FOR:
Board of Governors
Wayne State University
Detroit, Michigan

Owner’s Representative:
Robert Hoekstra, Project Manager
Facilities Planning & Management
Design & Construction Services
5454 Cass
Wayne State University
Detroit, Michigan 48202

Owner’s Agent:
Robert Kuhn, Sr. Buyer
WSU – Procurement & Strategic Sourcing
5700 Cass, Suite 4200
Detroit, Michigan 48202
313-577-3712 / 313-577-3747 fax
ac6243@wayne.edu and copy ag5343@wayne.edu

Consultant:
i Design Solutions
400 Water Street, Suite LL1
Rochester, MI 48307

March 25, 2015
# Table of Contents

<table>
<thead>
<tr>
<th>Division</th>
<th>Section Description</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Title Page</strong></td>
<td>00001-1</td>
<td></td>
</tr>
<tr>
<td><strong>Table of Contents</strong></td>
<td>00002-1</td>
<td></td>
</tr>
<tr>
<td><strong>Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>00005</td>
<td>Information for Bidders</td>
<td>00005-1 thru 00005-2</td>
</tr>
<tr>
<td>00100</td>
<td>Instructions to Bidders</td>
<td>00100-1 thru 00100-5</td>
</tr>
<tr>
<td>00250</td>
<td>Notice of Pre-Bid Conference</td>
<td>00250-1 thru 00250-2</td>
</tr>
<tr>
<td>00300</td>
<td>Form of Proposal &amp; Qualification Statement</td>
<td>00300-1 thru 00300-7</td>
</tr>
<tr>
<td>00410</td>
<td>Prevailing Wage Rate Schedule</td>
<td>00410-1 thru 00410-3</td>
</tr>
<tr>
<td>00430</td>
<td>Payment Package Document Requirements</td>
<td>00430-1</td>
</tr>
<tr>
<td>00440</td>
<td>Contractor's Performance Evaluation</td>
<td>00440-3</td>
</tr>
<tr>
<td>00500</td>
<td>Agreement between Contractor and Owner for Construction</td>
<td>00500-1 thru 00500-9</td>
</tr>
<tr>
<td>00510</td>
<td>Form of Guarantee</td>
<td>00510-1</td>
</tr>
<tr>
<td>00700</td>
<td>General Conditions (A.I.A. A-201)</td>
<td>00700-1</td>
</tr>
<tr>
<td>00800</td>
<td>WSU Supplementary General Conditions of the Contract for Construction</td>
<td>00800-1 thru 00800-12</td>
</tr>
<tr>
<td>00850</td>
<td>Drawings</td>
<td>00850-1</td>
</tr>
<tr>
<td><strong>Division 1 - General Requirements</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01000</td>
<td>General Requirements</td>
<td>01000-1 thru 01000-9</td>
</tr>
<tr>
<td>01010</td>
<td>Summary of Work (Includes Scope of Work)</td>
<td>01010-1</td>
</tr>
</tbody>
</table>
INFORMATION FOR BIDDERS

OWNER:
Board of Governors
Wayne State University

PROJECT:
Materials Science and Nano-engineering Lab
Project No. 090-248124

LOCATION:
Wayne State University
5050 Anthony Wayne Drive
Detroit, Michigan 48202

OWNER’S AGENT:
Robert Kuhn, Sr. Buyer
WSU – Procurement & Strategic Sourcing
5700 Cass, Suite 4200
Detroit, Michigan 48202
313-577-3712 / 313-577-3747 fax
ac6243@wayne.edu & copy ag5343@wayne.edu

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

Architect:
i Design Solutions
400 Water Street, Suite LL1
Rochester, MI 48307

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: March 25, 2015

BIDDING: Bidding documents may be obtained by vendors from the University Purchasing Web Site at http://www.forms.purchasing.wayne.edu/Adv_bid/Adv_bid.html beginning March 25, 2015. 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 pm, local time, March 31, 2015 to be held at Wayne State University – 5050 Anthony Wayne Drive, ENG G-1220, 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 April 7, 2015 at 12:00 Noon. All questions must be reduced to writing and emailed to the attention of Robert Kuhn, Sr. Buyer at ac6243@wayne.edu, copy to Robin Ellis-Watkins, Buyer at: ag5343@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 April 10, 2015, 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 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
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.purchasing.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: Materials Science and Nano-engineering Lab
Project No. 090-248124

LOCATION: Wayne State University
5050 Anthony Wayne Drive,
Detroit, Michigan 48202

OWNER’S AGENT: Robert Kuhn, Sr. Buyer
WSU – Procurement & Strategic Sourcing
5700 Cass, Suite 4200
Detroit, Michigan 48202
313-577-3712 / 313-577-3747 fax
ac6243@wayne.edu & copy ag5343@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 partnership 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. BIDDING DOCUMENTS

A. Bid specifications are not available at the University, but are available beginning March 25, 2015 through Wayne State University Procurement & Strategic Sourcing’s Website for Advertised Bids: http://www.forms.purchasing.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.purchasing.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).
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.purchasing.wayne.edu/Adv_bid/Adv_bid.html, and click on the “Join our List-serve” link at the top of the page.
NOTICE OF MANDATORY PRE-BID CONFERENCE

PROJECT: Materials Science and Nano-engineering Lab.

PROJECT NOS.: WSU PROJECT NO. 090-248124

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
5050 Anthony Wayne Drive, ENG G-1220
Detroit MI 48202

2:00 pm, local time, March 31, 2015

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.

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.purchasing.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 Robert Kuhn, 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 April 7, 2015, 12:00 noon.

IV. Proposal Due Date- April 10, 2015, 2:00 p.m.

V. Final Comments

VI. 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: Materials Science and Nano-engineering Lab

PROJECT NO.: WSU PROJECT NO. 090-248124

PROJECT TYPE: Construction Type: General, Mechanical, & Electrical Work

PURCHASING AGENT: Robert Kuhn, Sr. Buyer
WSU – Procurement & Strategic Sourcing
5700 Cass, Suite 4200
Detroit, Michigan 48202
313-577-3712/ 313-577-3747 fax
ac6243@wayne.edu & copy ag5343@wayne.edu

OWNER’S REPRESENTATIVE: Robert Hoekstra, 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 Materials Science and Nano-engineering Lab project (WSU Project No. 090-248124) 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 June, 22, 2015.

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 $500.00, Five Hundred Dollars per day, and therefore the contractor shall pay as liquidated damages to the Owner the sum of $500.00, Five 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:  Construction Type:  General, Mechanical, & Electrical 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>
</tr>
<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>
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<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>
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<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) ____________________________
  ____________________________
  ____________________________

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: ________________________________
    ____________________________________________________________

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: ____________________________

FORM OF PROPOSAL FOR THE GENERAL CONTRACT 00300 - 4
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

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

F. 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/wh347.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.

SEE ATTACHED STATE PREVAILING WAGE INFORMATION
State of Michigan  
WHPWRequest@michigan.gov  

Official Request #: 215  
Requestor: Wayne State University  
Project Description: Materials Science & Nano-engineering Lab 1335 - Renovation  
Project Number: 090-248124  

Wayne County  

Official 2015 Prevailing Wage Rates for State Funded Projects  

<table>
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<tr>
<th>Classification Name</th>
<th>Description</th>
<th>Last Updated</th>
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<th>Half Time Hourly</th>
<th>Double Time Hourly</th>
<th>Overtime Provision</th>
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Apprentice Rates:

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<th>Third 6 months</th>
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Wayne County  

Official 2015 Prevailing Wage Rates for State Funded Projects  

Contract must be awarded by: 5/19/2015  

Every contractor and subcontractor shall keep posted on the construction site, in a conspicuous place, a copy of all prevailing wage and fringe benefit rates prescribed in a contract.
### Official 2015 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 2/18/2015  
**Contract must be awarded by:** 5/19/2015

#### Page 2 of 33

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name Description</th>
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<td>10/15/2014</td>
<td>$52.43 $78.65 $104.86 H H D D D Y</td>
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Make up day allowed  
Saturday for 5 day 8 hour week  
Friday for 4 day 10 hour week  
4 10s allowed M-TH

#### Apprentice Rates:

- **First 6 months**  
  $31.87 $47.81 $63.74
- **2nd 6 months**  
  $33.72 $50.60 $67.44
- **3rd 6 months**  
  $35.57 $53.37 $71.14
- **4th 6 months**  
  $37.42 $56.14 $74.84
- **5th 6 months**  
  $39.27 $58.92 $78.54
- **6th 6 months**  
  $41.12 $61.70 $82.24
- **7th 6 months**  
  $42.97 $64.46 $85.94
- **8th 6 months**  
  $44.82 $67.24 $89.64

#### Carpenter

<table>
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<tbody>
<tr>
<td>Diver</td>
<td>CA 687 D</td>
<td>6/25/2014 $64.65 $93.14 $121.63 X X H X X H D Y</td>
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</table>

Make up day allowed  
Saturday

---

**Official Request #:** 215  
**Requestor:** Wayne State University  
**Project Description:** Materials Science & Nano-engineering Lab 1335 - Renovation  
**Project Number:** 090-248124  
**County:** Wayne

---

**Official Rate Schedule**  
Every contractor and subcontractor shall keep posted on the construction site, in a conspicuous place, a copy of all prevailing wage and fringe benefit rates prescribed in a contract.
Official 2015 Prevailing Wage Rates for State Funded Projects

