecting conduits.
C. Identification: Identify panelboards per “Equipment Identification Nameplates” requirements of Section 260553, “Identification for Electrical Systems”. Type panelboard directories neatly and indicate circuit numbers and provide a description of associated branch circuits.

D. Nameplates: Securely fasten nameplates with sheet metal screws, stick-on nameplates are not acceptable. For panelboards with hinged door, fasten nameplate to barrier trim behind hinged door.

E. Touch-up Painting: Touch-up paint all equipment finish damaged during construction to bring to “as new” condition.

F. Filler Plates: Install filler plates in unused spaces.

G. Provision for Future Circuits at Flush Panelboards: Stub four (4) 1 inch (27 mm) empty conduits from panelboard into accessible ceiling or space designated to be ceiling space in the future.

H. Wiring in Panelboard Gutters: Arrange conductors into groups, and bundle and wrap with wire ties after completing load balancing.

I. Remove and re-install covers on existing wireways and pull boxes containing branch circuit wiring associated with panelboards supplying laboratory areas, as required, for installation of additional circuiting.

J. The neutral bar of the panelboard shall not be used for termination of equipment ground wires. Terminate equipment ground wires at ground bus only.

K. Overcurrent Protective Devices: Set field adjustable switches and circuit breaker trip ranges.

3.3 CONNECTIONS

A. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer’s published torque-tightening values. Where manufacturer’s torque-values are not indicated, use those specified in UL 486A.

3.4 CLEANING

A. On completion of installation and before panelboards are energized, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt and debris. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surface to match original finish.
3.5 TESTING

A. Contractor shall balance loads on new lighting and receptacle panels, and those having circuiting modified under this project. There shall not be more than 20% difference between phases.
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. Extent of wiring devices work is indicated by Drawings and by requirements of this Section.

B. Provide receptacle and outlet services as required, and all materials and equipment, including, but not limited to the following:

1. Convenience Receptacles.
2. Special Receptacles.
4. Device Plates.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Comply with applicable requirement of Section 260500, “General Requirement, Electrical Work”.

B. Comply with applicable requirements of Section 260519, “Wire and Cables (600 Volts and Less)”.

C. Comply with applicable requirements of Section 260529, “Hangers and Supports for Electrical Systems”.

D. Comply with applicable requirements of Section 260533 “Raceways and Fittings”.

E. Comply with applicable requirements of Section 260553, “Identification for Electrical Systems”.

F. Comply with applicable requirements of Section 260923, “Lighting Control Devices”.

1.4 ABBREVIATIONS AND DEFINITIONS

B. AWG: American Wire Gauge.
C. GFCI: Ground Fault Circuit Interrupter.
D. LED: Light Emitting Diode.
G. OSHA: Occupational Safety and Health Administration.
H. TR: Tamper Resistant.
I. UL: Underwriters Laboratories.

1.5 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC as applicable to installation and wiring of electrical wiring devices.

B. UL Compliance: Provide products that are UL listed and labeled for their application and installation conditions and for the environments in which installed. Comply with applicable requirements of:
   1. UL 498, “Attachment Plugs and Receptacles”.
   2. UL 943, “Ground-Fault Circuit Interrupters”.
   3. UL 1436, “Outlet Circuit Testers and Similar Indicating Devices”.
   4. UL 1863, “Communications-Circuits Accessories”.

C. NEMA Compliance: Comply with applicable requirements of:
   1. NEMA 250, “Enclosures for Electrical Equipment (1000 Volts Maximum)”.
   2. NEMA WD 1, “General Color Requirements for Wiring Devices”.
   3. NEMA WD 6, “Wiring Devices, Dimensional Requirements”.

1.6 SUBMITTALS

A. Product Data: None required.
B. Shop Drawings: None required.
C. Samples: None required.
1.7 COORDINATION

A. Coordinate voice/data outlet device plate requirements with voice/data systems installer(s).

1.8 WARRANTY

A. Manufacturer shall warranty equipment to be free from defects in material and workmanship for one (1) year from date of Owner’s acceptance.

B. Installation contractor shall warranty installation to be free from defects in material and workmanship for one (1) year from date of Owner’s acceptance.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide devices in colors and finishes as indicated in Division 09, “Finish and Color Schedule”, or if not indicated, Contractor shall, prior to submitting bid, obtain requirements from the Architect.

2.2 CONVENIENCE RECEPTACLES

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following, unless otherwise indicated:

2. Leviton (www.leviton.com).
5. Cooper (www.cooperwiringdevices.com).

B. Duplex Convenience Receptacles for 120 Volt AC, Single Phase Service: Straight blade, 2 pole, 3 wire, NEMA configuration 5-20R, rated 20 amperes, 125 volt AC, specification grade, for back and side wiring.

1. Specification Grade - Standard Style:

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<tr>
<td>20A 120V 1PH 3W</td>
<td>5-20R</td>
<td>HBL536 2 Series</td>
<td>5362 Series</td>
<td>BRY5362 Series</td>
<td>5362-A Series</td>
<td>AH5362 Series</td>
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</table>
2.3 SPECIAL RECEPTACLES

A. General: Furnish all special receptacles and/or devices indicated to serve the purpose intended.

B. Ground Fault Circuit Interrupter (GFCI): Duplex, 2 pole, 3 wire, grounding type, rated 20 amperes, 125 volt AC, NEMA configuration 5-20R with 4-6 ma fault current trip. Receptacle shall be UL listed for weather-resistant (WR) and tamper-resistant (TR). Receptacle shall have front mounted “Test” and “Reset” pushbuttons and LED notification of tripped or “end of life” condition.

1. Specification Grade - Decorator Style:

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<tr>
<td>20A 120V 1PH 3W</td>
<td>5-20R</td>
<td>GFTR20W</td>
<td>012-W7899-TRW</td>
<td>GF82WT R Series</td>
<td>2095TRW R Series</td>
<td>TWRVG 20W-SP Series</td>
</tr>
</tbody>
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C. UPS System Receptacle: Yellow duplex receptacle, straight blade, 2 pole, 3 wire, NEMA configuration 5-20R, rated 20 amperes, 125 volt AC, marine grade, for back and side wiring.

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<td>HBL53CM62</td>
<td>53CM-62</td>
<td>BRY5362CR</td>
<td>Not Available</td>
<td>5362CRY</td>
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2.4 MULTI-OUTLET RACEWAY SYSTEMS - TWO COMPARTMENT (FOR LABORATORIES)

A. Multi-outlet raceway system shall be provided at all locations indicated on the Drawings. The multi-outlet raceway system shall be a two compartment system, surface mounted. Raceways shall be an extruded aluminum alloy with a minimum wall thickness meeting UL requirements of 0.078 inch (2.0 mm). Finish of raceway shall be clear anodized with a minimum anodize finish of 0.004 inch (4 mil) thick. The fittings shall have a satin anodized finish to match the raceway. Raceway shall be approximately 2-1/4 inch (57.2 mm) deep by 6 inch (152 mm) high and shall contain an extruded barrier dividing the height into two equal compartments. Raceway shall be UL listed specifically as a Multi-outlet Assembly.

B. Multi-outlet system shall consist of a factory assembled product including body, covers, end caps, couplers for joining sections of raceway, elbows, grounding adapters, device cover plates, fittings, receptacles, wires, wire retainers and pre-manufactured outlet openings for the telephone/communication outlets. Manufacturer shall cut each length of raceway to the exact field measurements. Where field cutting of raceway is required, it shall be performed in accordance with manufacturer’s written instructions. Raceway shall be set in place plumb, square, level and in alignment with walls, casework or furniture as required. Secure raceway to structural surface in accordance with manufacturers’ directions and as shown on the Drawings. Provide wall box connectors where required, for connecting from flushed-in wall boxes.

C. Each multi-outlet assembly shall contain the quantity and type of receptacles as specified and as indicated and spaced apart as shown on the plans. Receptacles shall be installed in a 12 inch (305 mm) extruded cover to match the blank cover of the raceway. Under normal usage, the cover of the raceway is securely held in place by extruded protrusions. All cover plates are to be removable by use of a standard screwdriver without marring the extrusion finish. Cover sections containing receptacles shall have devices factory installed so that cover plate and receptacle are removable as a single integral unit. All receptacle circuits shall be factory pre-wired with stranded THHN wire for the entire length of each section, leaving a 12 inch (305 mm) pigtail for field connection at the designated entry point of the raceway. Provide a separate neutral wire for each single phase load. The neutral shall not be shared between phases in 3 phase, 4 wire system. Wiring shall be color coded per Section 260519, “Wire and Cables (600 Volt and Less)”. Provide each receptacle circuit with a factory installed code sized green grounding conductor. Provide factory installed wire retainers for every 36 inch (914 mm) of raceway.

D. Multi-outlet raceway shall include pre-manufactured outlet opening with threaded screw holes for field installation of telephone/communication outlets at locations shown on the Drawings. The portion of the raceway designated or allocated for voice and data cabling shall have a removable cover plate, (for covering a 12” section of raceway), directly above each power receptacle position indicated on Drawings. The cover plate shall be blank, except where a voice/data outlet is shown. Where voice/data outlets are shown at multi-outlet raceways, provide specified voice/data outlet device plates. Provide factory installed wire retainer for every 36 inch (914 mm) of raceway for field installed telephone/communication cable.

2.5 DEVICE PLATES

A. General: Gang together all switches located in one location and cover with one custom made wall plate. Select the correct combination device plate and type for the opening. Plates shall mate to the type of wiring device to which they attach.

B. Color of Device Plates:

1. In offices and other finished areas provide smooth stainless steel No.302 finish, unless otherwise indicated. Stainless steel device plates shall be nominally 0.032 inch (0.81 mm) thick.
2. In laboratory areas provide same as paragraph above.
3. In mechanical rooms, utility and similar areas provide zinc or cadmium plated steel, unless otherwise indicated.
4. For devices in surface mounted raceway, provide manufacturer’s standard device plates, color as indicated in Division 09, “Finish and Color Schedule”, unless otherwise indicated.
5. For color of other device plates refer to Division 09, “Finish and Color Schedule”.

C. Screws: Provide screws having a finish matching the plate.
D. Manufacturer: Provide device plate of the same manufacturer as the switch and receptacle.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install wiring devices and accessories as indicated, in accordance with manufacturer’s written instructions, applicable requirements of NEC and in accordance with recognized industry practices to fulfill project requirements.
B. Install wiring devices vertically, unless otherwise noted.
C. Install wiring devices only in electrical boxes that have been cleaned of excess building materials, dirt and debris.
D. Install wiring devices after all wall preparation, including painting, is complete.
E. Connect devices to branch circuits using pigtails that are not less than 6 inch (152 mm) in length.
F. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
G. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
H. Install ground pin of vertically mounted receptacles up and on horizontally mounted receptacles to the left (neutral blade at top).
I. Install wiring devices with uniform orientation throughout the project.
J. Connect wiring device grounding terminals to branch circuit equipment grounding conductors.
K. Provide ground fault type interrupting receptacles at each location indicated on drawings. Do not use GFI outlets to protect downstream outlets. Provide a separate GFI receptacle for every receptacle or location identified or noted on plans as “GFI”. Do not install GFI circuit breakers in lieu of providing GFI receptacles at every location indicated on plans.
L. Mount wiring devices level, plumb and square with ceilings and walls. Align multiple devices designated on plans with the same elevation.

M. Install above-ceiling devices to enable convenient accessibility for maintenance and future wiring operations.

N. Install individual wiring devices in outlet boxes.

O. All multi-outlet raceway systems shall be electrically continuous and bonded in accordance with the NEC for proper grounding.

P. In laboratory areas, provide two compartment, multi-outlet raceway systems where indicated on Drawings.

Q. Multi-outlet raceway systems shall be installed complete, and in accordance with manufacturer’s installation instructions. Install all multi-outlet raceway systems mechanically continuous and connected to all electrical outlets, boxes, cabinets in accordance with manufacturer’s installation sheets.

R. Perform field drilling and/or cutting of multi-outlet raceway as required, to accommodate conduits, wall boxes or entrances to service drops, as applicable, and in accordance with manufacturer's written instructions.

S. Fasten all multi-outlet raceways, plug-in strips and appropriate fittings and device plates for a complete installation.

T. All receptacles connected to emergency circuits shall be “RED”.

U. All receptacles connected to UPS circuits shall be “Yellow”.

V. Install multi-outlet raceway systems as indicated on the Drawings. If not indicated, install multi-outlet raceway systems above counters 1 inch (25.4 mm) above backsplash and strips above baseboard flush with top of baseboard.

W. Install plates on flush mounted outlets with all four edges in continuous contact with finished wall surfaces. Do not use plaster or similar fillings. Install plates with an alignment tolerance of 1/16 inch (1.6 mm).

3.2 IDENTIFICATION

A. Comply with applicable requirements of Section 260553, “Identification for Electrical Systems”.

B. Provide circuit labeling at all device coverplates indicating the source panelboard and circuit number. In addition, provide updated type written panel directories at all utilized panelboard which indicates the room number(s) and load description(s). Coverplate labels shall be made
using a Brady #TLS2200 (handheld labeling system) with #PLT-45-430 (labels) using Size 7 Font and #LAM-3-103 (clear polyester) applied over the top of the label (www.bradyid.com). Room numbers used shall be derived from the Wayne State University room numbering system, and do not necessarily correspond to the general room numbers shown on the plan drawings.

3.3 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer’s published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing wiring devices and after electrical circuitry has been energized, test for proper polarity, ground continuity, and compliance with requirements.
2. Test GFCI operation with both local and remote fault simulations according to manufacturer’s written instructions.
3. Use caution when testing devices having solid-state components. Test devices having solid-state components per manufacturer’s written instructions.

B. Examine control components and wiring devices for defects and damage. Remove malfunctioning units, replace with new units, and re-test as specified above.

END OF SECTION
BEN
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. Cartridge fuses rated 600 volt AC and less for use in disconnect switches, enclosed
         switches, panelboards, enclosed controllers and motor control equipment.