Issue Date: 2/18/2015
Contract must be awarded by: 5/19/2015
Page 3 of 33

<table>
<thead>
<tr>
<th>Classification</th>
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<th>Half Time</th>
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<th>Overtime Provision</th>
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**Apprentice Rates:**

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<th>3rd 6 months</th>
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<tr>
<td>1st year</td>
<td>$24.23</td>
<td>$32.71</td>
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<tr>
<td>2nd year</td>
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<tr>
<td>4th year</td>
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Carpenter

four 10s allowed Mon-Sat; double time due when over 12 hours worked per day

Make up day allowed comment Saturdays

<table>
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<tr>
<th>Name</th>
<th>Description</th>
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**Apprentice Rates:**

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Official Request #: 215
Requestor: Wayne State University
Project Description: Materials Science & Nano-engineering Lab 1335 - Renovation

Official Rate Schedule
Every contractor and subcontractor shall keep posted on the construction site, in a conspicuous place, a copy of all prevailing wage and fringe benefit rates prescribed in a contract.
Official 2015 Prevailing Wage Rates for State Funded Projects

Issue Date: 2/18/2015
Contract must be awarded by: 5/19/2015

Page 4 of 33

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name</th>
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<td>$55.24 $79.04 $102.84 X X H X H D Y</td>
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</table>

Four 10s allowed Monday-Saturday; double time due when over 12 hours worked per day

Make up day allowed comment Saturday

Apprentice Rates:
- 1st 6 months: $33.82 $46.92 $60.00
- 2nd 6 months: $38.58 $54.05 $69.52
- 3rd 6 months: $43.33 $61.17 $79.02
- 4th 6 months: $48.09 $68.32 $88.54

Cement Mason

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<th>Classification</th>
<th>Name</th>
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- 2nd 6 months: $31.20 $42.54 $53.87
- 3rd 6 months: $35.31 $48.67 $62.01
- 4th 6 months: $39.46 $54.85 $70.23
- 5th 6 months: $41.52 $57.91 $74.30
- 6th 6 months: $45.67 $64.10 $82.52

Cement Mason

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Apprentice Rates:
- 1st 6 months: $26.77 $36.07 $45.36
- 2nd 6 months: $28.68 $38.91 $49.13
- 3rd 6 months: $32.50 $44.59 $56.66
- 4th 6 months: $36.32 $50.26 $64.19
- 5th 6 months: $38.24 $53.11 $67.98
- 6th 6 months: $42.06 $58.79 $75.51
Official 2015 Prevailing Wage Rates for State Funded Projects

Issue Date: 2/18/2015
Contract must be awarded by: 5/19/2015

Page 5 of 33

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<thead>
<tr>
<th>Classification</th>
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<td>Drywall Taper</td>
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<td>Four 10s allowed Monday-Thursday</td>
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<td>Make up day allowed comment</td>
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<tr>
<td></td>
<td>Friday make-up day for bad weather or holidays</td>
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<td></td>
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Official Request #: 215
Requestor: Wayne State University
Project Description: Materials Science & Nano-engineering Lab 1335 - Renovation

Every contractor and subcontractor shall keep posted on the construction site, in a conspicuous place, a copy of all prevailing wage and fringe benefit rates prescribed in a contract.
Official 2015 Prevailing Wage Rates for State Funded Projects

Issue Date: 2/18/2015
Contract must be awarded by: 5/19/2015

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name</th>
<th>Description</th>
<th>Last Updated</th>
<th>Straight Time and a Half Time</th>
<th>Double Overtime</th>
<th>Overtime Provision</th>
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<tbody>
<tr>
<td></td>
<td>Elevator Constructor</td>
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<td>3rd Year Apprentice</td>
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<td>$70.95</td>
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<td>GL-357</td>
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<td>$65.97</td>
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<td>If a four 10 hour day workweek is scheduled, four 10s must be consecutive, M-F.</td>
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<td>$45.85</td>
<td>$57.76</td>
</tr>
<tr>
<td></td>
<td>3rd 6 months</td>
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<td></td>
<td>$38.41</td>
<td>$52.56</td>
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<td></td>
<td>5th 6 months</td>
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<td>$39.90</td>
<td>$54.79</td>
<td>$69.68</td>
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<tr>
<td></td>
<td>6th 6 months</td>
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<td></td>
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<td>$75.64</td>
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</table>

Official Request #: 215
Requestor: Wayne State University
Project Description: Materials Science & Nano-engineering Lab 1335 - Renovation
County: Statewide
Project Number: 090-248124

Official Rate Schedule
Every contractor and subcontractor shall keep posted on the construction site, in a conspicuous place, a copy of all prevailing wage and fringe benefit rates prescribed in a contract.
# Official 2015 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 2/18/2015  
**Contract must be awarded by:** 5/19/2015

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name Description</th>
<th>Updated</th>
<th>Last</th>
<th>Straight Time and a Half</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat and Frost Insulator and Asbestos Worker</td>
<td>Heat and Frost Insulators and Asbestos Workers</td>
<td>1/29/2014</td>
<td>$60.25</td>
<td>$76.00</td>
<td>$91.74</td>
<td>H H H H H D Y</td>
</tr>
</tbody>
</table>

Four 10s must be worked for a minimum of 2 weeks consecutively, Monday thru Thursday. All hours worked in excess of 10 will be paid at double time. All hours worked on the fifth day, **require time and one half.**

Four 10s must be worked for a minimum of 2 consecutive weeks. OVERTIME is different on a four 10 week. OT is 2x for hours beyond 10. All hours on fifth day, M-F require time and one half. Sat first 8 hours, 1.5, all hours after 8 require double time.

### Apprentice Rates:

<table>
<thead>
<tr>
<th>Level</th>
<th>1st Year</th>
<th>2nd Year</th>
<th>3rd Year</th>
<th>4th Year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$46.08</td>
<td>$49.23</td>
<td>$50.80</td>
<td>$53.95</td>
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<tr>
<td></td>
<td>$54.74</td>
<td>$59.46</td>
<td>$61.82</td>
<td>$66.54</td>
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<td>$63.40</td>
<td>$69.70</td>
<td>$72.84</td>
<td>$79.14</td>
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</table>

### Ironworker

<table>
<thead>
<tr>
<th>Description</th>
<th>Updated</th>
<th>Last</th>
<th>Straight Time and a Half</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fence, Sound Barrier &amp; Guardrail erection/installation and Exterior Signage work</td>
<td>8/13/2014</td>
<td>$34.20</td>
<td>$46.45</td>
<td>$58.69</td>
<td>X X H X X H D Y</td>
</tr>
</tbody>
</table>

Four ten hour work days may be worked during Monday-Saturday.

### Apprentice Rates:

<table>
<thead>
<tr>
<th>Level</th>
<th>60% Level</th>
<th>65% Level</th>
<th>70% Level</th>
<th>75% Level</th>
<th>80% Level</th>
<th>85% Level</th>
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<tr>
<td></td>
<td>$23.04</td>
<td>$24.37</td>
<td>$25.70</td>
<td>$27.02</td>
<td>$28.34</td>
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<td>$40.29</td>
<td>$42.84</td>
<td>$45.39</td>
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<td>$50.49</td>
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**Official Request #: 215**  
**Requestor:** Wayne State University  
**Project Description:** Materials Science & Nano-engineering Lab 1335 - Renovation  
**County:** Wayne  

**Official Rate Schedule**  
Every contractor and subcontractor shall keep posted on the construction site, in a conspicuous place, a copy of all prevailing wage and fringe benefit rates prescribed in a contract.
<table>
<thead>
<tr>
<th>Classification</th>
<th>Name</th>
<th>Description</th>
<th>Last Updated</th>
<th>Straight Time and a Half Time</th>
<th>Double Time</th>
<th>Overtime Provision</th>
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</thead>
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<tr>
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<td>IR-25-GZ2</td>
<td>9/4/2014</td>
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<td>$58.07</td>
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<td>X X H H H D D Y</td>
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<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td>Make up day allowed</td>
<td>comment</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4 tens may be worked Monday thru Thursday</td>
<td>@ straight time.</td>
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</tr>
<tr>
<td>Level 1</td>
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<td>$36.09</td>
<td>$42.68</td>
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<td>$31.59</td>
<td>$38.83</td>
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<td>comment</td>
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<td>H H D D D D D N</td>
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<td>$72.39</td>
<td>$96.43</td>
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## Official 2015 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 2/18/2015  
**Contract must be awarded by:** 5/19/2015

### Classification Last Straight Overtime
Name Description Updated Hourly Half Double Provision

**Rigging Work**  
IR-25-RIG 9/3/2014  
$61.33 $91.67 $122.00 H H H H H D N

#### Apprentice Rates:

- Level 1 & 2  
  $36.63 $54.59 $72.55
- Level 3  
  $39.46 $58.84 $78.21
- Level 4  
  $42.28 $63.07 $83.85
- Level 5  
  $45.11 $67.31 $89.51
- Level 6  
  $47.94 $71.56 $95.17

**Decking**  
IR-25-SD 9/4/2014  
$53.29 $79.63 $105.96 X X H H H D D Y

4 tens may be worked Monday thru Thursday @ straight time. If bad weather, Friday may be a make up day. If holiday celebrated on a Monday, 4 10s may be worked Tuesday thru Friday. Work in excess of 12 hours per day must be paid @ double time.

Make up day allowed

#### Apprentice Rates:

- Levels 1 & 2  
  $36.05 $54.01 $71.97
- Level 3  
  $38.88 $58.26 $77.63
- Level 4  
  $41.70 $62.49 $83.27
- Level 5  
  $44.53 $66.73 $88.93
- Level 6  
  $47.36 $70.98 $94.59
- Level 7  
  $50.18 $75.20 $100.23
- Level 8  
  $53.01 $79.46 $105.89

**Structural, ornamental, welder and pre-cast**  
IR-25-STR 9/3/2014  
$61.46 $91.84 $122.21 H H H H D D Y

4 tens may be worked Monday thru Thursday @ straight time. If bad weather, Friday may be a make up day. If holiday celebrated on a Monday, 4 10s may be worked Tuesday thru Friday. Work in excess of 12 hours per day must be paid @ double time.

Make up day allowed

#### Apprentice Rates:

- Levels 1 & 2  
  $36.05 $54.01 $71.97
- Level 3  
  $38.88 $58.26 $77.63
- Level 4  
  $41.70 $62.49 $83.27
- Level 5  
  $44.53 $66.73 $88.93
- Level 6  
  $47.36 $70.98 $94.59
- Level 7  
  $50.18 $75.20 $100.23
- Level 8  
  $53.01 $79.46 $105.89

---

Official Request #: 215  
Requestor: Wayne State University  
Project Description: Materials Science & Nano-engineering Lab 1335 - Renovation  
Project Number: 090-248124  
County: Wayne

Official Rate Schedule

Every contractor and subcontractor shall keep posted on the construction site, in a conspicuous place, a copy of all prevailing wage and fringe benefit rates prescribed in a contract.

Page 9 of 33
### Official 2015 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 2/18/2015  
**Contract must be awarded by:** 5/19/2015  

**Classification Last Updated Straight Time and a Half Double Time Overtime Provision**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name Description</th>
<th>Updated</th>
<th>Hourly</th>
<th>$62.68</th>
<th>$83.33</th>
<th>$ H $ H $ H $ H $ D $ Y</th>
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<tr>
<td>Industrial Door erection &amp; construction</td>
<td>IR-25-STR-D 9/4/2014</td>
<td>$42.02</td>
<td>$62.68</td>
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</tr>
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</table>

**Make up day allowed** comment

Friday for bad weather when 4 tens scheduled for M-Th. If holiday celebrated on M, 4 tens may be worked T-F. Work in excess of 12 hours per day must be paid @ double time.

**Laborer**

<table>
<thead>
<tr>
<th>Construction Laborer, Demolition Laborer, Mason Tender, Carpenter Tender, Drywall Handler, Concrete Laborer, Cement Finisher Tender, Concrete Chute, and Concrete Bucket Handler</th>
</tr>
</thead>
<tbody>
<tr>
<td>L33401-A-CC 7/15/2013</td>
</tr>
</tbody>
</table>

If conditions beyond the employer/employee's control prevent one or more hours of working during Mon-Fri, the employer may choose to work up to 10 hour straight time weekdays. Work may be scheduled up to 10 hours per Mon-Fri for the purpose of reaching 40 hours @ straight time. Make up days may also include 8 Saturday.

**Apprentice Rates:**

<table>
<thead>
<tr>
<th>Work Hours</th>
<th>Hourly</th>
<th>Half Time</th>
<th>Double Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1,000 work hours</td>
<td>$37.60</td>
<td>$53.03</td>
<td>$68.45</td>
</tr>
<tr>
<td>1,001 - 2,000 work hours</td>
<td>$38.79</td>
<td>$54.81</td>
<td>$70.83</td>
</tr>
<tr>
<td>2,001 - 3,000 work hours</td>
<td>$39.98</td>
<td>$56.60</td>
<td>$73.21</td>
</tr>
<tr>
<td>3,001 - 4,000 work hours</td>
<td>$42.35</td>
<td>$60.15</td>
<td>$77.95</td>
</tr>
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</table>

**Signal Man (on sewer & caisson work), Air, Electric or Gasoline Tool Operator, Concrete Vibrator Operator, Acetylene Torch & Air Hammer Operator; Scaffold Builder, Caisson Worker**

| L33401-B-SB 7/16/2013 | $43.80 | $62.33 | $80.85 | $ H $ H $ H $ H $ D $ Y |

If conditions beyond the employer/employee's control prevent one or more hours of working during Mon-Fri, the employer may choose to work up to 10 hour straight time weekdays. Work may be scheduled up to 10 hours per Mon-Fri for the purpose of reaching 40 hours @ straight time. Make up days may also include 8 Saturday.

**Official Rate Schedule**

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Official 2015 Prevailing Wage Rates for State Funded Projects

Issue Date: 2/18/2015
Contract must be awarded by: 5/19/2015

Page 11 of 33

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name</th>
<th>Description</th>
<th>Updated</th>
<th>Last Straight Time and a Double Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Furnace Battery Heater Tender, Burning Bar &amp; Oxy-Acetylene Gun</td>
<td>L33401-D-HH</td>
<td>7/16/2013</td>
<td>$44.04 $62.69 $81.33 H H H H H D Y</td>
</tr>
<tr>
<td></td>
<td>Expediter Man, Top Man and/or Bottom Man (Blast Furnace Work or Battery Work)</td>
<td>L33401-E-EX</td>
<td>7/16/2013</td>
<td>$44.79 $63.81 $82.83 H H H H H D Y</td>
</tr>
<tr>
<td></td>
<td>Cleaner/Sweeper Laborer; Furniture Laborer</td>
<td>L33401-F-CL</td>
<td>7/16/2013</td>
<td>$38.09 $53.76 $69.43 H H H H H D Y</td>
</tr>
<tr>
<td></td>
<td>Lansing Burner, Blaster &amp; Powder Man; Air, Electric or Gasoline Tool Operator (Blast Furnace Work or Battery Work)</td>
<td>L334C</td>
<td>7/16/2013</td>
<td>$44.29 $63.06 $81.83 X X X H H H D Y</td>
</tr>
</tbody>
</table>

If conditions beyond the employer/employee's control prevent one or more hours of working during Mon-Fri, the employer may choose to work up to 10 hour straight time weekdays. Work may be scheduled up to 10 hours per Mon-Fri for the purpose of reaching 40 hours @ straight time. Make up days may also include 8 hours of work on Saturdays @ straight time.

Make up day allowed comment
Saturday

Official Rate Schedule
Requestor: Wayne State University
Project Description: Materials Science & Nano-engineering Lab 1335 - Renovation

Every contractor and subcontractor shall keep posted on the construction site, in a conspicuous place, a copy of all prevailing wage and fringe benefit rates prescribed in a contract.
### Official 2015 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 2/18/2015  
**Contract must be awarded by:** 5/19/2015

**Page 12 of 33**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name Description</th>
<th>Updated</th>
<th>Straight Time and a Half</th>
<th>Double Time</th>
<th>Overtime Provision</th>
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</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td></td>
<td>Last Updated</td>
<td></td>
<td>Hourly</td>
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</tr>
<tr>
<td>Plasterer Tender, Plastering Machine Operator</td>
<td>LPT-1</td>
<td>10/25/2013</td>
<td>$43.54</td>
<td>$61.94</td>
<td>$80.33 X X H H H H D Y</td>
</tr>
</tbody>
</table>

If conditions beyond the employer/employee's control prevent one or more hours of working during Mon-Fri, the employer may choose to work up to 10 hour straight time weekdays. Work may be scheduled up to 10 hours per Mon-Fri for the purpose of reaching 40 hours @ straight time. Make up days may also include 8

*Make up day allowed comment*

**Apprentice Rates:**

<table>
<thead>
<tr>
<th>Hours</th>
<th>Straight Time</th>
<th>Half Time</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 1,000</td>
<td>$37.60</td>
<td>$53.03</td>
<td>$68.45</td>
<td></td>
</tr>
<tr>
<td>1,001 - 2,000</td>
<td>$38.79</td>
<td>$54.81</td>
<td>$70.83</td>
<td></td>
</tr>
<tr>
<td>2,001 - 3,000</td>
<td>$39.98</td>
<td>$56.60</td>
<td>$73.21</td>
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</tr>
<tr>
<td>3,001 - 4,000</td>
<td>$42.35</td>
<td>$60.15</td>
<td>$77.95</td>
<td></td>
</tr>
</tbody>
</table>

**Laborer - Hazardous**

Class A performing work in conjunction with site preparation and other preliminary work prior to actual removal, handling, or containment of hazardous waste substances not requiring use of personal protective equipment required by state or federal regulations; or a laborer performing work in conjunction with the removal, handling, or containment of hazardous waste substances when use of personal protective equipment level "D" is required.