1.3 ABBREVIATIONS AND DEFINITIONS

1.4 SUBMITTALS
   A. Product Data:
      1. None Required.

1.5 QUALITY ASSURANCE
   A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single
      source from single manufacturer.
   B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NEC, by a
      qualified testing agency, and marked for intended location and application.
   C. Comply with NEMA FU 1 for cartridge fuses.
   D. Comply with NEC.
1.6 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer’s ambient temperature adjustment factors to fuse ratings.

1.7 COORDINATION

A. Coordinate fuse ratings based on manufacturer’s coordination charts utilizing the equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.8 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1.  Provide one spare set of three of each size and type of fuses.

1.9 WARRANTY

A. Manufacturer shall warranty equipment to be free from defects in material and workmanship for one (1) year from date of Owner’s acceptance.

B. Installation contractor shall warranty installation to be free from defects in material and workmanship for one (1) year from date of Owner’s acceptance.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

2. Ferraz Shawmut, Inc (www.ferrazshawmut.com).

2.2 FUSES (600V OR LESS)

A. Fuses and Fuse Holders in General: Fuses shall be non-renewable 200,000 ampere interrupting rating, dual element type, current-limiting fuses. Equip the fuse holder with Class R rejection type fuse clips.
B. Fuses for Power Feeders and/or Branch Circuits Rated 600 Ampere or Lower: UL Class RK1, dual element, time delay, current-limiting type with replacement fuse indicator (where available) and 200,000 ampere interrupting rating.

1. Bussmann Low-Peak LPN-RK_SP (250V) and LPS-RK_SP (600V) ([www.bussmann.com](http://www.bussmann.com)).
2. Ferraz Shawmut A2D-R and A6D-R ([www.ferrazshawmut.com](http://www.ferrazshawmut.com)).

C. Fuses for Motors: UL Class RK1, dual element, time-delay, current limiting with replacement fuse indicator (where available) and 200,000 ampere interrupting rating.

1. Bussmann Low-Peak LPN-RK_SP (250V) and LPS-RK_SP (600V) ([www.bussmann.com](http://www.bussmann.com)).
2. Bussmann Low-Peak LPJ (only where so noted) ([www.bussmann.com](http://www.bussmann.com)).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of correct sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so replacement fuse indicator and rating information is readable without removing fuse.

B. All fuses shall be of the same manufacturer, including spares.
3.3 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553, “Identification for Electrical Systems” and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block and holder.

END OF SECTION
BEN
SECTION 265100 - LIGHTING 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. Extent of lighting systems and accessories work is indicated by Drawings and by requirements of this Section.

B. Provide lighting systems as required, and all materials and equipment, including luminaires, lamps, ballasts, accessories and associated systems and equipment, as indicated or specified.

C. All luminaires shall be purchased through local distribution houses and have local manufacturer representatives support.

1.3 RELATED WORK SPECIFIED ELSEWHERE

A. Comply with applicable requirements of Section 260553, “Identification for Electrical Systems”.

B. Comply with applicable requirements of Section 260923, “Lighting Control Devices”.

1.4 DEFINITIONS AND ABBREVIATIONS


B. AWG: American Wire Gauge.

C. CRI: Color Rendering Index.

D. EMI: ElectroMagnetic Interference.

E. FC: Footcandle.

F. IES: Illuminating Engineering Society.

1.5 QUALITY ASSURANCE

A. NEC Compliance: Furnish luminaires and other equipment, including all modifications thereto and component electrical parts, listed by Underwriters Laboratories as meeting NEC requirements and bearing the UL Label where such service is available for equipment specified.

B. Listing and Labeling: Provide luminaires that are listed and labeled for their indicated use on the project.

C. Comply with the requirements of NFPA 101.


E. Manufacturer Support: All luminaires shall be purchased through local distribution houses and have local manufacturer’s representatives support.

F. NEMA Compliance: Construction of luminaires shall be in accordance with applicable NEMA Standards.

G. Luminaires shall be completely factory wired by the luminaire manufacturer. The finish of each installed luminaire shall be uniform in quality and free from defects such as scratches, whirls, discoloration, cracks, chips and paint runs.

H. Special Listing and Labeling: Provide luminaires for use in damp or wet locations, and recessed in combustible construction specifically listed and labeled for such use.

I. Each luminaire installed on branch circuits with voltages exceeding 150 volts-to-ground shall be provided with a disconnecting means integral with the luminaire that simultaneously opens all circuit conductors between the branch circuit conductors and the conductors supplying the ballast(s); and marked in a conspicuous, legible and permanent manner adjacent to the disconnecting means, identifying the specific purpose.

J. Provide manufacturer labeling for maximum lamp wattage per luminaire schedule.
K. Comply with the requirements of the Michigan Department of State Police, Fire Marshal Division, pertaining to plastic lenses for luminaires.

1.6 SUBMITTALS
A. Product Data: Not required.
B. Submittals: Not required.

1.7 PRODUCT SUBSTITUTION
A. NO substitutions of luminaires will be allowed during the bidding process. Bids shall be based on project documents. Any substitutions will be evaluated after award of bids as a value engineering and/or voluntary alternate.

B. It shall be the responsibility of the Electrical Contractor to provide new point by point Lighting Footcandle Calculations and Lighting/Power Density Calculations where the luminaire(s) have been substituted for those listed in the Luminaire Schedule. These calculations shall be provided for all areas (not typical areas) affected by the product substitution.

C. Point by point Lighting Footcandle Calculations’ input parameters (mounting heights, work plane, reflectance, light lumen depreciation, etc.) shall be the same as those of the Architect/Engineers’. Request in writing from the Architect/Engineer the lighting design parameters for areas affected by the product substitution. Request for lighting design parameters shall list specific areas (as different areas have different design parameters).

D. Point by point Lighting Footcandle Calculations shall be submitted in calculation format and scaled plot format. Calculations shall clearly indicate design parameters used for the calculations for product substitution evaluation.

E. Separate point by point Lighting Footcandle Calculations shall be provided for both general illumination calculations and egress lighting calculations for affected product substitution.

F. These calculations and luminaire cut sheets along with cost impact (adds or deducts) for each substitution shall be submitted to the Architect/Engineer for review and approval prior to shop drawing submittals.

G. If any substitution of luminaires are made and approved by the Engineer, it will be the responsibility of the Electrical Contractor to provide new Energy Calculations with a Professional Engineer’s seal for re-submittal to the appropriate authority.

1.8 PROJECT RECORD DOCUMENTS
A. Drawings:
1. Per ASHRAE 90.1-2010: Provide record drawings of the actual installation to the Owner or Owner’s Representative. Drawings shall include, as a minimum, the location, luminaire identifier, control, and circuiting for each piece of lighting equipment.

B. Manuals:

1. Per ASHRAE 90.1-2010: Provide for all lighting equipment and lighting controls, an operating and maintenance manual to the Owner or Owner’s Representative within 90 days after the date of system acceptance. These manuals shall include, at a minimum, the following:
   a. Submittal data indicating all selected options for each piece of lighting equipment and lighting controls.
   b. Operation and maintenance manuals for each piece of lighting equipment and lighting controls with routine maintenance clearly identified including, as a minimum, a recommended relamping program and a schedule for inspecting and recalibrating all lighting controls.
   c. A complete narrative of how the lighting control within the lab is intended to operate including recommended settings.

1.9 COORDINATION

A. Coordinate layout and installation of luminaires with other construction elements to ensure adequate headroom, working clearance, and access.

B. Coordination of Luminaires with Ceiling: Coordinate luminaire mounting hardware and trim with the various ceiling systems and areas where the luminaires are being installed. Contractor shall coordinate and verify that the luminaires are compatible with the ceiling system where the luminaire is being installed. No extras will be allowed for not coordinating with other trades.

1.10 DELIVERY, STORAGE AND HANDLING

A. Handle all luminaires, standards and brackets carefully to prevent breakage, denting and scoring finish.

B. Deliver luminaires and fittings wrapped in factory-fabricated fiberboard type containers.

C. Replace broken lenses, lamps and damaged luminaires.

D. Store luminaires and fittings in original cartons in a clean dry space. Protect products from weather, damaging fumes, dirt, water, construction traffic and debris.
1.11 WARRANTY

A. Manufacturer shall warranty equipment to be free from defects in material and workmanship for one (1) year from date of Owner’s acceptance, unless otherwise noted.

B. Installation contractor shall warranty installation to be free from defects in material and workmanship for one (1) year from date of Owner’s acceptance.

PART 2 - PRODUCTS

2.1 BALLASTS

A. Ballasts – General: Ballasts shall be factory installed in luminaires by the luminaire manufacturer. Ballasts shall have a two year warranty, commencing upon the date of final acceptance. The warranty shall provide for all labor and material necessary to restore accepted operation. Warranty shall include replacement of ballasts that produce noise levels in excess of the levels specified herein.

B. Electronic ballasts shall be integrated circuit type and shall be operationally compatible with the specified lamp. Ballast cases shall be properly grounded. Ballasts shall meet the requirements of FCC Rules and Regulations, Part 18, Class A pertaining to suppression of radio frequency interference and electromagnetic interference. Ballasts shall comply with requirements of IEEE 587 Category A for surge or transient voltage protection.

C. Fluorescent Ballasts:

1. Fluorescent Electronic Program Start: Energy saving, high power factor, non-PCB Class “P” approved ballast. Individually fuse with Bussmann Type GMF (slow blow) fuses in HLR holders (www.bussmann.com). Except in recessed luminaires, fuses shall be accessible from outside of luminaire chassis. Use fuse rating as recommended by luminaire manufacturer. Furnish commercial and recessed type luminaires with ballasts having a NEMA sound rating of “A” minimum. All ballasts shall match the lamps specified. Ballasts shall have the following characteristics:
   a. Power Factor: 97% minimum.
   b. Ballast Factor: 0.85 to 1.00.
   c. Total Harmonic Distortion: Less than 10%.
   d. Crest Factor: 1.7 maximum.
   e. Temperature Rise: 30 deg C (54 deg F) maximum over 40 deg C (104 deg F) ambient.
   f. “End of Lamp Life” circuitry.
   g. Ballast shall have the capability to restart replacement lamps without resetting power.
   h. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
      1) Advance “Centium” for T5 lamps; (www.advancetransformer.com).
3) Sylvania “Quicktronic Prostart” (www.sylvania.com).
4) ULT Universal Lighting Technologies “Triad” (www.universalballast.com).

2.2 FLUORESCENT LAMP SOCKETS

A. Lamp Sockets: All linear fluorescent luminaires shall be provided with “positive rotating locking” type sockets. These sockets shall provide an audible “click” to ensure that lamp is engaged. Manufactured from injection molded thermoplastic material, high temperature resistance, environmentally friendly thermoplastic, one-piece housing.

2.3 LAMPS

A. Lamps - General: Provide lamps in all luminaries as specified herein and as specified in the Luminaire Schedule. Dimensional and electrical characteristics of lamps shall, as a minimum, be in accordance with ANSI Standards. Lamp performance shall be rated in accordance with the applicable IESNA recommended procedures. Lamps which within 90 days after the final acceptance, fail to properly operate in accordance with the manufacturer’s published data shall be replaced immediately after the failure at no cost to the Owner.

B. Fluorescent Lamps:

1. General: Fluorescent lamps shall comply with US Environmental Protection Agency’s Toxicity Characteristic Leaching Procedure (TCLP) test.
   a. Manufacturers: Subject to compliance with requirements, provide products of one of the following:

2. Fluorescent T-5: Programmed start, nominal 46 inch long, 28 watt, miniature bipin lamp, minimum 2600 initial lumens at 25 deg. C (77 deg. F), and 2900 initial lumens at 35 deg. C (95 deg. F) 4100K color temperature, 85 CRI (minimum), unless otherwise noted or specified in the Luminaire Schedule. Fluorescent T-5 lamps shall have a rated life of not less than 20,000 hours at 3 hours per start, and 12 hours per start.
   a. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
      2) Sylvania FP28/841/ECO (www.sylvania.com).

2.4 LENSES

A. General:
1. Prismatic lenses shall be extruded of 100% virgin acrylic.

B. Minimum Thickness:

1. Prismatic lenses shall be a minimum thickness of 0.156 inch (3.4 mm). The lens shall have a minimum thickness of 0.076 inch (1.93 mm) from the valley of the prism to the smooth side of the lens. Prismatic lenses shall have a minimum transmissivity of 83.1%.

2. Overlays shall be a minimum thickness of 0.040 inch (1.02 mm) minimum.

2.5 GRID CLIPS

A. All “lay-in” grid luminaires shall have earthquake clips installed. Install a minimum of two at opposite corners of the luminaire.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Coordinate luminaire installation with the relevant trades, to eliminate interferences with hangers, ducts, sprinklers, pipes, steel, etc.

2. All lighting systems, luminaires and associated equipment shall be grounded by an approved insulated equipment ground wire.

3. Install lamps in each luminaire.

B. Supports:

1. Provide supports, rods and hangers for all luminaires as specified or as otherwise required by the luminaire specified. Support single units from luminaire studs in outlet boxes. For continuous row fluorescent type, provide a support for each end plus at least one for each channel section, or as required. Swivel mount all stems. Provide concrete expansion anchors at points of luminaire support in unfinished areas where a concrete slab serves as the ceiling. In finished areas, provide supports independent of the acoustic tile, plaster or ceiling suspension members. Support luminaires from the concrete floor or steel above the ceiling.

2. All “lay-in” grid lighting luminaires shall have earthquake clips installed and shall be supported independently of the ceiling grid system using a minimum of two (2) safety wires on diagonally opposite corners of the luminaire. Safety wire shall withstand a 3-foot, 50 pound drop test. All fluorescent luminaires surface mounted to the suspended grid ceiling shall also be supported independently of the grid. Generic Caddy clips shall not be used. Clip shall be provided by the luminaire manufacturer for the specific luminaire being installed.
3. Provide supports for recessed luminaires as recommended by the luminaire manufacturer or as specified. Furnish plaster frames for all recessed luminaires mounted in plaster ceilings. Coordinate luminaire mounting with type of ceilings specified. Verify ceiling support systems and coordinate luminaire installation.

4. Framing members of suspended ceiling systems to support luminaires shall be securely fastened to each other and shall be securely attached to the building structure at appropriate intervals. Luminaires shall be securely fastened to the ceiling framing member by mechanical means, such as bolts, screws, or rivets. Clips identified for use with the type of ceiling framing member(s) and luminaire(s) shall also be permitted.

C. Wiring:

1. Wire luminaires in accordance with the requirements of the latest edition of the National Electrical Code. Wire fluorescent luminaires with no less than #16 AWG (1.31 mm²), high temperature (per NEC, but not less than 150 deg C) wire. Do not splice or tap within arm, stem or chain. Install continuous wire from splice in outlet box of the building wiring system to lamp socket or to ballast terminals.

2. Wiring of “lay-in” grid luminaires shall be from junction box to luminaire and not from luminaire to luminaire, unless otherwise specified. Snap-in type terminations are not acceptable.

3. Each luminaire and ballast shall be grounded, to assure safety, proper lamp starting and performance. Grounding means shall be in full compliance with NEC Article 250.

3.2 TEST ON LIGHTING SYSTEMS

A. General:

1. Inspect each installed fixture for damage. Replace damaged fixtures and components.

2. Perform operating tests on lighting systems to prove that all design functions are satisfactorily performed. If adjustments are made to lighting system, retest to demonstrate satisfactory compliance.

3. Perform test for emergency lighting. Interrupt power supply to demonstrate proper operation. Verify transfer from normal to emergency and retransfer to normal. If adjustments are made to lighting system, retest to demonstrate satisfactory compliance.

4. Report and correct any and all deficiencies as they arise. Provide documentation of all tests, inspections and adjustments.

5. When required by the Architect, verify ballast sound levels with a laboratory certified sound pressure level meter in accordance with appropriate ballast sound level measurement standards and as directed by Architect.

B. ASHRAE 90.1-2010:

1. Functional Testing:
   a. Lighting system with its control devices and control systems shall be tested to ensure that control hardware and software are calibrated, adjusted, programmed, and in proper working condition in accordance with the construction documents.
and manufacturer’s installation instructions. When occupant sensors are installed, at a minimum, the following procedures shall be performed and documented.
Construction

1) Confirm that the placement, sensitivity and time-out adjustments for the occupant sensors yield acceptable performance, lights turn off only after space is vacated and do not turn on unless space is occupied.

END OF SECTION

BEN
SECTION 271100 - BASIC VOICE AND DATA 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. Extent of basic voice and data systems work is indicated by Drawings and by requirements of this
      Section.
   B. Provide all labor, material, equipment, and services and perform all operations required for basic
      voice and data systems consisting of raceway systems, J-hooks, pull boxes, outlet boxes and
      grounding. Include all supports, fittings, bushings and hardware.

1.3 RELATED WORK FURNISHED AND INSTALLED BY OTHERS
   A. The following shall be furnished and installed by others:
      1. All telephone and data instruments.
      2. All personal computers.

1.4 RELATED WORK SPECIFIED ELSEWHERE
   A. Comply with applicable requirement of Section 260500, “General Requirement, Electrical Work”.
   B. Comply with applicable requirements of Section 260526, “Grounding”.
   C. Comply with applicable requirements of Section 260529, “Hangers and Supports for Electrical
      Systems”.
   D. Comply with applicable requirements of Section 260533, “Raceways and Fittings”.
   E. Comply with applicable requirements of Section 260553, “Identification for Electrical Systems”.
   F. Comply with applicable requirements of Section 262726, “Wiring Devices”.
   G. Comply with applicable requirements of Section 271300, “Backbone and Horizontal Cabling for
      Voice and Data Systems”.

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H. Comply with the current edition of Wayne State University Standards for Communications Infrastructure, which shall form a part of these specifications.

1.5 ABBREVIATIONS AND DEFINITIONS

A. AWG: American Wire Gauge.
B. LAN: Local Area Network.

1.6 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC as applicable to communication system materials and installations.
B. Work Coordination: Coordinate Work of this Section with Owner’s tel/com switch, telephone instrument, workstation, and LAN equipment suppliers. Coordinate the work with Wayne State University voice and data network representatives.
   1. Meet with Owner’s representatives to exchange information and agree on details of equipment arrangements and installation interfaces.
   2. Record agreements reached in meetings and distribute record to other participants.
   3. Coordinate work of voice and data systems with that being provided by other trades. Adjust the exact arrangements and locations of raceway systems and outlet boxes for voice and data systems, to optimize their location and space requirements, and to coordinate with work of other trades.

1.7 SUBMITTALS

A. Product Data: None required.
B. Shop Drawings: None required.
C. Samples: None required.

1.8 COORDINATION

A. Coordinate arrangement, mounting, and support of communications equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting pathways, cables, wireways and cable trays will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices.

C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08, “Access Doors and Frames”.

D. Coordinate sleeve selection, application and firestopping as specified in applicable Sections of Division 07 regarding firestopping.

E. Coordinate location of outlets with Architectural Trades and Telecommunications Trades.

1.9 WARRANTY

A. Manufacturer shall warranty equipment to be free from defects in material and workmanship for one (1) year from date of Owner’s acceptance.

B. Installation contractor shall warranty installation to be free from defects in material and workmanship for one (1) year from date of Owner’s acceptance.

PART 2 - PRODUCTS

2.1 CONDUITS, J-HOOKS, PULL AND OUTLET BOXES

A. Comply with applicable requirements of Section 260533, “Raceways and Fittings”.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Contractor shall work in close cooperation with the Owner and all work shall conform to their standard requirements. Should the Owner make known to the Contractor an objection to the layout, the Contractor shall immediately notify the General Contractor, Construction Manager and Architect/Engineer of any discrepancies before proceeding with the work.

B. Conduits, j-hooks, outlet boxes, pull and junction boxes:

1. Install conduits, j-hooks, outlet boxes, pull and junction boxes as indicated on Drawings or
as specified.
2. No section of conduit shall be longer than 100 ft (30.5 m) or contain more than three (3) 90 degree bends between pull points or pull boxes.
3. The inside radius of a bend in a conduit shall be at least 10 times the internal diameter.
4. Pull boxes shall be readily accessible.
5. Outlet boxes shall be a 2-gang box with a single gang adapter ring. Extend a 1” conduit from each individual (stand-alone flush wall mount) voice/data outlet box to accessible ceiling space or to cable tray, unless otherwise indicated on Drawings. Conduits extended to cable tray shall be bonded to cable tray system. Mount outlets per “Mounting Heights” requirements of Section 260500, “General Requirement, Electrical Work”.
6. Terminate conduit with bushings or fittings and caps. Install monofilament plastic line in conduit.

END OF SECTION
BEN
SECTION 271300 - HORIZONTAL CABELING FOR VOICE AND DATA 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.
B. Extent of work is indicated by Drawings and by requirements of this Section.
C. Provide all equipment, materials, labor, and overall project management necessary for the layout and installation of horizontal cabling as described herein. Work shall include but not be limited to the provision, installation, testing, labeling and documentation of new and/or revised cabling to accommodate fit-up work for the Radio Chem. Laboratory.

1.2 SUMMARY
A. Section Includes:
1. Cable.
2. Jacks and faceplates.
3. Patch cords.
4. Outlet assemblies.
5. Cable connecting hardware, patch panels, and cross-connect blocks.
6. Telecommunications outlet/connectors.
7. Cabling system identification products.
8. Cable management.
9. Requirement for compliance with Wayne State University Standards for Communications Infrastructure.
B. It is the intent of this project that new and/or revised voice and data provisions in the laboratory area of renovation match in general, voice and data provisions in other laboratory areas in the same vicinity as the Radio Chem. Lab.

1.3 RELATED WORK SPECIFIED ELSEWHERE
A. Comply with applicable requirements of Section 058010, “Post-Installed Anchors”.
B. Comply with applicable requirement of Section 260500, “General Requirement, Electrical Work”.
C. Comply with applicable requirements of Section 260526, “Grounding”.

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D. Comply with applicable requirements of Section 260529, “Hangers and Supports for Electrical Systems”.

E. Comply with applicable requirements of Section 260533, “Raceways and Fittings”.

F. Comply with applicable requirements of Section 260553, “Identification for Electrical Systems”.

G. Comply with applicable requirements of Section 262726, “Wiring Devices”.

H. Comply with applicable requirements of Section 262813, “Fuses”.

I. Comply with applicable requirements of Section 271100, “Basic Voice and Data Systems”.

J. Comply with the current edition of Wayne State University Standards for Communications Infrastructure, which shall form a part of these specifications.

1.4 ABBREVIATIONS AND DEFINITIONS

C. AWG: American Wire Gauge.
D. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.
F. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.
G. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
H. dB: Decibel.
I. EMI: ElectroMagnetic Interference.
J. ETL: Electronic Testing Labs.
L. HVAC: Heating, Ventilating, and Air Conditioning.
M. ICEA: Insulated Cable Engineers Association.
N. IDC: Insulation Displacement Connector.
O. IT: Information Technology.
Q. LAN: Local Area Network.
R. MUTOA: MultiUser Telecommunications Outlet Assembly, a grouping in one location of several telecommunications outlet/connectors.
S. NEC: National Electrical Code.
T. NECA: National Electrical and Communications Association.
W. NRTL: National Recognized Testing Laboratory.
X. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.
1.5 CABLING SYSTEM DESCRIPTIONS

A. Horizontal Cabling:

1. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called “permanent link”, a term that is used in the testing protocols.

   a. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
   b. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
   c. Bridged taps and splices shall not be installed in the horizontal cabling.
   d. Splitters shall not be installed as part of the optical fiber cabling.

2. A work area is approximately 100 sq ft (9.3 sq m), and includes the components that extend from the telecommunications outlet/connectors to the station equipment.

3. The maximum allowable horizontal cable length is 295 ft (90 m). This maximum allowable length does not include an allowance for the length of 16 ft (4.9 m) to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 ft (4.9 m) in the horizontal cross-connect.

1.6 PERFORMANCE REQUIREMENTS

A. General Performance: Cabling systems shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.7 SUBMITTALS

A. General:

1. The contractor shall not purchase any equipment for the System specified herein until the project submittals have been approved in their entirety and have been returned to the contractor. It is the responsibility of the contractor to meet the entire intent and functional performance detailed in these specifications and in Wayne State University Standards for
Communications Infrastructure. Approved submittals shall only allow the contractor to proceed with the installation and shall not be construed to mean that the contractor has satisfied the requirements of these specifications.

2. Each submittal shall include a cover letter providing a list of each variation that the submittal may have from the requirements of the contract documents. In addition the Contractor shall provide specific notation on each shop drawing, sample, catalog cut, data sheet, installation manual, etc. submitted for review and approval, of each such variation.

3. All drawings and diagrams shall include the contractor's title block, complete with drawing title, contractor’s name, address, date including revisions, and preparer and reviewer’s initials.

B. Product Data:

1. Submit manufacturer’s data on all system components.

2. Indicated in the documentation will be the type, size, rating, style, and catalog number for all items proposed to meet the system performance detailed in this specification. The proposed equipment shall be subject to the approval of the Owner and Architect/Engineer.

C. Wiring Diagrams:

1. Submit interconnection wiring diagrams for new and/or modified portions of the voice and data system pertaining to the fit-up area of renovation for this project.

D. Shop Drawings:

1. Submit shop drawings for all work of this Section. Submit shop drawings to Wayne State University C & IT Computing & Network Services, and obtain submittal review commentary from WSU C & IT Computing & Network Services.

2. A complete set of shop drawings shall be supplied. The shop drawings shall be reproduced electronically in digital format. The shop drawings shall include but not be limited to:
   a. Riser diagram.
   b. New and/or revised cabinet rack wiring.
   c. Point-to-point wiring diagrams for new and/or revised cabling.
   d. Floor plan drawings locating new and/or revised system devices, and routing of new and/or revised cabling.
   e. Complete system bill of materials.

1.8 PROGRESS SUBMITTALS

A. Provide up to date As-Built Drawings as requested by the Owner.
B. Horizontal cabling test results as they occur. Provide in Owner’s required format including naming convention.

1.9 PROJECT CLOSE OUT DOCUMENTS

A. General:

1. Three (3) copies of the following documents shall be delivered to the Owner’s Representative at the time of system acceptance. The close out submittals shall include:

a. Project specific manuals covering new and/or revised portions of the installed system. The manual shall contain a detailed narrative description of the system architecture, inputs, outputs, expansion capability, application considerations and limitations. Manufacturer’s data sheets and installation manuals/instructions for new and/or revised equipment. A generic or typical Owner’s instruction and operation manual shall not be acceptable to fulfill this requirement.

b. As-Built drawings consisting of:

1) Scaled plans showing the placement of each individual equipment as well as raceway size and routing of new and/or revised cabling with cabling identification.
2) Plans indicating actual routing and labeling of new and/or revised UTP cabling.
3) All drawings shall reflect point to point wiring with cabling identification.
4) Details of equipment interconnections and labeling of interconnect cables, and associated racks where new and/or revised cabling is terminated.

c. Results of all test reports described in this document, in electronic format.

d. Complete parts list of all equipment installed under this project with spare parts lists.

2. All drawings shall be provided in standard .DWG format per the Owner’s CAD Standard. A plot of each sheet shall also be provided.

1.10 QUALITY ASSURANCE

A. NEC Compliance: Comply with NEC as applicable to communication system materials and installations.

B. Work Coordination: Coordinate Work of this Section with Owner’s voice and data network representatives.

C. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings by an RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Minimum Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.

3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

D. Testing Agency Qualifications: A NRTL.

D. Testing Agency Qualifications:

1. Testing Agency’s Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

E. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
2. Smoke-Developed Index: 50 or less

F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NEC, by a qualified testing agency, and marked for intended location and application.

G. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.


1.11 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of new UTP cable for open and short circuits.

1.12 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and HVAC system equipment is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.13 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and data network representatives.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.
1.14 WARRANTY
   A. Manufacturer shall warranty equipment to be free from defects in material and workmanship for one (1) year from date of Owner’s acceptance.
   B. Installation contractor shall warranty installation to be free from defects in material and workmanship for one (1) year from date of Owner’s acceptance.