*Make up day allowed comment*

4 10s allowed M-Th or T-F; inclement weather makeup day Friday

**Apprentice Rates:**

<table>
<thead>
<tr>
<th>Hours</th>
<th>Straight Time</th>
<th>Half Time</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
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<tbody>
<tr>
<td>0-1,000 work hours</td>
<td>$37.60</td>
<td>$53.03</td>
<td>$68.45</td>
<td></td>
</tr>
<tr>
<td>1,001-2,000 work hours</td>
<td>$38.79</td>
<td>$54.81</td>
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<tr>
<td>2,001-3,000 work hours</td>
<td>$39.98</td>
<td>$56.60</td>
<td>$73.21</td>
<td></td>
</tr>
<tr>
<td>3,001-4,000 work hours</td>
<td>$42.35</td>
<td>$60.15</td>
<td>$77.95</td>
<td></td>
</tr>
</tbody>
</table>

**Official Rate Schedule**

Requestor: Wayne State University  
Project Description: Materials Science & Nano-engineering Lab 1335 - Renovation

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### Official 2015 Prevailing Wage Rates for State Funded Projects

#### Issue Date: 2/18/2015

#### Contract must be awarded by: 5/19/2015

---

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name</th>
<th>Description</th>
<th>Last Updated</th>
<th>Straight Time Hourly</th>
<th>Half Time</th>
<th>Double Overtime Hourly</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class B working in conjunction with the removal, handling, or containment of hazardous waste substances when the use of personal protective equipment levels &quot;A&quot;, &quot;B&quot; or &quot;C&quot; is required.</td>
<td>LHAZ-Z1-B</td>
<td>11/7/2014</td>
<td>$44.54</td>
<td>$63.44</td>
<td>$82.33</td>
<td>H H H H H D Y</td>
<td></td>
</tr>
<tr>
<td>4 10s allowed M-Th or T-F; inclement weather makeup day Friday</td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Apprentice Rates:</strong></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-1,000 work hours</td>
<td>$38.36</td>
<td>$54.17</td>
<td>$69.97</td>
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<td>1,001-2,000 work hours</td>
<td>$39.59</td>
<td>$56.01</td>
<td>$72.43</td>
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<tr>
<td>2,001-3,000 work hours</td>
<td>$40.83</td>
<td>$57.87</td>
<td>$74.91</td>
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<tr>
<td>3,001-4,000 work hours</td>
<td>$43.30</td>
<td>$61.58</td>
<td>$79.85</td>
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</tbody>
</table>

**Laborer Underground - Tunnel, Shaft & Caisson**

Class I - Tunnel, shaft and caisson laborer, dump man, shanty man, hog house tender, testing man (on gas), and watchman.

- **Apprentice Rates:**
  - 0-1,000 work hours: $33.05, $41.43, $49.80
  - 1,001-2,000 work hours: $34.02, $42.88, $51.74
  - 2,001-3,000 work hours: $34.98, $44.32, $53.66
  - 3,001-4,000 work hours: $36.91, $47.21, $57.52

Class II - Manhole, headwall, catch basin builder, bricklayer tender, mortar man, material mixer, fence erector, and guard rail builder.

- **Apprentice Rates:**
  - 0-1,000 work hours: $33.14, $41.56, $49.98
  - 1,001-2,000 work hours: $34.10, $43.00, $51.90
  - 2,001-3,000 work hours: $35.07, $44.45, $53.84
  - 3,001-4,000 work hours: $37.01, $47.37, $57.72

---

**Official Rate Schedule**

Every contractor and subcontractor shall keep posted on the construction site, in a conspicuous place, a copy of all prevailing wage and fringe benefit rates prescribed in a contract.

- Official Request #: 215
- Requestor: Wayne State University
- Project Description: Materials Science & Nano-engineering Lab 1335 - Renovation
- Project Number: 090-248124
- County: Wayne

Page 13 of 33
Class III - Air tool operator (jack hammer man, bush hammer man and grinding man), first bottom man, second bottom man, cage tender, car pusher, carrier man, concrete man, concrete form man, concrete repair man, cement invert laborer, cement finisher, concrete shoveler, conveyor man, floor man, gasoline and electric tool operator, gunnite man, grout operator, welder, heading dinky man, inside lock tender, pea gravel operator, pump man, outside lock tender, scaffold man, top signal man, switch man, track man, tugger man, utility man, vibrator man, winch operator, pipe jacking man, wagon drill and air track operator and concrete saw operator (under 40 h.p.).

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Updated</th>
<th>Straight Time and a Half Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAUCT-Z1-3</td>
<td>9/6/2013</td>
<td>$38.04</td>
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Apprentice Rates:

<table>
<thead>
<tr>
<th>Hours</th>
<th>Rate Hourly</th>
<th>Rate Half Hourly</th>
<th>Rate Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1,000 work hours</td>
<td>$33.18</td>
<td>$41.62</td>
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<td>1,001-2,000 work hours</td>
<td>$34.15</td>
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<td>2,001-3,000 work hours</td>
<td>$35.12</td>
<td>$44.53</td>
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</tr>
<tr>
<td>3,001-4,000 work hours</td>
<td>$37.07</td>
<td>$47.45</td>
<td>$57.84</td>
</tr>
</tbody>
</table>

Class IV - Tunnel, shaft and caisson mucker, bracer man, liner plate man, long haul dinky driver and well point man.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Updated</th>
<th>Straight Time and a Half Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>LAUCT-Z1-4</td>
<td>9/6/2013</td>
<td>$38.22</td>
<td>$49.18</td>
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Apprentice Rates:

<table>
<thead>
<tr>
<th>Hours</th>
<th>Rate Hourly</th>
<th>Rate Half Hourly</th>
<th>Rate Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-1,000 work hours</td>
<td>$33.32</td>
<td>$41.83</td>
<td>$50.34</td>
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<tr>
<td>1,001-2,000 work hours</td>
<td>$34.30</td>
<td>$43.30</td>
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<tr>
<td>2,001-3,000 work hours</td>
<td>$35.28</td>
<td>$44.77</td>
<td>$54.26</td>
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<tr>
<td>3,001-4,000 work hours</td>
<td>$37.24</td>
<td>$47.71</td>
<td>$58.18</td>
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</tbody>
</table>

Official Request #: 215

Official Rate Schedule

Every contractor and subcontractor shall keep posted on the construction site, in a conspicuous place, a copy of all prevailing wage and fringe benefit rates prescribed in a contract.

Page 14 of 33
<table>
<thead>
<tr>
<th>Classification</th>
<th>Name Description</th>
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<th>Straight Time and a Half Hourly</th>
<th>Double Time Hourly</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class V</td>
<td>Tunnel, shaft and caisson miner, drill runner, keyboard operator, power knife operator, reinforced steel or mesh man (e.g. wire mesh, steel mats, dowel bars)</td>
<td>9/6/2013</td>
<td>$38.47 $49.56 $60.64 X X X X X X D Y</td>
<td></td>
<td></td>
</tr>
<tr>
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<td>Apprentice Rates:</td>
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</tr>
<tr>
<td></td>
<td>0-1,000 work hours</td>
<td>$38.47</td>
<td>$49.56 $60.64 X X X X X X D Y</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>1,001-2,000 work hours</td>
<td>$38.47</td>
<td>$49.56 $60.64 X X X X X X D Y</td>
<td></td>
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<tr>
<td></td>
<td>2,001-3,000 work hours</td>
<td>$38.47</td>
<td>$49.56 $60.64 X X X X X X D Y</td>
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</tr>
<tr>
<td></td>
<td>3,001-4,000 work hours</td>
<td>$38.47</td>
<td>$49.56 $60.64 X X X X X X D Y</td>
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</tr>
<tr>
<td>Class VI</td>
<td>Dynamite man and powder man.</td>
<td>9/6/2013</td>
<td>$38.80 $50.05 $61.30 X X X X X D Y</td>
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<tr>
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<td>0-1,000 work hours</td>
<td>$38.80</td>
<td>$50.05 $61.30 X X X X X D Y</td>
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<td></td>
<td>1,001-2,000 work hours</td>
<td>$38.80</td>
<td>$50.05 $61.30 X X X X X D Y</td>
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<td></td>
<td>2,001-3,000 work hours</td>
<td>$38.80</td>
<td>$50.05 $61.30 X X X X X D Y</td>
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<tr>
<td></td>
<td>3,001-4,000 work hours</td>
<td>$38.80</td>
<td>$50.05 $61.30 X X X X X D Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class VII</td>
<td>Restoration laborer, seeding, sodding, planting, cutting, mulching and topsoil grading and the restoration of property such as replacing mail boxes, wood chips, planter boxes and flagstones.</td>
<td>9/6/2013</td>
<td>$32.08 $39.97 $47.86 X X X X X D Y</td>
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<td></td>
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<tr>
<td></td>
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<td></td>
<td>0-1,000 work hours</td>
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<td>$34.91 $41.12</td>
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<td>$31.41</td>
<td>$38.97 $46.52</td>
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## Official 2015 Prevailing Wage Rates for State Funded Projects

### Issue Date: 2/18/2015

**Contract must be awarded by:** 5/19/2015

**Page 16 of 33**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name</th>
<th>Description</th>
<th>Updated</th>
<th>Last Straight Time and a Double Overtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landscape Laborer</td>
<td>Landscape Laborer</td>
<td>Landscape Specialist includes air, gas, and diesel equipment operator, skidsteer (or equivalent), lawn sprinkler installer on landscaping work where seeding, sodding, planting, cutting, trimming, backfilling, rough grading or maintenance of landscape projects occurs. Sundays paid at time &amp; one half. Holidays paid at double time.</td>
<td>LLAN-Z1-A</td>
<td>6/26/2014 $28.58 $39.49 $50.39 X X H X X X D Y</td>
</tr>
<tr>
<td>Skilled Landscape Laborer</td>
<td>Skilled Landscape Laborer: small power tool operator, lawn sprinklers' tender, material mover, truck driver when seeding, sodding, planting, cutting, trimming, backfilling, rough grading or maintaining of landscape projects occurs. Sundays paid at time &amp; one half. Holidays paid at double time.</td>
<td>LLAN-Z1-B</td>
<td>6/26/2014 $24.36 $33.16 $41.95 X X H X X X H D Y</td>
<td></td>
</tr>
<tr>
<td>Marble Finisher</td>
<td>Marble Finisher</td>
<td>A 4 ten workweek may be worked Monday thru Thursday or Tuesday thru Friday.</td>
<td>BR1-MF</td>
<td>10/20/2014 $43.48 $54.29 $65.10 H H D D D D Y</td>
</tr>
</tbody>
</table>