1.15 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. Device Plates: Two of each type.
      2. Multiuser Telecommunications Outlet Assemblies: Two of each type.

PART 2 - PRODUCTS

2.1 PATHWAYS
   A. General Requirements: Comply with TIA/EIA-569-A.
   B. Cable Support: NRTL labeled for support of associated cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
      1. Support brackets with cable tie slots for fastening cable ties to brackets.
      2. Lacing bars, spools, J-hooks, and D-rings.
      3. Straps and other devices.
   C. Cable Trays: Comply with applicable requirements of Section 260533, “Raceways and Fittings”.

2.2 CABLE AND HARDWARE
   A. Comply with Wayne State University Standards for Communications Infrastructure for all requirements.

2.3 JACKS, CONNECTORS, PATCH PANELS, CROSS-CONNECT BLOCKS, FACEPLATES, PATCH CORDS, OUTLET ASSEMBLIES & CONSOLIDATION POINTS
   A. Comply with Wayne State University Standards for Communications Infrastructure for all requirements.
2.4 GROUNDING

A. Comply with requirements in Section 260526, “Grounding” for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

2.5 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with applicable requirements of Section 260553, “Identification for Electrical Systems”.

2.6 CABLE MANAGEMENT

A. Document and keep track of physical characteristics by recording the network, TIA/EIA details, and connections between equipment and cable.

B. Information shall be presented in database view, spreadsheet and/or CAD drawings.

2.7 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays. Make all required cabling and raceway system connections.

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Comply with applicable requirements for raceways and boxes as specified in Section 260533, “Raceways and Fittings”. Conceal raceway cables except in unfinished spaces.
B. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer’s limitations on bending radii. Provide and use lacing bars and distribution spools.

3.2 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. Comply with the current edition of Wayne State University Standards for Communications Infrastructure.

C. General Requirements for Cabling:

2. Comply with BICSI ITSIM, Ch. 6, “Cable Termination Practices”.
3. Install 110-style IDC termination hardware, unless otherwise indicated.
4. Multiuser Telecommunications Outlet Assemblies shall not be used as a cross-connect point.
5. Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors:
   a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
   b. Locate consolidation points for UTP at least 49 ft (15 m) from communications equipment room.
6. Terminate conductors; no cable shall contain un-terminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inch (760 mm) and not more than 6 inch (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
8. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer’s limitations on bending radii, but not less than radii specified in BICSI ITSIM, “Cabling Termination Practices” Chapter. Install lacing bars and distribution spools.
10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
11. Cold-Weather Installation: Bring cable to room temperature before de-reeling. Heat lamps shall not be used for heating.
12. In the communications equipment room, install a 10 ft (3 m) long service loop on each end of cable.
13. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, “Pulling Cable”. Monitor cable pull tensions.
D. UTP Cable Installation:
   2. Do not untwist UTP cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

E. Open-Cable Installation:
   1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
   2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inch (200 mm) above ceilings by cable supports not more than 48 inch (1219 mm) apart.
   3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:
   1. Comply with BICSI TDMM and TIA/EIA-569-A for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
   2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
      a. 12 inch (305 mm) minimum perpendicular distance from 600 volt AC cables.
      b. 24 inch (610 mm) minimum parallel distance from 600 volt AC cables.
      c. 48 inch (1219 mm) minimum from motors or transformers.
      d. 6 inch (152 mm) minimum from lighting fixtures.
   3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inch (64 mm).
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inch (150 mm).
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inch (300 mm).
   4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inch (76 mm).
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inch (150 mm).
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inch (1219 mm).

6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 6 inch (152 mm).

3.3 FIRESTOPPING

A. Comply with requirements in Division 07 Section “Penetration Firestopping”.

B. Comply with TIA/EIA-569-A, Annex A, “Firestopping”.


3.4 GROUNDING

A. Install grounding according to BICSI TDMM, “Grounding, Bonding, and Electrical Protection” Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Bond metallic equipment to the grounding bus bar, using not smaller than #6 AWG (13.30 mm²) equipment grounding conductor.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in the current edition of Wayne State University Standards for Communications Infrastructure.

1. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

B. Provide Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable documentation shall reflect as-built conditions.

C. For fire-resistant plywood, do not paint over manufacturer's label.

D. Cable Schedule: Provide updated cable schedule to include all work of this project for which new and/or revised cabling occurs. Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
E. Cable and Wire Identification:

1. Label each cable within 4 inch (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 ft (4.5 m).
3. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
   a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device. Identify with name and number of particular device as shown.
   b. Label each unit and field within distribution racks and frames.
4. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
5. Uniquely identify and label work area cables extending to each work area.

F. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.6 FIELD QUALITY CONTROL

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

B. Perform tests and inspections. In addition to test and inspection requirements specified herein, provide testing per Wayne State University Standards for Communications Infrastructure.

C. Tests and Inspections:

2. Visually confirm marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
   a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in “Test Instruments (Normative)” Annex, complying with measurement accuracy specified in
“Measurement Accuracy (Informative)” Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

5. UTP Performance Tests:

a. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:

1) Wire map.
2) Length (physical vs. electrical, and length requirements).
3) Insertion loss.
4) Near-end crosstalk (NEXT) loss.
5) Power sum near-end crosstalk (PSNEXT) loss.
6) Equal-level far-end crosstalk (ELFEXT).
7) Power sum equal-level far-end crosstalk (PSELFEXT).
8) Return loss.
9) Propagation delay.
10) Delay skew.

6. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.

a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.

b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

D. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION

BEN
SECTION 280720 - INTELLIGENT REPORTING FIRE DETECTION AND ALARM SYSTEM

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 SCOPE

A. Extent of fire alarm system work is indicated by Drawings and by requirements of this Section. Provide all labor, material, equipment and services and perform all operations required for complete installation of a low voltage, electrically supervised, continuous ringing, intelligent reporting UL approved fire detection and alarm devices and related work as shown and as specified herein. Furnish, install and connect new microprocessor controlled, addressable, intelligent fire alarm devices required to form complete coordinated system modifications, ready for operation. New devices shall include, but not be limited to, alarm initiating devices, alarm notification appliances, smoke detectors, control relay modules, auxiliary control devices, hardware, software, raceway systems, programming, wiring, electrical boxes, terminations, equipment and incidentals as shown on the drawings, as specified herein and as necessary for system completion. Fire alarm system modifications shall be installed in accordance with the specifications and drawings and in full compliance with all Codes. All features and system capacities contained in this specification shall be included whether or not specifically itemized herein. All equipment furnished shall be new and include the latest state of the art products from the same manufacturer as the existing system, and which are compatible with the existing system.

B. New fire alarm devices shall be manufactured 100% by a U.S. manufacturer (or division thereof).

C. The building fire alarm control panel and the basic fire alarm system infrastructure are existing. This Contractor shall provide new devices as indicated and as required for all work indicated on Drawings, as specified herein and as required by the Fire Marshal, and shall extend conduit and wiring from all new devices to the fire alarm system. Coordinate all work and extensions of the existing fire alarm system with the provider of the building fire alarm system infrastructure, and obtain all requirements from the provider of the building fire alarm infrastructure for this purpose. The fire alarm system modifications and additional new devices shall be furnished fully operational in all respects at the completion of work provided in this Contract.

1. The installing contractor shall contract with the following source for supplying devices, materials, shop drawings, wiring diagrams, and programming, including final inspection.
and test services for the fire alarm system modifications. The following source is currently the provider of the existing building fire alarm system, including maintenance.

a. Siemens Industry, Inc., 45470 Commerce Center Drive, Plymouth Twp., MI 78170, Tel: (734) 456-3800, Fax (866) 815-0749.

D. The installing company shall employ NICET (minimum Level II Fire Alarm Technology) technicians on site to guide the final checkout and to ensure system integrity.

E. The fire alarm system modifications shall comply with requirements of NFPA Standard No. 72 for protected premises signaling systems except as modified and supplemented by this specification. The system field wiring shall be supervised either electrically or by software-directed polling of field devices.

F. Perform all other fire alarm system work as specified herein, as indicated on Drawings, and as required by the Fire Marshal.

G. Examine the drawings of other trades and verify the conditions governing the work on the job site. Arrange work accordingly, providing such fittings, conduit, junction boxes and accessories as may be required to meet such conditions. It shall be the responsibility of the equipment supplier/installer to ensure that all equipment supplied will fit in locations designated on plans and in the specifications. The contractor shall be responsible during the installation, testing and guarantee periods for any damage caused by the Contractor, Subcontractors, or by defects in the Contractor’s or Subcontractor’s work, materials or equipment.

H. This contractor shall coordinate all work with the Electrical Trades Contractor.

I. Software Modifications

1. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes.

2. Provide all hardware, software, programming tools and documentation necessary to program and perform programming modifications for the fire alarm system on-site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. Program all system functions required for operation of new additional devices. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.

1.3 SUBMITTALS

A. General:

1. Submit shop drawings for all work of this Section to the Fire Marshal and to the Owner’s insurance carrier and obtain both of their written approvals, prior to Construction. Shop drawings are not required to be submitted to Architect-Engineer. All associated fees for
plan review, permits and local authority inspections shall be the responsibility of the electrical contractor.

2. All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality.

3. All equipment proposed shall meet or exceed the standards, quality, features, capacity and functional performance specified herein.

B. Shop Drawings shall be reproduced electronically in digital format and shall include the following:

1. Cover sheet with drawing index, client name and location, project title and client project number. Complete 1/8” = 1’ – 0” floor plan drawings shall be provided, locating all system devices.

2. Project specific notes, system operation sequencing, device symbols, wire schedule, device addressing schedule, addressable wiring legend, wire run distance/voltage drop chart, device mounting details and wiring diagrams, cable communication detail, battery capacities, conduit runs, box locations, and wire counts and fill. Submittals shall include system power calculations specified herein. Reference paragraph 1.10 for power calculations submittals.

3. Equipment list, identifying types and models of all materials, devices, and wiring proposed. Include a complete system bill of materials.

4. Show main control panel module & annunciator layouts, configurations and terminations.

5. Submit manufacturer's data on fire alarm system components. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications. Submit a riser diagram indicating fire alarm system components including type and number & gauge of wires, initiating devices, indicating devices, processing units, the interface of fire safety control functions, and all other components required or as specified. Riser diagram shall show system tie-in points.

6. Submit interconnection wiring diagrams for fire alarm system. Clearly differentiate between portions of wiring that are manufacturer-installed and portions that are field-installed. Include manufacturer's name(s), model numbers, ratings, power requirements, voltage drop calculations, battery calculations, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts. Submit data sheets for each new fire alarm device. Evidence of ULI listings shall be submitted with the data sheets.

7. Show main control panel module layout, configurations, wiring and terminations required to incorporate the system modifications.

8. All shop drawings submitted shall prior to submittal, be reviewed and signed off by an individual having a minimum of a NICET certification in fire protection engineering technology, subfield of fire alarm systems.

C. Certifications:

1. Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of installation and the proposed performer of system programming is an authorized representative of the major equipment manufacturer, and is NICET certified.
1.4 GUARANTY

A. All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of Owner acceptance. The full cost of maintenance, labor, field service, materials, parts pick-up and delivery required to correct any defect during this one year period shall be included in the submittal bid.

1.5 QUALITY ASSURANCE

The publications listed below form a part of this specification. The publications are referenced in text by the basic designation only.

A. Comply with the following National Fire Protection Association (NFPA) Standards pertaining to fire alarm systems and facilities:

- No. 70 National Electric Code (NEC)
- No. 72 National Fire Alarm Code
- No. 90A Air Conditioning Systems
- No. 101 Life Safety Code
- No. 221 Standard for Fire Walls and Fire Barriers

B. Provide fire alarm systems and components which are UL-listed and labeled. Comply with applicable requirements of the following UL Standards pertaining to fire alarm facilities and installation:

- No. 13 Sprinkler Systems
- No. 50 Cabinets and Boxes
- No. 268 Smoke Detectors for Fire Protective Signaling Systems
- No. 864 Control Units for Fire Protective Signaling Systems
- No. 268A Smoke Detectors for Duct Applications
- No. 228 Door Closers-Holders for Fire Protective Signaling Systems
- No. 464 Audible Signaling Appliances
- No. 38 Manually Actuated Signaling Boxes for Use with Fire-Protection Signaling Systems
- No. 217 Single and Multiple Station Smoke Alarms
- No. 346 Waterflow Indicators for Fire Protective Signaling Systems
- No. 1481 Power supplies for Fire Protective Signaling Systems
- No. 1711 Amplifiers for Fire Protection Signaling Systems

C. Comply with Local and State Building Codes and ADA Federal guidelines. Comply with applicable requirements of ADA pertaining to fire alarm systems.

D. Comply with all requirements of the authority having jurisdiction. The fire alarm system modifications shall be provided by a certified fire alarm contractor. The certified fire alarm contractor...
contractor shall, before the installation of the fire alarm system, submit detailed plans and specifications of the proposed system modifications to the authority having jurisdiction for review.

E. FM Compliance:
   1. Provide fire alarm systems and accessories that are FM-approved.

F. All components for which ULI listing is required shall be listed in the current edition of the ULI Fire Protection Equipment Directory and shall be delivered to the project site with factory applied, UL stickers. System components which do not meet this requirement are not acceptable. Compatibility listing requirements for fire alarm devices and smoke detectors shall be met.
   1. Components proposed in this specification shall be UL listed to operate together as a system. The supplier shall provide evidence, with submittal, of listings of all proposed equipment and combinations thereof.

G. Michigan Public Acts Compliance:
   1. The fire alarm contractor shall install fire alarm system or systems in complete accordance with Act No. 144 of the Public Acts of Michigan of 1982 and shall perform installation in complete compliance of the Act.