### Apprentice Rates:

- Level 1: $19.04 $25.12 $31.20
- Level 2: $20.24 $26.92 $33.60
- Level 3: $27.01 $33.96 $40.90
- Level 4: $28.47 $36.14 $43.82
- Level 5: $29.99 $37.84 $45.70
- Level 6: $31.61 $39.86 $48.10
- Level 7: $33.30 $41.59 $49.87
- Level 8: $34.79 $43.48 $52.17

### Official Rate Schedule

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Requestor: Wayne State University  
Project Description: Materials Science & Nano-engineering Lab 1335 - Renovation  
Project Number: 090-248124  
County: Wayne
## Official 2015 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 2/18/2015  
**Contract must be awarded by:** 5/19/2015

### Page 17 of 33

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<tr>
<th>Classification</th>
<th>Name</th>
<th>Description</th>
<th>Last Updated</th>
<th>Straight Time</th>
<th>Half Hourly</th>
<th>Double Overtime</th>
<th>Overtime Provision</th>
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</thead>
<tbody>
<tr>
<td>Marble Mason</td>
<td>BR1-MM</td>
<td>Marble Mason</td>
<td>10/17/2014</td>
<td>$50.29</td>
<td>$64.51</td>
<td>$78.72</td>
<td>H H D D D D Y</td>
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<tr>
<td></td>
<td></td>
<td>A 4 ten workweek may be worked Monday thru Thursday or Tuesday thru Friday.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

#### Apprentice Rates:

- **Level 1**  
  - Straight Time: $25.14  
  - Hourly: $32.65  
  - Double Overtime: $40.15
- **Level 2**  
  - Straight Time: $28.20  
  - Hourly: $36.49  
  - Double Overtime: $44.78
- **Level 3**  
  - Straight Time: $33.41  
  - Hourly: $41.97  
  - Double Overtime: $50.53
- **Level 4**  
  - Straight Time: $36.15  
  - Hourly: $45.66  
  - Double Overtime: $55.17
- **Level 5**  
  - Straight Time: $38.42  
  - Hourly: $48.17  
  - Double Overtime: $57.92
- **Level 6**  
  - Straight Time: $42.07  
  - Hourly: $53.56  
  - Double Overtime: $65.05
- **Level 7**  
  - Straight Time: $42.74  
  - Hourly: $54.38  
  - Double Overtime: $66.02
- **Level 8**  
  - Straight Time: $43.67  
  - Hourly: $55.78  
  - Double Overtime: $67.88

### Operating Engineer

- **Crane with boom & jib or leads 120' or longer**  
  - Straight Time: $57.11  
  - Hourly: $74.62  
  - Double Overtime: $92.13  
  - Overtime Provision: X X H H D D D Y  
  - Double time after 12 hours M-F

- **Crane with boom & jib or leads 140' or longer**  
  - Straight Time: $57.93  
  - Hourly: $75.85  
  - Double Overtime: $93.77  
  - Overtime Provision: X X H H D D D Y  
  - Work in excess of 12 per day M-F shall be paid at double time.

- **Crane with boom & jib or leads 220' or longer**  
  - Straight Time: $58.23  
  - Hourly: $76.30  
  - Double Overtime: $94.37  
  - Overtime Provision: X X H H D D D Y  
  - Work in excess of 12 per day M-F shall be paid at double time.

- **Crane with boom & jib or leads 300' or longer**  
  - Straight Time: $59.73  
  - Hourly: $78.55  
  - Double Overtime: $97.37  
  - Overtime Provision: X X H H D D D Y  
  - Work in excess of 12 per day M-F shall be paid at double time.

---

**Official Request #:** 215  
**Requestor:** Wayne State University  
**Project Description:** Materials Science & Nano-engineering Lab 1335 - Renovation

---

**Official Rate Schedule**

Every contractor and subcontractor shall keep posted on the construction site, in a conspicuous place, a copy of all prevailing wage and fringe benefit rates prescribed in a contract.
### Official 2015 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 2/18/2015  
**Contract must be awarded by:** 5/19/2015

#### Page 18 of 33

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name Description</th>
<th>Updated</th>
<th>Last Hourly</th>
<th>Straight Time and Half</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crane with boom &amp; jib or leads 400' or longer</td>
<td>EN-324-A400 6/12/2014</td>
<td>$61.23</td>
<td>$80.80</td>
<td>$100.37</td>
<td>X X H H D D D D Y</td>
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<td>Work in excess of 12 per day M-F shall be paid at double time.</td>
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</table>

| Compressor or welding machine | EN-324-CW 6/12/2014 | $46.26 | $58.35 | $70.43 | X X H H D D D D Y |
| Work in excess of 12 per day M-F shall be paid at double time. |

| Forklift, lull, extend-a-boom forklift | EN-324-FL 6/12/2014 | $53.57 | $69.31 | $85.05 | X X H H D D D D Y |
| Work in excess of 12 per day M-F shall be paid at double time. |

| Fireman or oiler | EN-324-FO 6/12/2014 | $45.23 | $56.80 | $68.37 | X X H H D D D D Y |
| Work in excess of 12 per day M-F shall be paid at double time. |

| Regular crane, job mechanic, concrete pump with boom | EN-324-RC 6/12/2014 | $56.25 | $73.33 | $90.41 | X X H H D D D D Y |
| Work in excess of 12 per day M-F shall be paid at double time. |

| Regular engineer, hydro-excavator, remote controlled concrete breaker | EN-324-RE 6/12/2014 | $55.28 | $71.88 | $88.47 | X X H H D D D D Y |
| Work in excess of 12 per day M-F shall be paid at double time. |

#### Apprentice Rates:

<table>
<thead>
<tr>
<th>Hours Range</th>
<th>Hourly Rate</th>
<th>Half Time Rate</th>
<th>Double Time Rate</th>
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<tbody>
<tr>
<td>0-999 hours</td>
<td>$44.32</td>
<td>$55.94</td>
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<td>1,000-1,999 hours</td>
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<td>5,000-5,999 hours</td>
<td>$52.62</td>
<td>$68.39</td>
<td>$84.15</td>
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</table>

#### Official Rate Schedule

- Every contractor and subcontractor shall keep posted on the construction site, in a conspicuous place, a copy of all prevailing wage and fringe benefit rates prescribed in a contract.
### Official 2015 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 2/18/2015  
**Contract must be awarded by:** 5/19/2015  

#### Page 19 of 33

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name Description</th>
<th>Updated</th>
<th>Straight Hourly</th>
<th>Half Hourly</th>
<th>Double Time</th>
<th>Overtime Provision</th>
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<tr>
<td>Operating Engineer - DIVER</td>
<td>Diver/Wet Tender/Tender/Rov Pilot/Rov Tender</td>
<td>4/2/2014</td>
<td>$52.80</td>
<td>$79.20</td>
<td>$105.60</td>
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</table>

**Operating Engineer - Marine Construction**

Diver/Wet Tender, Engineer (hydraulic dredge)  
GLF-1  
2/12/2014  
$65.00 $84.85 $104.70  
X  
X  
H  
H  
H  
H  
H  
D  
Y

**Make up day allowed**

**Subdivision of county**  
All Great Lakes, islands therein, & connecting & tributary waters

Crane/Backhoe Operator, 70 ton or over Tug Operator, Mechanic/Welder, Assistant Engineer (hydraulic dredge), Leverman (hydraulic dredge), Diver Tender  
GLF-2  
2/12/2014  
$63.50 $82.60 $101.70  
X  
X  
H  
H  
H  
H  
H  
D  
Y

**Holiday pay = $120.80 per hour, wages &**

**Make up day allowed**

**Subdivision of county**  
All Great Lakes, islands therein, & connecting & tributary waters  
Friction, Lattice Boom or Crane License Certification  
GLF-2B  
2/12/2014  
$64.50 $84.10 $103.70  
X  
X  
H  
H  
H  
H  
H  
D  
Y

**Holiday pay = $123.30**

**Make up day allowed**

**Subdivision of county**  
All Great Lakes, islands therein, & connecting & tributary waters  
Deck Equipment Operator, Machineryman, Maintenance of Crane (over 50 ton capacity) or Backhoe (115,000 lbs or more), Tug/Launch Operator, Loader, Dozer on Barge, Deck Machinery  
GLF-3  
2/12/2014  
$59.30 $76.30 $93.30  
X  
X  
H  
H  
H  
H  
H  
D  
Y

**Holiday pay = $110.30 per hour, wages &**

**Make up day allowed**

**Subdivision of county**  
All Great Lakes, islands therein, & connecting & tributary waters  
Official Request #: 215  
Official Rate

---

**Schedule**  
Requestor: Wayne State University  
Project Description: Materials Science & Nano-engineering Lab 1335 - Renovation

---

Every contractor and subcontractor shall keep posted on the construction site, in a conspicuous place, a copy of all prevailing wage and fringe benefit rates prescribed in a contract.
### Official 2015 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 2/18/2015  
**Contract must be awarded by:** 5/19/2015