1.6 RELATED WORK SPECIFIED ELSEWHERE

A. Comply with applicable requirements of Section 260500, “General Requirement, Electrical Work”.

B. Comply with applicable requirements of Section 260529, “Hangers and Supports for Electrical Systems”.

C. Comply with applicable requirements of Section 260533, “Raceways and Fittings”.

D. Comply with applicable requirements of Section 260553, “Identification for Electrical Systems”.

E. Comply with applicable requirements of Section 262813, “Fuses”.

1.7 RECORD DOCUMENTS

A. The fire alarm system manufacturer(s), working with the Contractor, shall prepare a set of drawings that show the complete fire alarm system “as-built” conditions. Based on the detail in which design drawings must be prepared, it is desired that “as-built” revisions will be minimal. The fire alarm system contractor shall revise the original design CAD drawing files to indicate
“as-built” conditions. These revised “as-built” drawings shall be included in project “Record Documents” and will be used as Master Record Fire Alarm Drawings.

B. A set of as-built drawings of the fire alarm system shall be provided to the Owner, indicating the final layout of all wiring and devices at the completion of the approved installation.

C. One marked up set of “as-built” drawings shall be provided at the time of system tie in.

D. As built drawings prepared by the fire alarm system installer shall show the installed location of new and/or modified fire alarm system devices, conduits, wiring, boxes, system interfaces, etc. As-built drawings shall include all final device addresses and mapnet numbers for all addressable components and notification appliances, speaker circuit numbers, strobe circuit numbers, etc. All conduit sizes and wire types shall also be shown.

E. Provide on as-built drawings any revisions to the device descriptor chart used to program system information.

F. Information conveyed with as-built drawings shall be with the same level of detail as the original documents. Include with as-built drawings all system wiring diagrams, control diagrams, fire alarm panels, terminal cabinets, enclosures, annunciators, etc.

G. As-built drawings shall include all authority having jurisdiction (Fire Marshal) comments not previously issued in a bulletin/project change order.

H. As-built CAD drawings shall be consistent with all other Harley Ellis Devereaux design drawings produced for the project. Contractor shall request electronic drawing files in writing from the Project Manager. Electronic copies of the original design drawings will be provided to the Contractor.

I. Following the completion of construction, project design drawings shall, after being updated by the Contractor to reflect as-built conditions, become a master record document for the WSU iBio building. As-built drawings shall be prepared in a manner that will facilitate insertion into the master record drawings.

1.8 SYSTEM POWER CALCULATIONS

A. Standby battery capacity calculations shall list the type of devices and modules, quantities, unit and extended amperage draw for quiescent and alarm conditions, total amperage draw and battery amp/hour rating. For design criteria, the battery amp/hour rating listed by the manufacturer shall be de-rated by 20%. Include all system power requirements including those requirements for electrical door holders and door unlocking systems, visual signaling appliances, or any other auxiliary function powered by the system.
1. Note: Battery calculations are to be provided with the shop drawing submittals indicating that the system battery capacity, (including replacement and/or additional batteries), are of sufficient amp-hour capacity to supply operating power to the fire alarm system for a duration as herein specified.

B. AC power supply calculations shall include all system loads associated with AC power supplies. This shall include requirements for electrical door unlocking systems, visual signaling appliances, or any other auxiliary function powered by AC power.

C. DC power supply calculations shall include all system loads associated with DC power supplies. This shall include requirements for electrical door unlocking systems, visual signaling appliances, or any other auxiliary function powered by DC power.

D. Complete calculations shall be provided, showing the electrical load on each notification appliance circuit, and on each auxiliary control circuit.

1.9 APPROVALS

A. All system devices shall have proper listing and/or approval from the following nationally recognized agencies:

- UL Underwriters Laboratories Inc
- FM Factory Mutual

B. Modular Labeling

1. To facilitate system changes and expansions, and to ensure that all subassemblies have the proper listing, each subassembly of the FACP shall carry the appropriate UL modular label. This includes all printed circuit board assemblies, power supplies, and enclosure parts.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIAL, GENERAL:

A. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling (fire alarm) system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system modifications.
B. All equipment and components shall be installed in strict compliance with manufacturers' recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation. Refer to manufacturer’s riser / connection diagram for all specific system installation / termination / wiring data.

C. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

2.2 ACCEPTABLE MANUFACTURER

A. All fire alarm components and services provided under this Contract shall be as manufactured by Siemens.

2.3 CONDUIT AND WIRE

A. Conduit:

1. Conduit shall be in accordance with the National Electrical Code (NEC), local and state requirements.
2. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
3. Cable must be separated from any open conductors of Power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, as per NEC Article 760.
4. Wiring for 24 volt control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
5. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.
6. Conduit shall be 3/4 inch (19.1 mm) minimum.

B. Wire:

1. Comply with Section 260519, "Wire and Cable, 600 Volts and Less", for applicable wire requirements for this Section.
2. Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the Authority Having Jurisdiction and shall be installed in accordance with the appropriate articles from the approved current edition of NEC.
3. Contractor shall obtain from the fire alarm system manufacturer written instructions regarding the appropriate wire/cable to be used for this installation. No deviation from
the written instruction shall be made by the contractor without the prior written approval of the fire alarm system manufacturer.

4. Wires shall be sized to reduce voltage drop to the values permitted by the fire alarm system device manufacturer’s specifications.

5. All fire alarm system wiring shall be new.

6. All field wiring shall be completely supervised. In the event of a primary power failure, disconnected standby battery, removal of any internal modules, or any open circuits in the field wiring; a trouble signal will be activated until the system and its associated field wiring are restored to normal condition.

C. Terminal Boxes, Junction Boxes and Cabinets:

1. All boxes and cabinets shall be UL listed for their use and purpose.

D. Initiating circuits shall be arranged for consistency with the existing system, and to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.

2.4 EXISTING MAIN FIRE ALARM CONTROL PANEL, GENERAL OPERATION

A. The existing FACP contains a microprocessor based Central Processing Unit (CPU). The CPU can communicate with and control the following types of equipment used to make up the system: intelligent detectors, addressable modules, operator terminals, annunciators, conventional initiating device circuits, optional printers, and other system controlled devices.

1. Function: The main FACP can perform the following functions:

a. Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.

b. Supervise all initiating signaling and notification circuits throughout the facility by way of connection to monitor and control modules.

c. Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed.

d. Visually and audibly annunciate any trouble, supervisory, or alarm condition on operator's terminals, panel display, and annunciators.

1) When a fire alarm condition is detected and reported by one of the system initiating devices or appliances, the following functions immediately occur, but are not limited to the following:

a) The system alarm LED shall flash. Notification appliances shall operate.

b) A local audible device in the control panel shall sound a distinctive signal.
c) The FACP display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.

d) Record in nonvolatile historical memory the occurrence of the event, the time & date of the occurrence and the device initiating the alarm condition. Print the event information (on optional printer) with a time and date stamp.

e) All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

f) Transmit signal to building mechanical systems to initiate shutdown or operation of certain fans and damper operation.

g) Close all smoke doors and/or barriers at fire rated assemblies. Return all elevators to the primary floor of egress.

h) Activate any alarm contacts provided for remote or central station monitoring.

i) Actuation of any duct smoke detector shall shut down its associated air handling unit.

j) Initiate other fire alarm functions as indicated elsewhere in the design documents.

k) Alarm RESET function shall restore system to normal if alarm initiating circuits have cleared.

2) When a trouble condition is detected, including grounding or opening of supervised circuits, disarrangement of system wiring, or power or system component failure, and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

a) The system trouble LED shall flash.

b) A local audible device in the control panel shall sound a distinctive signal.

c) The FACP display shall indicate all information associated with the trouble condition, including the type of trouble point and its location within the protected premises.

d) Record in nonvolatile historical memory the occurrence of the event, the time and date of the occurrence and the device initiating the trouble condition. Print the event information (on optional printer) with a time and date stamp.

e) All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated system outputs (trouble notification appliances and/or relays) shall be activated.

f) Transmission of trouble signal to remote alarm receiving station.
3) When a supervisory condition is detected and reported by one of the system initiating devices or appliances, the following functions shall immediately occur:

a) The system trouble LED shall flash.

b) A local audible device in the control panel shall sound a distinctive signal.

c) The FACP display shall indicate all information associated with the supervisory condition, including the type of supervisory point and its location within the protected premises.

d) Record in nonvolatile historical memory the occurrence of the event, the time and date of the occurrence and the device initiating the supervisory condition. Print the event information (on optional printer) with a time and date stamp.

e) All system outputs assigned via preprogrammed equations for a particular point in supervisory alarm shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.

f) Transmission of supervisory condition to remote alarm receiving station.

B. System Capacity and General Operation

1. The control panel shall be expanded as required, to accommodate new additional devices and/or system modifications. All new and existing system devices shall display normal and alarm conditions consistently, whether operating from normal or standby power.

2. All programming or editing of the program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel.

3. The system can automatically route alarm, supervisory and trouble signals to a remote location by means of a digital alarm communicator transmitter and telephone lines.

4. Annunciation and initiation circuits shall be zoned and separated as follows:

a. Manual devices, such as pull stations, shall report independently from automatic devices.

b. Sprinkler flow switches shall report independently from other devices.

c. New devices connected to the existing system shall be zoned as required per Codes and application.

d. Address assignments on any single circuit shall not exceed 80% of the address capacity of the circuit.

e. Power draw and/or voltage drop on any single circuit shall not exceed 80% of the power and/or voltage limitation of the circuit.

f. A signal on one zone shall not prevent the receipt of signals from other zones.

g. Automatic alarm response functions resulting from an alarm signal from one zone or device shall not be altered by subsequent alarm, supervisory or trouble signals. Alarm signals shall have highest priority. All alarm, supervisory and trouble signals shall be annunciated regardless of priority or order received.
h. Initiating device circuits, supervisory initiating circuits, signaling line circuits and notification appliance circuits shall be configured with class and style wiring as specified herein.

C. Loop Interface (Signaling Line Circuit) Board:

1. The SLC board monitors and control intelligent addressable devices and control modules.
2. The SLC interface board shall provide power and communicate with all new and existing intelligent addressable detectors and modules on a single pair of wires.
3. The SLC interface board shall receive analog information from all existing and new intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular device. Provide additional SLC interface board(s) as required, to provide power and communicate with additional intelligent addressable detectors and modules installed under this project.

D. Power Supply:

1. The power supply shall be modified or replaced as required, to provide all necessary power for the FACP, including all system modifications.
2. It shall provide sufficient usable notification appliance power for all existing and new additional connected devices.
3. It shall be expanded for additional notification appliance power, as required for additional devices.
4. It shall be power-limited per UL864 requirements.

E. System Circuit Supervision:

1. The FACP shall supervise all circuits to new and existing intelligent devices, annunciators and conventional peripherals and announce loss of communications with these devices. The CPU shall continuously scan above devices for proper system operation and upon loss of response from a device shall sound an audible trouble, indicate that device or devices are not responding and store the information in the history buffer, and on an optional printer.

F. Existing Operators Terminal: The following standard operator full-system programming functions shall apply to the new and/or modified system devices, consistent with operation of the existing system:

1. Acknowledge (ACK/STEP) Switch:
   a. Activation of the control panel acknowledge switch in response to a single new alarm and/or trouble condition shall silence the local panel signal and change the system alarm or trouble LED from flashing mode to steady-ON mode. If additional alarm or trouble conditions exist or are detected and reported in the system, depression of this switch shall acknowledge and/or advance the display to the next alarm or trouble condition.
2. Signal Silence Switch:
   a. Activation of the signal silence switch shall cause all new and/or modified notification appliances and relays which are programmed to do so to return to the normal condition after an alarm condition. The selection of new and/or modified notification circuits and relays that are silenceable by this switch shall be fully field programmed within the confines of all applicable standards.

3. System Reset Switch:
   a. Activation of the system reset switch shall cause all new and existing electronically-latched initiating devices, appliances or software zones, as well as all associated new and existing output devices and circuits, to return to their normal condition.
   b. If the alarm condition(s) still exist, or if they reoccur in the system after system reset switch activation, the system shall then resound the alarm conditions.

4. System Test Switch:
   a. Activation of the system test switch shall initiate an automatic test of all existing and new analog/addressable detectors in the system. The system test shall activate the electronics in each analog/addressable sensor, simulating an alarm condition and causing the transmission of the alarm condition from that sensor to the fire alarm control panel. The fire alarm control panel shall interpret the data from each sensor installed in the system. A report summarizing the results of this test shall be displayed automatically on the control panel's display. This report shall display any detector that failed, or an all "Tested OK" message.

G. Field Programming
   1. The system shall be programmed, configured and expanded in the field as required.
   2. Program through the standard FACP keypad, all system functions.
   3. All field defined programs shall be stored in non-volatile memory.
   4. The system programming incorporating modifications shall be "backed" up on electronic media, utilizing an upload/download program. This system back-up electronic media shall be completed and given in duplicate to the building owner and/or operator upon completion of the final inspection. The electronic media and program that performs this function shall be "non-proprietary", in that, it shall be possible to forward it to the building owner/operator upon his or her request.

H. The installer's field programming and hardware shall be functionally tested on a computer against known parameters/norms which are established by the FACP manufacturer. A software program shall test Input-to-Output correlation, device Type ID associations, point associations, time equations, etc. This test shall be performed on an IBM-compatible PC with a verification software package. A report shall be generated of the test results and two copies turned in to the engineer(s) on record.
I. Specific System Operations

1. System Point Operations:
   a. New addressable devices in the system shall have the capability to be enabled or
disabled through the system keypad/control panel.
   b. New system output points shall be capable of being turned on or off from the
system keypad/control panel.

2. Point Read: The system shall be able to display the following point status diagnostic
functions for new devices. Each point shall be annunciated, consistent with the existing
system operation, for the parameters listed:
   a. Device Status.
   b. Device Type.
   c. Custom Device Label.
   d. Software Zone Label.
   e. Device Zone Assignments.
   f. All Program Parameters.