#### Classification

<table>
<thead>
<tr>
<th>Name Description</th>
<th>Updated</th>
<th>Last Straight Time and Double Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deck Equipment Operator, (Machineryman/Fireman), (4 equipment units or more), Off Road Trucks, Deck Hand, Tug Engineer, &amp; Crane Maintenance 50 ton capacity and under or Backhoe 115,000 lbs or less, Assistant Tug Operator</td>
<td>2/12/2014</td>
<td>$53.60 $67.75 $81.90 X X H H H D Y</td>
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<td>Holiday pay = $96.05 per hour, wages &amp; fringes</td>
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<tr>
<td>Make up day allowed</td>
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<td></td>
</tr>
<tr>
<td>Subdivision of county</td>
<td>All Great Lakes, islands therein, &amp; connecting &amp; tributary waters</td>
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#### Operating Engineer Steel Work

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<th>Last Straight Time and Double Overtime Provision</th>
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<tbody>
<tr>
<td>Forklift, 1 Drum Hoist</td>
<td>9/5/2014</td>
<td>$58.16 $76.37 $94.58 H H D H H D D Y</td>
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</tr>
<tr>
<td>4 10s allowed M-Th with Friday makeup day because of bad weather</td>
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<td></td>
</tr>
<tr>
<td>Crane w/ 120' boom or longer</td>
<td>9/5/2014</td>
<td>$60.86 $80.42 $99.98 H H D H H D D Y</td>
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<tr>
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<tr>
<td>4 10s allowed M-Th with Friday makeup day because of bad weather</td>
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<td></td>
</tr>
<tr>
<td>Crane w/ 120' boom or longer w/ Oiler</td>
<td>9/5/2014</td>
<td>$61.86 $81.92$101.98 H H D H H D</td>
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<tr>
<td>Make up day allowed</td>
<td>comment</td>
<td></td>
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<tr>
<td>Y 4 10s allowed M-Th with Friday makeup day because of bad weather</td>
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<td></td>
</tr>
<tr>
<td>Crane w/ 140' boom or longer</td>
<td>9/5/2014</td>
<td>$62.04 $82.19 $102.34 H H D H H D D Y</td>
</tr>
<tr>
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<td>comment</td>
<td></td>
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<tr>
<td>4 10s allowed M-Th with Friday makeup day because of bad weather</td>
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</tr>
<tr>
<td>Crane w/ 140' boom or longer W/ Oiler</td>
<td>9/5/2014</td>
<td>$63.04 $83.69$104.34 H H D H H D</td>
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</tr>
<tr>
<td>Y 4 10s allowed M-Th with Friday makeup day because of bad weather</td>
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<tr>
<td>Boom &amp; Jib 220' or longer</td>
<td>9/5/2014</td>
<td>$62.31 $82.60 $102.88 H H D H H D D Y</td>
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<td>4 10s allowed M-Th with Friday makeup day because of bad weather</td>
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<tr>
<td>Crane w/ 220' boom or longer w/ Oiler</td>
<td>9/5/2014</td>
<td>$63.31 $84.10$104.88 H H D H H D</td>
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<tr>
<td>Make up day allowed</td>
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<tr>
<td>D Y 4 10s allowed M-Th with Friday makeup day because of bad weather</td>
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</table>

**Official Rate Schedule**  
Every contractor and subcontractor shall keep posted on the construction site, in a conspicuous place, a copy of all prevailing wage and fringe benefit rates prescribed in a contract.
## Official 2015 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 2/18/2015  
**Contract must be awarded by:** 5/19/2015

### Page 21 of 33

<table>
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<tr>
<th>Classification</th>
<th>Name Description</th>
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<th>Double Time</th>
<th>Overtime Provision</th>
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<td></td>
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<td>Updated Hourly</td>
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<tr>
<td>Boom &amp; Jib 300' or longer</td>
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<tr>
<td>Crane w/ 300' boom or longer w/ Oiler</td>
<td>EN-324-SW300-O Y</td>
<td>9/5/2014</td>
<td>$64.81</td>
<td>$86.35</td>
<td>$107.88 H H D H H D</td>
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<tr>
<td>Boom &amp; Jib 400' or longer</td>
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<tr>
<td>Crane w/ 400' boom or longer w/ Oiler</td>
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<td>$88.60</td>
<td>$110.88 H H D H H D</td>
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<tr>
<td>Crane Operator, Job Mechanic, 3 Drum Hoist &amp; Excavator</td>
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<td>Apprentice Rates:</td>
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<tr>
<td>Compressor or Welder Operator</td>
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**Official Request #:** 215  
**Requestor:** Wayne State University  
**Project Description:** Materials Science & Nano-engineering Lab 1335 - Renovation  
**Project Number:** 090-248124  
**County:** Wayne

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**Official Rate Schedule**

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<table>
<thead>
<tr>
<th>Classification</th>
<th>Name</th>
<th>Description</th>
<th>Last Updated</th>
<th>Straight Time and a Half Time</th>
<th>Double Time</th>
<th>Overtime Provision</th>
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<tbody>
<tr>
<td></td>
<td>Hoisting Operator, 2 Drum Hoist, &amp; Rubber Tire</td>
<td>EN-324-SWHO</td>
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<td>$97.98</td>
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<td>4 10s allowed M-Th with Friday makeup day because of bad weather</td>
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<tr>
<td></td>
<td>Oiler</td>
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<tr>
<td></td>
<td>Tower Crane &amp; Derrick where work is 50’ or more above first level</td>
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<td>Tower Crane &amp; Derrick 50’ or more w/ Oiler where work station is 50’ or more above first</td>
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<td>$62.59</td>
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<td>1,000-1,999 hours</td>
<td>$43.32</td>
<td>$54.75</td>
<td>$66.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2,000-2,999 hours</td>
<td>$44.84</td>
<td>$57.03</td>
<td>$69.22</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3,000-3,999 hours</td>
<td>$46.36</td>
<td>$59.31</td>
<td>$72.26</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4,000-4,999 hours</td>
<td>$47.89</td>
<td>$61.61</td>
<td>$75.32</td>
<td></td>
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<tr>
<td></td>
<td>5,000-5,999 hours</td>
<td>$49.41</td>
<td>$63.89</td>
<td>$78.36</td>
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<tr>
<td></td>
<td>Class II Equipment</td>
<td>EN-324A1-UC2</td>
<td>10/14/2014</td>
<td>$47.01</td>
<td>$59.89</td>
<td>$72.76</td>
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<td>Class III Equipment</td>
<td>EN-324A1-UC3</td>
<td>10/14/2014</td>
<td>$46.28</td>
<td>$58.79</td>
<td>$71.30</td>
</tr>
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</table>
## Official 2015 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 2/18/2015  
**Contract must be awarded by:** 5/19/2015

### Classification: Class IV Equipment

<table>
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<tr>
<th>Name</th>
<th>Description</th>
<th>Last Updated</th>
<th>Straight Time and a Half Hourly</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class IV Equipment</td>
<td>EN-324A1-UC4 10/14/2014</td>
<td>$45.71</td>
<td>$57.94</td>
<td>$70.16</td>
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</tr>
</tbody>
</table>

### Classification: Master Mechanic

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Last Updated</th>
<th>Straight Time and a Half Hourly</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master Mechanic</td>
<td>EN-324A1-UMM 10/14/2014</td>
<td>$51.99</td>
<td>$67.81</td>
<td>$83.63</td>
<td>H H H H H D</td>
</tr>
</tbody>
</table>

### Painter

**Painter** (8 hours of repaint work performed on Sunday shall be paid time & one half rate)

- **PT-22-P** 10/8/2014
  - Straight Time and a Half Hourly: $42.82
  - Double Time: $55.63
  - Overtime Provision: H H D D D D Y

Four 10s allowed Monday-Thursday with Friday makeup day if job down due to weather, holiday or other conditions beyond the control of the employer.

**Make up day allowed comment**

Fridays for bad weather or holidays

### Apprentice Rates:

- **First 6 months**: $30.02, $36.43, $42.83
- **Second 6 months**: $33.86, $42.19, $50.51
- **Third 6 months**: $35.14, $44.11, $53.07
- **Fourth 6 months**: $36.42, $46.03, $55.63
- **Fifth 6 months**: $37.70, $47.95, $58.19
- **Final 6 months**: $38.98, $49.87, $60.75

### Pipe and Manhole Rehab

- **General Laborer for rehab work or normal cleaning and cctv work-top man, scaffold man, CCTV assistant, jetter-vac assistant**
  - **TM247** 10/15/2012
    - Straight Time and a Half Hourly: $27.20
    - Double Time: $36.70
    - Overtime Provision: H H H H H H H H N

- **Tap cutter/CCTV Tech/Grout Equipment Operator**: unit driver and operator of CCTV, grouting equipment and tap cutting equipment
  - **TM247-2** 10/15/2012
    - Straight Time and a Half Hourly: $31.70
    - Double Time: $43.45
    - Overtime Provision: H H H H H H H H N

---

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## Official 2015 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 2/18/2015  
**Contract must be awarded by:** 5/19/2015

### Page 24 of 33

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name Description</th>
<th>Updated</th>
<th>Straight Time Hourly</th>
<th>Half Time</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCTV Technician/Combo Unit Operator</td>
<td>unit driver and operator of cctv unit or combo unit in connection with normal cleaning and televising work</td>
<td>10/15/2012</td>
<td>$30.45</td>
<td>$41.57</td>
<td>H H H H H H H H N</td>
<td></td>
</tr>
<tr>
<td>Boiler Operator</td>
<td>unit driver and operator of steam/water heater units and all ancillary equipment associated</td>
<td>10/15/2012</td>
<td>$32.20</td>
<td>$44.20</td>
<td>H H H H H H H H N</td>
<td></td>
</tr>
<tr>
<td>Combo Unit driver &amp; Jetter-Vac Operator</td>
<td>Pipe Bursting &amp; Slip-lining Equipment Operator</td>
<td>10/15/2012</td>
<td>$32.20</td>
<td>$44.20</td>
<td>H H H H H H H H N</td>
<td></td>
</tr>
</tbody>
</table>