2.5 SYSTEM COMPONENTS:

A. Audible devices
   1. Audible devices shall provide a sound level of not less than 90dBA at ten feet or
more than 120dBA at the minimum hearing distance from the audible appliance. Audible
notification appliances shall be designed for voice intelligibility of mass notification
feature.
   2. Audible devices shall be field programmable without the use of special tools, to provide
slow whoop, continuous, temporal or interrupted tones with an output sound level of at
least 90 dBA measured at 10 feet from the device. Provisions shall be made to adjust
sound levels of audible devices. Audible devices shall have variable watt input taps.
Minimum tap shall be ¼ watt. Remaining taps shall be ½, 1 and 2 watts.
   3. Audible devices shall produce a sound level of at least 15 dBA above the average
ambient sound level or 5 dBA above the maximum sound level having a duration of at
least 60 seconds, whichever is greater, measured five feet above the floor in all
occupiable areas.
   4. Where inspection and testing reveals that the quantity of audible devices shown on plans
is insufficient to meet audibility requirements specified herein, provide and install
additional audible devices, amplifiers, etc., as part of the project, all at no additional cost.
Audibility testing shall include times during which the building is in full operation during
commissioning.
   5. Audible device housings shall be white color.

B. Visual Notification Appliances:
1. Visual notification appliances shall be 24 VDC polarized visual signaling devices. Strobes shall be xenon type or equivalent, with minimum repetition rate of 1 Hz, not exceeding 2 Hz and a maximum duty cycle of 40% with a maximum pulse duration of 0.2 seconds. Pulse duration is defined as the time interval between initial and final points of 10 percent of maximum signal.

2. Visual notification appliances shall meet the requirements of the ADA. Additionally, strobes shall comply with polar dispersion requirements of UL 1971.

3. Effective strobe intensity shall be no less than the minimum required by NFPA 72 (2007) Section 7.5.4.3 for rooms, and Section 7.5.4.4 for corridors.

4. Where more than two strobe devices are visible within an area, arrange strobes for synchronized flashes per NFPA requirements, to minimize the possibility of producing flash rates or flash patterns that would impact those with photosensitivity.

5. Strobe color shall be clear or nominal white (unfiltered or clear filtered white light) unless otherwise noted on Drawings. Light sources shall be sealed, and protected with a Lexan or equivalent lens. Inscribe the word "FIRE" on the lens.

6. Visual notification appliance housings shall be white color.

C. Audible/Visual Combination Devices:

1. Shall meet the applicable requirements of Section A listed above for audibility.

2. Shall meet the requirements of Section B listed above for visibility.

D. Addressable Devices - General

1. Detectors shall be analog and addressable, and shall connect to the fire alarm control panel's Signaling Line Circuits.

2. New detectors shall have performance characteristics and features consistent with existing detectors. Detectors shall be the latest, state of the art products suitable for use on the Project.

3. The detectors shall be ceiling-mount or as indicated on Drawings.

4. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself or initiated remotely on command from the control panel.

E. Intelligent Photoelectric Smoke Detector

1. The detectors shall use the photoelectric (light-scattering) principle to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density. Photoelectric detectors shall be listed for use as open area protective coverage and shall be insensitive to air velocity changes.

2. Each spot-type smoke detector shall be monitored individually, via an integral, addressable element.

3. Spot-type smoke detectors shall have provision for calibrated sensitivity testing consistent with the requirements of NFPA 72, (2007).

4. The detector head shall be equipped with a mesh insect screen to prevent foreign objects from entering the sensing chamber.

5. Sensitivity voltage shall be factory set by the manufacturer.
6. Exposed components and detector housings shall be white color.

F. Addressable Dry Contact Monitor Module

1. Addressable monitor modules shall be provided as required for system modifications, to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLC loops.
2. The monitor module shall match existing others on the system.
3. The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
4. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch x 1-1/4 inch x 1/2 inch. This version need not include Style D or an LED.

G. Two Wire Detector Monitor Module

1. Addressable monitor modules shall be provided as required to connect one supervised IDC zone of conventional 2-wire smoke detectors or alarm initiating devices (any N.O. dry contact device).
2. The two-wire monitor module shall match existing others on the system.
3. The IDC zone shall be suitable for Class A or B (Style D or Style B) operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.

H. Addressable Control Module

1. Addressable control modules shall be provided as required for system modifications, to supervise and control the operation of one conventional NAC of compatible, 24 VDC powered, polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contact relay. The relay shall be capable of providing a direct signal to control panels, or other devices, such as a circuit breaker shunt trip for elevator recall or power shutdown or RESET functions.
2. The control module shall match existing others on the system.
3. The control module NAC shall be suitable for Style Z or Style Y (Class A/B) operation, or as a dry contact (Form-C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
4. Audio/visual power shall be provided by a separate supervised power loop from the main fire alarm control panel or from a supervised, UL listed remote power supply.
5. The control module relay contacts shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC, and a minimum of 0.5 amps at 120 volts AC.

I. Isolator Module
1. Isolator modules shall be provided as required for system modifications, to automatically isolate wire-to-wire short circuits on an SLC loop. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC Loop. At least one isolator module shall be provided for each protected zone.

2. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC loop. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section.

3. The isolator module shall not require any address-setting, and its operations shall be totally automatic. It shall not be necessary to replace or reset an isolator module after its normal operation.

4. The isolator module shall mount in a standard 4-inch deep electrical box or in a surface mounted backbox. It shall provide a single LED that shall flash to indicate that the isolator is operational and shall illuminate steadily to indicate that a short circuit condition has been detected and isolated.

J. Remote Signaling Relays:

1. The existing fire alarm control panel shall be provided with all required remote signaling relays for all functions required by Codes and all functions specified on Drawings.

2. Remote signaling relays shall be included as required, for release of fire doors, shutdown of ventilation systems, interlocking with HVAC equipment, interlocking with elevator controllers for elevator recall, and for remote annunciation.

K. LED's for Concealed Detectors:

1. When detectors and flow switches are installed concealed from plain view, remote LED notification lights shall be installed at the corridor ceiling directly outside the room or where otherwise readily visible to responding personnel, to show the location of the concealed detectors.

2. Provide lamps flush mounted in a single gang wall plate.

3. Provide a red, laminated phenolic-resin plate to identify, in engraved white letters, the device initiating the signal and its associated system address and location.

2.6 BATTERIES AND BATTERY CHARGER:

A. Battery:

1. Provide additional battery capacity as required, to accommodate system modifications and additional new devices.

2. Battery shall have sufficient capacity to power the modified fire alarm system for not less than twenty-four hours, and at the end of that period, shall be capable of operating all alarm notification appliances used for evacuation or to direct aid to the location of an emergency for not less than 15 minutes, upon loss of normal AC power.

3. The batteries are to be completely maintenance free. No liquids shall be required. Fluid level checks, refilling, spills and leakage shall not be required.
Construction

B. Battery Charger:
   1. Modify or increase the capacity of the existing charger as required, to accommodate any additional battery capacity required for system modifications and additional new devices. The batteries shall be fully charged under all service conditions.

2.7 REMOTE ANNUNCIATOR

A. Description: Modify existing remote annunciator as required, so that its domain of monitoring includes the area of renovation and/or new devices on this project. Duplicate annunciator functions of the FACP for alarm, supervisory, and trouble indications added and/or modified on this project.

B. Control Capability: Controls with associated LEDs permit acknowledging, silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the FACP. Expand domain of control capability, to include the area of renovation on this project.

PART 3 - EXECUTION

3.1 QUALIFICATIONS

A. Installing Contractor or field supervisor shall be qualified by the Michigan State MDCIS Office of Fire Safety as a Fire Alarm Installer. The contractor shall have successfully installed similar fire alarm system equipment and devices on a previous project of comparable size and complexity.

B. Provide the services of a factory authorized service representative to supervise the field assembly and connection of components, and the testing and adjustment of the system.

C. Michigan State MDCIS Office of Fire Safety Certificate shall be kept on hand and available any time work is in progress.

D. Contractor shall have the ability to prepare or have prepared as-built drawings on CAD using original design drawings as a base.

E. The contractor shall have in-house Factory Certified engineering and project management capability consistent with the requirements of this project. Qualified and approved representative of the system manufacturer shall perform the detailed engineering design of central and remote control equipment. Qualified and approved representative of the system manufacturer shall produce all panel and equipment drawings and submittals. The contractor is responsible for retaining qualified and approved representative(s) of those system manufacturers specified for detailed system design and documentation, coordination of system installation requirements, and final system testing and commissioning in accordance with these specifications.
3.2 DRAWING REVIEW/AGENCY APPROVAL

A. Review and Approval of Authority Having Jurisdiction:

1. Bid drawings shall be submitted for review to the authority having jurisdiction by the Electrical Contractor performing the work. Coordinate submission for review with Wayne State University.
2. Review comments of significance shall be revised on design drawings and incorporated into a bulletin or the original bid set when possible.
3. Review comments when minimal shall be incorporated into as-built documents.
4. Construction shall not proceed until a red stamped set of “Approved” drawings or “Approved as Noted” drawings is received from the authority having jurisdiction.
5. Upon receipt of approved drawings from the authority having jurisdiction, the supplier shall immediately forward two sets of drawings to the Architect-Engineer. These drawings shall be either stamped approved or a copy of the letter stating approval shall be included.

3.3 PERMITS, LICENSES AND CERTIFICATES

A. Prior to start of installation, the Contractor shall obtain and submit copies of all permits, licenses, certificates, inspections and approvals necessary to conduct this work. File all documents and pay all fees (including, but not limited to plan checking and permit).

3.4 INSTALLATION:

A. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer. Signaling line circuits, initiating device circuits and notification appliance circuits shall meet requirements of the authority having jurisdiction. Circuits shall be isolated as required. Separate power-limited and non-power-limited conductors as recommended by the manufacturer. Obtain approval of the authority having jurisdiction prior to installation. Install all equipment as indicated on Drawings and secure it to walls, floors or structural members as required.

B. Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems. Qualified personnel shall include, but not be limited to, the following:

1. Factory trained and certified personnel.
2. National Institute of Certification in Engineering Technologies (NICET) fire alarm level II certified personnel.
3. Personnel licensed or certified by State or local authority.

C. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the
system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

D. Fire detection and alarm system devices shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas. Ceiling mounted smoke detectors in finished areas shall be mounted on a recessed junction box.

E. All fire alarm junction boxes shall be clearly marked for easy identification.

F. Field programming: The system modifications shall be programmed, configured and expanded in the field as required. All field defined programs shall be stored in non-volatile memory.

G. No wiring other than that directly associated with fire alarm detection or auxiliary fire protection functions shall be permitted in fire alarm conduits. Wiring splices are to be avoided to the extent possible, and if needed, they must be made only in junction boxes and shall be crimp connected. Transposing or changing color coding of wire shall not be permitted. All conductors in conduit containing more than one wire shall be labeled on each end with "E-Z" markers or equivalent. Conductors in cabinets shall be carefully formed and harnessed so that each drops off directly opposite to its terminal. Cabinet terminals shall be labeled. All controls, function switches, etc., shall be clearly labeled on equipment panels. All wiring shall be checked to ensure there are no grounds, opens or shorts.

H. Grounding: Ground cable shields and equipment according to system manufacturer's written instructions to eliminate shock hazard and to minimize to the greatest extent possible, ground loops, common-mode returns, noise pickup, crosstalk, and other impairments.

1. Locate signal ground terminal at equipment control panel.
2. Ground equipment and conductor and cable shields. For audio circuits, minimize, to the greatest extent possible, ground loops, common-mode returns, noise pickup, and crosstalk.

I. Provide interlock wiring as required and where deemed necessary by the local Fire Marshal and authority having jurisdiction, to enable automatic unlocking of doors indicated on plans as being secured, in the event of a fire alarm condition. Coordinate all wiring for this purpose with Security System Contractor.

J. Make conduit and wiring connections to door release devices, and to fire alarm interface relays, as applicable.

K. Addressable remote relays shall be provided on the signaling line circuit to interface with the access control system for door unlocking and/or elevator access as required.

L. The Contractor shall remove rubbish and debris resulting from his work on a daily basis. Removal of debris shall be coordinated with Owner.

M. The Contractor shall clean all dirt and debris from the inside and outside of the fire alarm equipment after completion of installation.
3.5 RACEWAY SYSTEM INSTALLATION REQUIREMENTS

A. Fire alarm system raceways shall be routed and installed to minimize the potential for physical damage, mechanical or by fire, and so as not to interfere with building systems, facilities or equipment, and to facilitate service and minimize maintenance.

1. All fire alarm raceways, except flexible conduit whips to devices, shall be solidly attached to building structural members, ceiling slabs or permanent walls, and per the N.E.C. Raceways and boxes shall not be attached to conduit, duct work, cable trays, other ceiling equipment, drop ceiling hangers/grids or partition walls, except where necessary to connect to initiating, notification signaling or auxiliary function devices. Hanger rods shall be 1/4-inch minimum diameter threaded steel rods.

2. Fire alarm system raceways shall be routed/installed either parallel or perpendicular to building structural members.

3. Fire alarm system raceways shall be installed at a height so as not to obstruct any portion of a window, doorway, stairway or a passageway, and shall not interfere with the operation of any mechanical or electrical equipment.

4. Fire alarm system raceways, junction boxes, pull boxes, terminal cabinets, electrical enclosures and device backboxes shall be readily accessible for inspection, testing, service and maintenance.

5. Pullboxes shall be installed in each fire alarm system raceway at intervals not to exceed 100 feet. Pullboxes shall be 4-inch square, minimum.

6. All device backboxes, junction boxes and terminal cabinets shall be sized to accommodate the number of conductors contained therein. Extension rings or extension boxes are not to be used to meet conductor capacity requirements. Extension rings may be used for flush mounting of devices as needed.

7. Where fire alarm system cables are not routed in conduit, and penetrate walls and floors, the penetrations shall be sleeved and equipped with bushings at each end, for protection of the fire alarm system cabling.

8. Raceways, junction boxes, panels, electrical enclosures, relay and device backboxes shall be exposed in unfinished areas and concealed in walls, ceiling spaces, electrical shafts or closets in finished areas, unless otherwise noted on Drawings.