### Pipefitter

<table>
<thead>
<tr>
<th>Name Description</th>
<th>Updated</th>
<th>Straight Time Hourly</th>
<th>Half Time</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipefitter</td>
<td>6/30/2014</td>
<td>$66.73</td>
<td>$87.93</td>
<td>$105.13</td>
<td>H H D H D D D Y</td>
</tr>
</tbody>
</table>

**Comment**  
Four 10s allowed during the week preceding, following and/or the week of a holiday.

### Apprentice Rates:

<table>
<thead>
<tr>
<th>Periods</th>
<th>1st &amp; 2nd periods</th>
<th>3rd period</th>
<th>4th period</th>
<th>5th period</th>
<th>6th period</th>
<th>7th period</th>
<th>8th period</th>
<th>9th period</th>
<th>10th period</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st &amp; 2nd</td>
<td>$26.93</td>
<td>$35.28</td>
<td>$42.28</td>
<td>$28.93</td>
<td>$38.28</td>
<td>$46.28</td>
<td>$30.18</td>
<td>$40.16</td>
<td>$48.78</td>
</tr>
<tr>
<td>3rd period</td>
<td>$31.43</td>
<td>$42.03</td>
<td>$51.28</td>
<td>$32.68</td>
<td>$43.90</td>
<td>$53.78</td>
<td>$33.93</td>
<td>$45.78</td>
<td>$56.28</td>
</tr>
<tr>
<td>4th period</td>
<td>$34.93</td>
<td>$47.28</td>
<td>$58.28</td>
<td>$35.93</td>
<td>$48.78</td>
<td>$60.28</td>
<td>$37.36</td>
<td>$50.92</td>
<td>$63.14</td>
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</table>

Official Request #: 215  
Requestor: Wayne State University  
Project Description: Materials Science & Nano-engineering Lab 1335 - Renovation  
Project Number: 090-248124  
County: Wayne  

Official Rate Schedule  
Every contractor and subcontractor shall keep posted on the construction site, in a conspicuous place, a copy of all prevailing wage and fringe benefit rates prescribed in a contract.
### Official 2015 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 2/18/2015  
**Contract must be awarded by:** 5/19/2015

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name</th>
<th>Description</th>
<th>Updated</th>
<th>Straight Time and a Half Time</th>
<th>Double Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plasterer</td>
<td>BR1P</td>
<td>1/1/2012</td>
<td>$45.04</td>
<td>$67.56</td>
<td>$90.08</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>H H H H H H D N</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Make up day allowed</td>
<td>comment</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Saturday</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Apprentice Rates:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1st 6 months</td>
<td>$32.11</td>
<td>$48.17</td>
<td>$64.22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2nd 6 months</td>
<td>$33.40</td>
<td>$50.10</td>
<td>$66.80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3rd 6 months</td>
<td>$34.69</td>
<td>$52.04</td>
<td>$69.38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4th 6 months</td>
<td>$37.28</td>
<td>$55.92</td>
<td>$74.56</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5th 6 months</td>
<td>$39.87</td>
<td>$59.81</td>
<td>$79.74</td>
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<tr>
<td></td>
<td></td>
<td>6th 6 months</td>
<td>$42.45</td>
<td>$63.68</td>
<td>$84.90</td>
</tr>
</tbody>
</table>

| Plasterer      | PL67 | 9/8/2010    | $44.72  | $60.11                       | $75.50                    |
|                |      |             |         | H H X D D D N               |                           |
|                |      | Apprentice Rates: |
|                |      | 1st 6 months | $29.33  | $37.02                       | $44.72                    |
|                |      | 2nd 6 months | $30.87  | $39.34                       | $47.80                    |
|                |      | 3rd 6 months | $32.41  | $41.64                       | $50.88                    |
|                |      | 4th 6 months | $35.49  | $46.26                       | $57.04                    |
|                |      | 5th 6 months | $38.56  | $51.16                       | $63.76                    |
|                |      | 6th 6 months | $41.64  | $55.49$69.34                |                           |
|                |      | Official Request #: 215 |

**Official Rate Schedule**

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Requestor: Wayne State University  
Project Description: Materials Science & Nano-engineering Lab 1335 - Renovation  
Project Number: 090-248124  
County: Wayne

Page 25 of 33
# Official 2015 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 2/18/2015  
**Contract must be awarded by:** 5/19/2015  

### Classification Last Straight Time and a Double Overtime Provision

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Updated</th>
<th>Hourly</th>
<th>Half Time</th>
<th>Overtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plumber</td>
<td></td>
<td>7/18/2013</td>
<td>$64.45</td>
<td>$84.87</td>
<td>$101.29</td>
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</tbody>
</table>

*comment*

4 tens allowed M-Th or T-F; OT of time and one half required on 11th & 12th hour of any ten hour days

### Apprentice Rates:

<table>
<thead>
<tr>
<th>Period</th>
<th>Hourly</th>
<th>Half Time</th>
<th>Overtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$19.93</td>
<td>$26.43</td>
<td>$32.93</td>
</tr>
<tr>
<td>2</td>
<td>$23.90</td>
<td>$31.40</td>
<td>$38.90</td>
</tr>
<tr>
<td>3</td>
<td>$30.60</td>
<td>$39.19</td>
<td>$47.77</td>
</tr>
<tr>
<td>4</td>
<td>$31.23</td>
<td>$40.13</td>
<td>$49.03</td>
</tr>
<tr>
<td>5</td>
<td>$32.39</td>
<td>$41.87</td>
<td>$51.35</td>
</tr>
<tr>
<td>6</td>
<td>$33.54</td>
<td>$43.59</td>
<td>$53.65</td>
</tr>
<tr>
<td>7</td>
<td>$34.69</td>
<td>$45.32</td>
<td>$55.95</td>
</tr>
<tr>
<td>8</td>
<td>$35.86</td>
<td>$47.07</td>
<td>$58.29</td>
</tr>
<tr>
<td>9</td>
<td>$37.01</td>
<td>$48.80</td>
<td>$60.59</td>
</tr>
<tr>
<td>10</td>
<td>$38.16</td>
<td>$50.53</td>
<td>$62.89</td>
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</tbody>
</table>

### Roofer

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Updated</th>
<th>Hourly</th>
<th>Half Time</th>
<th>Overtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial Roofer</td>
<td></td>
<td>8/18/2008</td>
<td>$48.46</td>
<td>$62.29</td>
<td>$76.62</td>
</tr>
</tbody>
</table>

Straight time is not to exceed ten (10) hours per day or forty (40) hours per week.  
*Make up day allowed*

### Apprentice Rates:

<table>
<thead>
<tr>
<th>Apprentice</th>
<th>Hourly</th>
<th>Half Time</th>
<th>Overtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$32.62</td>
<td>$39.86</td>
<td>$48.04</td>
</tr>
<tr>
<td>2</td>
<td>$36.80</td>
<td>$44.80</td>
<td>$53.30</td>
</tr>
<tr>
<td>3</td>
<td>$38.22</td>
<td>$46.93</td>
<td>$56.14</td>
</tr>
<tr>
<td>4</td>
<td>$39.25</td>
<td>$48.48</td>
<td>$58.20</td>
</tr>
<tr>
<td>5</td>
<td>$40.47</td>
<td>$50.30</td>
<td>$60.64</td>
</tr>
<tr>
<td>6</td>
<td>$41.87</td>
<td>$52.40</td>
<td>$63.44</td>
</tr>
</tbody>
</table>

### Sewer Relining

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Updated</th>
<th>Hourly</th>
<th>Half Time</th>
<th>Overtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class I-Operator of audio visual CCTV system including remote in-ground cutter and other equipment used in conjunction with CCTV</td>
<td>SR-I</td>
<td>11/3/2014</td>
<td>$42.76</td>
<td>$57.75</td>
<td>$72.74</td>
</tr>
</tbody>
</table>

Official Request #: 215  
Requestor: Wayne State University  
Project Description: Materials Science & Nano-engineering Lab 1335 - Renovation  

Official Rate Schedule  
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### Classification

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
<th>Updated</th>
<th>Last Straight Time and a Half Double Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hourly</td>
</tr>
<tr>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Class II-Operator of hot water heaters and circulation system; water jetters; and vacuum and mechanical debris removal systems and those assisting.**

**Sheet Metal Worker**

<table>
<thead>
<tr>
<th>Name &amp; Description</th>
<th>Updated</th>
<th>Straight Time</th>
<th>a Half Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHM-80</td>
<td>9/9/2014</td>
<td>$61.83</td>
<td>$78.74</td>
<td>$95.65 H H D X H H D Y</td>
</tr>
</tbody>
</table>

A 4 10 schedule may be worked, 4 consecutive days Monday thru Friday.