B. All conduit penetrations of walls, floors and ceilings shall be sealed around the conduit(s) by the fire alarm Contractor, restoring the walls, floors and ceilings to their original condition, fire resistance and integrity. The fire alarm system Contractor shall be responsible for all patching and touch-up painting necessitated by the performance of his work. Removal and repair of all finished surfaces shall be coordinated with, and is subject to the approval of the Owner.

C. All fire alarm system pull boxes, junction boxes and terminal cabinets shall be painted red prior to installation. The Contractor shall provide touch-up painting of raceways, pull boxes, junction boxes and terminal cabinets prior to final acceptance testing. All raceway system couplings shall be painted red.

D. Device backboxes shall be of metal construction, designed and sized to accommodate contained devices. Undersized backboxes intended to accommodate flush mounting of devices, or backboxes with unused open conduit knockouts are not acceptable.
3.6 WIRING INSTALLATION REQUIREMENTS

A. All fire alarm system wiring shall be installed with wire numbers installed on the wire at each end and at all terminations. Locate wire numbers at accessible locations only, such as in junction boxes, enclosures, device boxes, etc. Wire numbering scheme for all control wiring shall be in accordance with J.I.C. standards.

B. All fire alarm system conductors shall be of the type(s) specified herein.
   1. All initiating circuit, signaling line circuit, AC power conductors, shield drain conductors and grounding conductors, shall be solid copper, stranded or bunch tinned (bonded) stranded copper. All indicating appliance circuit conductors shall be stranded copper or bunch tinned (bonded) stranded copper. Conductors shall not be field tinned.
   2. All signaling line circuits, including all addressable initiating device circuits shall be multi-conductor jacketed twisted cable or twisted shielded per the fire alarm system manufacturer’s recommendations.
   3. All non-addressable initiating device circuits, indicating appliance circuits, 24 VDC auxiliary function circuits and firefighters' telephone circuits shall be twisted pairs or twisted shielded per the fire alarm system manufacturer’s recommendations. Indicating appliance circuits, initiating device circuits, signaling line circuits and firefighters' telephone circuits shall be shielded if installed in common conduits.

C. All fire alarm conductor terminations, except splices in shield drain conductors, and including field connections to supervisory resistors, diodes, relays or other devices, shall be to numbered terminals or terminal strips and shall be readily accessible for inspection, service, testing and maintenance.
   1. All fire alarm conductor terminations shall be within junction boxes, device backboxes, terminal cabinets, control panels or other suitable metal enclosures.
   2. Terminals and terminal strips shall be suitable for the size and number of conductors connected to them.
   3. Each conductor termination shall be uniquely numbered with durable plastic tags or uniquely identifiable by a combination of numbers and color codes. These conductor numbers shall be shown on the Contractor's record drawings (floor plans and detailed wiring diagrams) in a manner allowing ready identification of all conductor terminations.
   4. All terminations are subject to the approval of the Owner.

D. All control panel wiring shall conform to the requirements of this section:
   1. All control panel wiring shall be fully dressed and bundled with nylon tie wraps at 3-inch intervals. Bundled wiring shall be routed parallel to terminal strips within control panels, with individual conductors turned out at 90 degree angles to their associated terminal connections. AC power conductors shall be bundled and routed separately from low voltage conductors. A minimum 2-inch separation shall be maintained between AC power conductors and low voltage conductors wherever possible. All control cabinets shall be sized to accommodate the requirements of this section.
2. Control panels shall not be used as raceways. Conductors which do not terminate within a control panel shall not be routed through that control panel.

3. In accordance with manufacturers installation requirements, power limited wiring shall be installed only within the power limited wiring section of fire alarm panels. Non-power limited wiring shall be installed only within the non-power limited wiring section of fire alarm panels.

4. Conduit shall not be stubbed into the battery compartment of a fire alarm panel.

E. Fire alarm conductors shall be separated into two categories:

1. Data circuits, including signaling line circuits, addressable initiating device and auxiliary function circuits and annunciator circuits, and 24 VDC power circuits for addressable devices. Also low voltage non-data circuits, including one and two-way voice communications circuits.

2. AC Power Circuits.

F. All fire alarm circuits shall be twisted and shielded as recommended by the fire alarm system manufacturer and as necessary to prevent electrical and/or audio crosstalk between conductors installed in common conduits.

1. All conductor shielding shall be continuous (with splices) for the length of the circuit, grounded at the associated control panel only.

2. Shield drain conductors and foil shall be trimmed and taped at each splice to prevent grounding of the shield at any location other than the associated control panel.

G. All low voltage fire alarm circuits shall be installed as non-power limited circuits in accordance with Article 760 of NFPA 70. All other fire alarm circuits shall be installed in accordance with the applicable requirements of Article 310 of NFPA 70.

H. Conductors looped around terminals are not acceptable.

I. T-tapping of addressable circuits shall be in accordance with the fire alarm system manufacturer's recommendations and within the limitations of the system's listing(s). T-tapping of non-addressable circuits is prohibited. T-tapping shall occur only at device terminals.

3.7 TYPICAL OPERATION OF EXISTING SYSTEM:

A. Actuation of any manual station, smoke detector, heat detector or water flow switch causes the following operations to occur unless otherwise specified:

1. Display the alarm condition at the control panel.

2. Activate all programmed notification circuits until silenced.

3. Actuate all audible and strobe units until the panel is reset.

4. Annunciate the active initiating devices and zones.
5. Release all magnetic door holders for doors to adjacent zones on the floor from which the alarm was initiated. Unlock certain secured doors, as required by the authority having jurisdiction. Doors shall remain released/unlocked until the fire alarm system has been reset.

6. Duct type smoke detectors and building smoke detectors shall, in addition to the above functions shut down the ventilation system and close associated control dampers as appropriate.

7. Activation of any sprinkler system low pressure switch, or valve tamper switch shall cause a system supervisory alarm indication.

8. Return elevators to the primary floor of egress.


3.8 WORK INCLUDED

A. Install fire alarm devices indicated on design drawings. Install conduit and wiring required for signaling line circuits, initiating circuits, notification line circuits and power circuits.

B. Assist in the scheduling and programming of system software.

C. Test and adjust installation as required for the current phase of work.

D. Protect all equipment and devices during installation and until accepted by Owner.

E. Prepare and submit shop drawings to the WSU Fire Marshal, contractor record drawings and other submittals required herein.

F. Repair all damage resulting from work related to the fire alarm system operation including cutting, patching, painting, ceiling tile replacement, etc.

G. Coordinate all work with other Contractors working in the building.

3.9 SYSTEM PROGRAMMING

A. Contractor shall provide Owner with one copy of marked up As-built drawings at time of tie in.

B. Programming shall be performed during off hours at time as coordinated with the Owner.

C. Device descriptor information used for programming shall be coordinated with Owner prior to programming.

D. Assist with system programming revisions. Programming shall be as required for the intended interaction of fire alarm input and output devices. Field program information shall include:

1. Adding or deleting monitor and control points.
2. Change in text descriptions associated with individual monitor/ control points.
3. Assign and change priority of individual monitor or control points.
4. Temporarily bypass control points independent of their associated monitor points. Use of this feature shall allow any operator selected detector(s)/zone(s) to be monitored by the system while inhibiting all alarm inputs except for local display. Access to this feature shall be password protected. A listing function shall be available to list all bypassed devices/zones at designated printers and CRT's.
5. Selective output of signals, by assigned priority, to annunciation devices including remote annunciators. Each type of annunciator shall be capable of displaying and/or recording a different group of signals.
6. Through programming, addressable monitor and control points may be combined into logical groups or zones (in software) to the extent that such grouping does not detract from the required operation of the system, including resounding of signals subsequent to actuation of the signal silence switch.

E. A copy of all software documentation required by this section shall be maintained on-site by the Contractor, in a binder, arranged in chronological order. This binder shall be turned over to the Owner at the completion of the project.

F. All software changes shall be fully documented by the Contractor.

G. Documentation of Software Modifications shall include:
   1. A complete printout of the system program prior to the change.
   2. A complete printout of the system program subsequent to the change, with all modifications highlighted.
   3. A letter prepared and signed by the individual who made the changes, describing each change made and the reason for that change. This letter shall certify that the preparer has personally reviewed and compared the before and after program printout and verified the correctness of the modification(s).
   4. Once the fire alarm system is put into service, in whole or in part, and the associated building(s) partially or wholly occupied, no software changes shall be performed without the prior written permission of the Owner.
   5. All software changes to the fire alarm system, once it is in service, shall be performed by a certified representative of the fire alarm system manufacturer, trained in the execution of such changes.

3.10 TESTS AND REPORTS:

A. Perform final tests and inspection of the modified system, to ensure that it is operating properly. Provide the service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system modifications performed.

   1. Upon completion of field wiring, including all terminations to initiating devices, indicating appliances and auxiliary function relays, and prior to connection of the field wiring to the associated control equipment, all field wiring circuits shall be tested for
continuity, shorts to ground, shorts between pairs and stray voltage using a digital multimeter.

2. All test values shall be recorded in ohms except for stray voltage which shall be recorded in volts AC/DC. Total circuit resistance (continuity test) excluding any end-of-line devices, shall not exceed 50% of the maximum resistance recommended by the fire alarm system manufacturer. All circuits measuring less than 10 M ohms to ground or between conductors installed in the same conduit shall be replaced. Stray voltage measurements over 0.1 VAC/DC shall require shielding or rerouting of circuits as necessary to eliminate the stray voltage.

3. The Owner reserves the right to witness all Contractor testing and shall be given 5 working days (minimum) notice of the start of all tests.

4. The Contractor shall provide all materials, equipment, coordination and personnel necessary to perform and document all required tests.

5. All testing shall be conducted with the final system program installed in non-volatile memory. In the event that errors are identified in the system program, the program shall be corrected and all required testing repeated with the new software iteration.

6. New and/or modified control panels, annunciators, alarm initiating devices, remote annunciation equipment, standby power supplies and associated circuits shall be functionally tested to verify proper operation and supervision.

7. Correct annunciation of all alarm, supervisory and trouble conditions, including any user programmable text messages, shall be verified at each new annunciation device.

8. Correct supervision, labeling and operation of all manual over-ride controls and associated status indicators shall be verified.

9. Correct operation of automatic auxiliary functions shall be verified including all control circuits and functions, auxiliary relays, control ZAMs, door control interfaces, magnetic door holders, fan shut downs, etc.

10. Test remote annunciator.

11. Open initiating device circuits modified under this project and verify that the trouble signal actuates.

12. Open signaling line circuits modified under this project and verify that the trouble signal actuates.

13. Open and short notification appliance circuits modified under this project and verify that trouble signal actuates.

14. Ground initiating device circuits modified under this project and verify response of trouble signals.

15. Ground signaling line circuits modified under this project and verify response of trouble signals.

16. Ground notification appliance circuits modified under this project and verify response of trouble signals.

17. Check presence and audibility of tone at alarm notification devices.

18. Check installation, supervision, and operation of intelligent smoke detectors during a walk test.

19. Each of the new alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and remote annunciator and the correct activation of the control points. Verify that the standby battery system is capable of operating the system, including modifications, for the duration specified.
20. When the system is equipped with optional features, the manufacturer's manual should be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, and verification of system functions.

21. Upon completion of the work, the fire alarm manufacturer shall provide written certification to the Owner documenting successful completion of all required Contractor testing, as specified.

B. Documentation of System Testing:

1. Provide certification by the fire alarm system manufacturer that the work has been inspected and tested, is installed entirely in accordance with the applicable codes, standards, the fire alarm manufacturer’s recommendations and ULI listings, and is in proper working order.

2. Provide complete documentation of approvals by all applicable Authorities Having Jurisdiction including copies of approved drawings and inspections.

3. Include the following programming data with testing documentation:
   a. A copy of all software documentation shall be maintained on-site by the Contractor. Software documentation shall be turned over to the Owner at the completion of the project.
   b. All software changes shall be fully documented by the Contractor.

4. Documentation of Software Modifications shall include:
   a. A complete printout of the system program prior to the change.
   b. A complete printout of the system program subsequent to the change, with all modifications highlighted.
   c. A letter prepared and signed by the individual who made the changes, describing each change made and the reason for that change. This letter shall certify that the preparer has personally reviewed and compared the before and after program printout and verified the correctness of the modification(s).

5. No software changes shall be performed without the prior written permission of the Owner.

6. All software changes to the fire alarm system, shall be performed by a certified representative of the fire alarm manufacturer, trained in the execution of such changes.

7. The final system software shall be included in the Test Records.

C. Test Record:

1. System certification and documentation of contractor's system testing required by Specifications shall be submitted to the Owner for review and approval at least 5 days prior to the final acceptance test. At a minimum, the Fire Alarm certification and description form depicted in Figure 10.6.2.3 of NFPA 72 (2007) shall be completed and submitted to the owner and to the authority having jurisdiction as certification of U.L. installation compliance.
2. Provide System Certification and Testing Documentation, including:
   a. Testing checklists for new fire alarm system devices for all required Contractor tests and verifications, including the date and time, results and the initials of the parties performing and witnessing each test/verification.
   b. A complete printout of the system program modifications. This printout shall be produced and dated upon completion of all required Contractor testing/verification, including any modifications necessary prior to final acceptance testing.

D. Acceptance of the system shall also require a demonstration of the stability of the modified system. This shall be adequately demonstrated while the system operates for a 90 day test period.

3.11 FINAL INSPECTION AND AS-BUILT DRAWINGS

A. At the final inspection a factory-trained representative of the manufacturer of the equipment shall demonstrate to the Owner and to the Local Statutory Authorities that the modified systems function properly in every respect. The manufacturer and Contractor shall check the system modifications and certify with certification number to the Owner in writing, that the system is properly wired and functioning per approved plans & specifications and has successfully passed testing in accordance with the manufacturer’s specifications and the appropriate NFPA requirements.

B. Verify that controls are properly installed, connected and labeled and that interconnecting wires and terminals are identified.

C. Provide a set of as-built drawings of the fire alarm system to the Owner, indicating final layout of all wiring at the completion of the approved installation.

3.12 FINAL APPROVAL AND ACCEPTANCE

A. Final approval and acceptance of the work will be given by the Owner when the complete system has been inspected, tested and approved in writing by the Owner and by the authority having jurisdiction.

3.13 PROJECT CLOSEOUT

A. General:
   1. Two (2) copies of the following documents shall be delivered to the Owner’s Representative at the time of system acceptance. The closeout submittals shall include:
      a. As-Built drawings consisting of: Scaled plans showing the placement of each individual new and/or modified item of the Fire Alarm System equipment as well
as raceway size and routing, junction boxes, and conductor size, quantity, and color in each raceway. All drawings shall reflect point to point wiring, device address and programmed characteristics as verified in the presence of the fire alarm field service engineer and/or the end user unless device addressing is electronically generated and automatically graphically self-documented by the system.

2. All drawings shall be provided in standard .DWG format. A plot of each sheet shall also be provided.

3. Provide the application program listing for the system as installed at the time of acceptance by the Owner and/or local AHJ (disk, hard copy printout, and all required passwords).

4. Provide the name, address and telephone of the authorized factory representatives.

END OF SECTION
BEN
SECTION 281000 - ELECTRONIC ACCESS CONTROL AND INTRUSION DETECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, and Division 1 Specifications Sections, apply to this Section.

1.2 DESCRIPTION OF WORK

A. Extent of Electronic Access Control and Intrusion Detection work is as indicated on drawings and as specified herein:

B. Provide all components and work as shown in the specifications and drawings, and also include all necessary components as may be required to provide the required access control operation for Room 0001 Radio Chem Lab. In general, the intended control operation for Room 0001 door shall include card required entry, emergency keyed entry override, REX detected free egress, and monitoring for forced and held condition by WSU Department of Public Safety.

C. Coordinate with WSU One Card Office representative for all programming and configuration of interior card reader door.

D. Coordinate with WSU One Card Office representative for new access control device(s) turn on and test. Compile checklist to verify that new devices have been installed, terminated, tested and report properly to WSU One Card Office CBORD system computer.

E. Coordinate with the WSU Department of Public Safety for programming of new access control and alarm monitoring input points and output points onto P2000 Access Control and Alarm Monitoring System server.

F. Termination of electrified door hardware shall be by security contractor with cost included under this section.

G. Point to point wiring schematics and programming configuration sheets for new access control and alarm monitoring components will be issued to the successful bidder after receipt of fully executed contracted. Successful bidder must supply Security Consulting, Inc. with a copy of the signed contract prior to receiving documents. Bidders are not to include the cost associated with preparing these documents in their bids; however the bidders must included the labor cost to implement the work outlined within this specification.
1.3 RELATED SECTIONS / WORK

A. Architectural specifications, including those pertaining to Finish Hardware.

B. Refer to Division 26 Sections for Electrical work. All conduits, conduit pull strings, back boxes and 120VAC (if so required) shall be provided and installed by electrical contractor as indicated on security system shop drawings. Equipment cabinets shall be provided by security contractor and installed by electrical contactor as indicated on security system shop drawings.

C. WSU One Card Office will provide CBORD (WSU Internal Card Reader System) access control panel programming and configurations. Contact Mr. Martin Korosso @ (313) 577-9514 for assistance.

D. WSU Design Services will provide all CBORD (WSU Internal Card Reader System) equipment as identified among security system shop drawings. It is the Security Contractor’s responsibility to coordinate the procurement of all CBORD equipment with the WSU-DS project manager assigned to this project.

E. WSU Department of Public Safety will provide administrative access to the JCI P2000 Access Control System Server for all control panel configurations and programming including card access, door control, input x output control and intrusion alarm programming. Contact Lt. Frank Smith @ (313) 577-6059 for assistance.

F. Carpentry Contractor shall install final key core at new emergency exit Chexit devices and/or emergency exit alarmed exit devices. It is the Security Contractor’s responsibility to coordinate the installation of new key core with the GC project manager assigned to this project.

1.4 SUBMITTALS

A. General: Submit the following in accordance with the conditions of Contract and Division 1 Specification Sections.

B. Product Data: Submit manufacturer’s specifications and installation instructions for types of security equipment indicated.

C. Templates: All electric hardware to be applied to metal door frames shall be made to template and packed with machine screws. Forward mortise hardware to the plant of the door manufacturer for application there if required, and provide necessary templates promptly upon receipt of frame shop drawings.

D. Schedule: After formal notice of award, prepare a security schedule setting forth the items proposed to be furnished for the door opening and device group. Submit proper number of copies of this schedule to allow the architect to retain two copies, and to furnish one copy for the owner, plus the number of copies required by the design / builder for distribution and use (10 copies max.) The schedule shall be written in the exact format as the specification wherein
the information shall provide an opening / device location description, and shall state the name of the manufacturer, and type, number and finish of each device proposed to be used.

1. Type the security schedule double spaced and submit on 8½ x 11 inch sheets of paper. Submittals not following this format will be returned unchecked.

E. Shop drawings: Submit ten copies of shop drawings which include riser and wiring diagrams and other information and details required for coordinated installation with other related work.

1. Drawings shall be identical versions of security drawings pertaining to this section with changes and additional details and shall include the following at a minimum.
   a. Floor plans showing door and device locations produced on AutoCAD 2008 and in an acceptable manner.
   b. Riser diagrams produced on AutoCAD 2008 showing proposed cable runs from each door device with cable manufacturer, cable description and outside diameter clearly marked.
   c. Wiring diagrams produced on AutoCAD 2008 showing new devices in system with point to point wiring between every device.

1) All drawings shall be professionally and clearly produced using AutoCAD 2008 or they will be returned unchecked.

1.5 AS BUILT DRAWINGS

A. Assemble three sets of as-built in formation, indexed as follows:

1. Index 1 “Security Schedule”: Copy of security schedule similar to submittal schedule, but revised to indicate as built material listing.
2. Index 2 “Data Sheets / Manuals”: Copy of all data sheets and / or manuals for all devices listed in security schedule.
3. Index 3 “Configuration Sheets”: Copy of configuration sheets showing all system program information relative to this project.
4. Index 4 “Floor Plans”: Copy of security floor plans similar to the submittal floor plans, but revised to indicate as built conditions.
5. Index 5 “Riser Diagrams”: Copy of riser diagrams similar to submittal riser diagrams, but revised to indicate as built conditions.
6. Index 6 “Wiring Diagrams”: Copy of wiring diagrams showing new devices installed under this project, with point to point wiring between every device.

1.6 QUALITY ASSURANCE

A. General: Electronic Access Control and Intrusion Detection system engineering and services shall be provided by Electronic Security Systems, Inc. or a security systems integrator who meets the following requirements:
1. Must be able to show evidence of past experience furnishing and servicing door locking hardware and electronic systems specified in this section.
2. Meet all applicable licensing and regulatory requirements of the State of Michigan, particularly Public Act 330.
3. Meet all applicable local jurisdiction licensing requirements.
4. Must have been engaged in the business of providing, installing, servicing and maintaining similar security measures in similar environments during the past five (5) years.
5. Must have a local support capacity consistent with the demands of this project and other local clients.
6. To insure the Security Systems Integrator is properly trained and knowledgeable of the system products they must be a factory direct authorized dealer for all products and equipment specified in this section. Equipment procured through wholesale houses, distributors or non factory authorized security integrator will be disqualified.
7. Must have a properly staffed facility with a properly stocked equipment warehouse within a four (4) hour drive of the job site.
8. Electronic Access Control and Intrusion Detection Systems Contractor must be a member of local 58 to avoid job delays. Subcontract work will not be accepted.
9. Insurance and Indemnity: The contractor shall take out and maintain, during the life of this agreement insurance coverage’s as set forth by the owner.

1.7 DELIVERY, STORAGE AND HANDLING

A. Deliver equipment to job site unless otherwise required or directed, wrapped in separate packages, complete with all the trimmings and screws, labeled and numbered for each opening.

B. Furnish typewritten schedule with each shipment in conformity with approved schedule. Furnish receipts in duplicate, upon delivery of hardware to the project site.

PART 2 - PRODUCTS

2.1 2.01 APPROVED MANUFACTURERS

A. Manufacturers for material, in accordance with the requirements of this Section are as follows, no substitutions allowed. This list defines the manufacturer only and does not in any way act to permit any deviation from the requirements of the Contract Documents.

B.

1. Key Switch报警控制系统
   2. Power Supply (Lock) Altronix
   3. Power Controllers Altronix
   4. IC Cylinder Housings Best
   5. Card Readers CBORD
### PART 3 - EXECUTION

#### 3.1 SYSTEM INSTALLATION REQUIREMENTS

A. General: Comply with manufacturer’s instructions for assembly and installation of Electronic Access Control and Intrusion Detection System, controls and accessories.

1. Assemble and prewire control boxes and other like assemblies in suppliers’ shop facility and test operation. Install completed assembly in field.
2. Install door control system components in locations indicated with work plumb, level, true and straight with no distortions. Secure exposed work with security fasteners.
4. Turn on and test new system components.
5. Terminations: Secure new termination points on terminal blocks.
6. Exposed Panels: Secure new exposed panels with tamper resistant screws. Supply owner with two (2) tools for removing all tamper-resistant hardware.
7. Electronic Equipment Enclosures: Lock new terminal enclosures located in secured and non secure areas, housing electronic components. New enclosures shall be equipped with tamper switches.
8. Field AC Power: Directly hardwire all field AC power to equipment as required.
9. Perform all work required to cut, patch and mount Electronic Access Control System hardware.
10. All wiring shall be in accordance with the manufacturer’s requirements and all applicable codes and standards including WSU C&IT Standards.
11. Tie-wrap all cabling and cleanly distribute to terminal strips. Additionally, systematically and logically number and mark new cabling using vinyl wire marker; document all cabling runs, distribution, splice points and terminations on the CAD generated “As – Built” drawings.
12. Contractor to conceal all cabling in ceilings, walls, doors and side light frames where possible. All routing of surface applied raceway must be approved by the owner and painted to match surroundings.
13. Contractor to reuse cable tray raceways where applicable.
14. Identification Nameplates – The contractor shall label new control panels, terminal boxes, and major items of the installed system and/or control description and show and describe all items on the drawings. The Contractor shall provide self-adhesive (1/8” thick plastic) labels with characters sized not less than ¼” and with a nameplate’s minimum size limited to 1” x 3”. The labels shall include the device identification and “Device Name”. Coordinate code with cabling, as-built documentation and system programming.
15. Remove, store, protect and re-install ceiling tiles upon completion of the work. Damaged tiles shall be replaced at Contractors expense.
16. Contractor shall remove only amounts of sprayed fire proofing as necessary to install hangers and supports to complete their scope of work. Patching of fireproofing shall be the responsibility of this contractor. Contractor shall use an installer certified in the use of sprayed resistive materials and the installation shall be in accordance with project specifications and University Standards regarding fireproofing.
17. Contractor shall provide the Owner seven (7) calendar days notice of any system tie-ins and/or any associated work on any existing Universities system to complete this scope of work. Contractor shall further abide by associated work on any existing university system to complete this scope of work. Contractor shall further abide by all owners procedures when working on existing systems. Contractor shall complete work at universities convenience.
18. Upon mobilizing, Contractor shall submit an initial master construction schedule outlining their complete scope of work. This schedule shall be based on owners sequencing, mile stone dates and schedule. Contractor shall then update/progress their schedule and be available for discussion at each foreman’s meeting.
19. Contractor shall provide all required fire stop systems to complete scope of work, and shall meet all requirements outlined in project specifications and University Standards regarding firestopping. Fire taping of pipe penetrations thru non-rated and smoke walls that extend to the deck above will be by the Contractor.
20. Due to the nature of these areas, the sequence of the work must be scheduled to minimize disruptions and disturbances to the owner’s operations and utilities.
21. Contractor shall be responsible for all saw cutting / core drilling, patching, and fire stopping that is required to complete their scope of work if it is not already covered in the electrical contractors section.

22. When necessary the contractor must obtain approvals, permits, and coordinate the inspection and testing of the systems with state and local governing agencies.

23. Provide all tests, data, affidavits, test results and certificates required by all governing authorities to the Design/Builder in a timely manner to facilitate Owner occupancy.

24. Contractor shall, as deemed necessary by the Owner, provide an up to date status on submittals, lead times, and expected delivery dates of the material/equipment to complete their scope of work.

25. Contractor shall furnish access doors to be installed by others. Contractor shall, as deemed necessary by the owner, provide all necessary coordination of the installation by others.

26. This Contractor shall be responsible for his own clean-up costs and shall at all times maintain a clean and safe jobsite. Dumpsters will be provided by the General Contractor.

27. Provide and maintain an effective safety program that will be in agreement and conform to the policies in the General Contractors Health & Safety Manual for this project.

28. Contractor will promptly process the submittals to ensure timely submittal of the items in this scope of work and ordering of the same. The contractor shall comply with the project schedule.

29. This bidder is responsible to review the site and be familiar with all existing conditions within and around the project including local conditions and requirements.

30. This Contractor shall be responsible to coordinate all required on-site testing, inspection and quality assurance requirements. This Contractor shall be responsible for conformance to all federal and local codes, regulations, testing, and inspection requirements as required for beneficial occupancy by the Owner. Secure and provide all inspections and permits required. Complete all certification of items as specified by the Contract Specifications, and the code and governing bodies. Testing is by the Owner.

3.2 ADJUSTMENTS, CLEANING, FINISHING AND PROTECTION

A. Clean exposed and semi-exposed surfaces. Touch-up shop applied finishes restoring damaged or soiled areas.

B. Operate Electronic Access Control and Intrusion Detection Systems including controls through all modes of operation and make final adjustments as necessary to ensure proper functioning.

C. Instruction: Instruct personnel in complete operation of system through all modes.

3.3 WARRANTY

A. The Contractor shall warrant the completed system wiring and equipment to be free from inherent mechanical and electrical defects for a period of two (2) years from the date of final acceptance by the Owner.
B. All proposed warranties shall be provided, as a minimum, from 8:00 AM – 4:30 PM Monday through Friday with response provided with four (4) business hours from the time of notification.

END OF SECTION 281000
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