**Apprentice Rates:**

- 1st & 2nd Periods Indentured after 6-1-11: $39.18 $46.79 $54.40
- 3rd & 4th Periods Indentured after 6-1-11: $40.88 $49.34 $57.80
- 5th & 6th Periods Indentured after 6-1-11: $42.56 $51.86 $61.16
- 7th & 8th Periods Indentured after 6-1-11: $44.25 $54.40 $64.54
- 9th & 10th Periods Indentured before 6-1-11: $51.92 $64.44 $76.96

**Siding and decking**

<table>
<thead>
<tr>
<th>Name &amp; Description</th>
<th>Updated</th>
<th>Straight Time</th>
<th>a Half Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHM-80-SD</td>
<td>1/13/2014</td>
<td>$42.07</td>
<td>$54.28</td>
<td>$66.48 H H H H H H D Y</td>
</tr>
</tbody>
</table>

**Make up day allowed**  
**Official Request #:** 215  
**Requestor:** Wayne State University  
**Project Description:** Materials Science & Nano-engineering Lab 1335 - Renovation

**Official Rate Schedule**

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### Official Prevailing Wage Rates for State Funded Projects

**Issue Date:** 2/18/2015  
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#### Page 28 of 33

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name Description</th>
<th>Updated</th>
<th>Last Straight Time and a Double Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hourly Half Time</td>
</tr>
<tr>
<td>Sprinkler Fitter</td>
<td>Sprinkler Fitter</td>
<td>12/19/2014</td>
<td>$64.92 $86.15 $107.38 H H D D D D Y</td>
</tr>
<tr>
<td>Terrazzo</td>
<td>Terrazzo Finisher</td>
<td>10/17/2014</td>
<td>$43.97 $55.03 $66.08 H H D D D D Y</td>
</tr>
</tbody>
</table>

**Sprinkler Fitter**

- Sprinkler Fitter SP 704  
- 4 ten hour days allowed Monday-Friday  
- Double time pay due after 12 hours worked M-F

**Apprentice Rates:**

1. 1st Period: $28.29 $36.78 $45.27  
2. 2nd Period: $41.57 $51.12 $60.68  
3. 3rd Period: $43.69 $54.30 $64.92  
4. 4th Period: $45.81 $57.48 $69.16  
5. 5th Period: $47.94 $60.68 $73.42  
6. 6th Period: $50.06 $63.86 $77.66  
7. 7th Period: $52.18 $67.04 $81.90  
8. 8th Period: $54.30 $70.22 $86.14  
9. 9th Period: $56.43 $73.42 $90.40  
10. 10th Period: $58.55 $76.60 $94.64

**Terrazzo**

- Terrazzo Finisher BR1-TRF 10/17/2014  
- A 4 ten workweek may be worked Monday thru Thursday or Tuesday thru Friday.

**Apprentice Rates:**

1. Level 1: $19.04 $25.12 $31.20  
2. Level 2: $20.24 $26.92 $33.60  
3. Level 3: $27.01 $33.96 $40.90  
4. Level 4: $28.47 $36.14 $43.82  
5. Level 5: $29.99 $37.84 $45.70  
7. Level 7: $33.30 $41.59 $49.87  
8. Level 8: $34.79 $43.48 $52.17

---

**Official Request #: 215**  
**Requestor:** Wayne State University  
**Project Description:** Materials Science & Nano-engineering Lab 1335 - Renovation

**Official Rate Schedule**

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## Official 2015 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 2/18/2015  
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### Page 29 of 33

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name Description</th>
<th>Updated</th>
<th>Last Straight Time and  a Double Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrazzo Worker</td>
<td>BR1-TRW 10/17/2014</td>
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<tr>
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A 4 ten workweek may be worked Monday thru Thursday or Tuesday thru Friday.

### Tile Finisher

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A 4 ten workweek may be worked Monday thru Thursday or Tuesday thru Friday.
## Official 2015 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 2/18/2015  
**Contract must be awarded by:** 5/19/2015  
**Page 30 of 33**

### Classification

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<tr>
<th>Name</th>
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A 4 ten workweek may be worked Monday thru Thursday or Tuesday thru Friday.

### Apprentice Rates:

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<td>43.67</td>
<td>55.78</td>
<td>67.88</td>
<td></td>
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</table>

### Truck Driver

- **on all trucks of 8 cubic yard capacity or less (except dump trucks of 8 cubic yard capacity or over, tandem axle trucks, transit mix and semis, euclid type equipment, double bottoms and low boys)**

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
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<th>Rate $</th>
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- **of all trucks of 8 cubic yard capacity or over**

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
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*Make up day allowed*  
*Official Request #: 215*  
*Requestor: Wayne State University*  
*Project Description: Materials Science & Nano-engineering Lab 1335 - Renovation*  

### Official Rate Schedule

Every contractor and subcontractor shall keep posted on the construction site, in a conspicuous place, a copy of all prevailing wage and fringe benefit rates prescribed in a contract.
Official 2015 Prevailing Wage Rates for State Funded Projects

Issue Date: 2/18/2015
Contract must be awarded by: 5/19/2015

Page 31 of 33

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name Description</th>
<th>Last Updated</th>
<th>Straight Time and a Half Hourly</th>
<th>Double Time Hourly</th>
<th>Overtime Provision</th>
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<td>$32.94</td>
<td>$41.26</td>
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<td>Mortar and material mixer, concrete form man, signal man, well point man, manhole, headwall and catch basin builder, guard rail builders, headwall, seawall, breakwall, dock builder and fence erector</td>
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<tr>
<td>Underground Laborer Open Cut, Class III</td>
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Official Request #: 215
Requestor: Wayne State University
Project Description: Materials Science & Nano-engineering Lab 1335 - Renovation

Official Rate Schedule
Every contractor and subcontractor shall keep posted on the construction site, in a conspicuous place, a copy of all prevailing wage and fringe benefit rates prescribed in a contract.

Project Number: 090-248124
County: Wayne

Page 31 of 33
<table>
<thead>
<tr>
<th>Classification</th>
<th>Name Description</th>
<th>Updated</th>
<th>Straight Time and a Half Time</th>
<th>Double Time</th>
<th>Overtime Provision</th>
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<td>Underground Laborer Open Cut, Class VI</td>
<td>Grouting man, top man assistant, audio visual television operations and all other operations in connection with closed circuit television inspection, pipe cleaning and pipe relining work and the installation and repair of water service pipe and appurtenances.</td>
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**Official 2015 Prevailing Wage Rates for State Funded Projects**

**Issue Date:** 2/18/2015  
**Contract must be awarded by:** 5/19/2015

### Classification

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<tr>
<th>Classification</th>
<th>Name</th>
<th>Description</th>
<th>Updated</th>
<th>Last Straight Time and Double Overtime Provision</th>
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<tr>
<td>Underground Laborer Open Cut, Class VII</td>
<td>LAUC-Z1-7</td>
<td>Restoration laborer, seeding, sodding, planting, cutting, mulching and topsoil grading and the restoration of property such as replacing mail boxes, wood chips, planter boxes, flagstones etc.</td>
<td>9/5/2013</td>
<td>$32.09 $39.99 $47.88 X X X X X X D Y</td>
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**Apprentice Rates:**

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<th>Work Hours</th>
<th>Hourly</th>
<th>Half Time</th>
<th>Overtime Provision</th>
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<td>$46.54 Official Request #: 215</td>
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**Official Rate Schedule**

Every contractor and subcontractor shall keep posted on the construction site, in a conspicuous place, a copy of all prevailing wage and fringe benefit rates prescribed in a contract.

Requestor: Wayne State University
Project Description: Materials Science & Nano-engineering Lab 1335 - Renovation
Project Number: 090-248124
County: Wayne
WAYNE STATE UNIVERSITY
PAYMENT PACKAGE DOCUMENT REQUIREMENTS Document Requirements (Revised 5-06-2011):

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

AIA DOCUMENT G702 & G703 – (or facsimile thereof) Payment Application 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. (i.e. 1, 2, 3, etc.)
- Correct Period Reporting Dates – Applications support docs must be sequential and within application range.
- Approved & Executed Change Orders must be listed. (Cannot invoice for unapproved changes.)
- 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, subcontractors, suppliers... ≥ $1000.00
- Contractor’s Sworn Statement amounts must coincide with Column “C” of the schedule of values document. Any unassigned or uncommitted value of contract shall be shown on an entry “Contractor – Unassigned” followed by the amount necessary to cause the “contracted to date” column of the sworn statement to equate with the schedule of value column totals.
- Current Date – Back dating not accepted.
- Signed and Notarized.
- A Sworn Statement is required from every Sub Contractor on the job with a material purchase or sub-subcontract of $1,000 or more. (all the way down to the bottom tier)

DEPT. of LABOR FORM WH-347 – Certified Payroll Checklist: (Union and Non-Union)
- For every contractor & sub-contractors work, for each week within the application for payment reporting period. (For every “boot” on the floor representing the weeks within the application period)
- Wayne State University Project Number – Found on your contract.
- List ALL workers who have worked on the project site.
- Make sure workers addresses are listed.
- NO Social Security Numbers, if present they 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. (Refer to Section 410 of Bid Front End Documents.) http://www.cis.state.mi.us/bwuc/bsr/wh/revised_rates/whc_tbl.htm
- Apprenticeship program status – proof of enrolled program and current completion required for any workers paid at Apprenticeship rates.
- Rate of Pay verified against the Prevailing Wage Schedule with an hourly costs breakdown of fringes paid. (Refer to attachment for State of Michigan instructions and example)
- Authorized signatures on affidavit.

APPLICATION PACKAGE SUPPORTING DOCUMENTATION – Must accompany all package reporting periods: (Union and Non-Union)
- Copies of Pay Stubs may be required for each Certified Payroll period reported – (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” (Sole Proprietor) contractors not claiming their time under prevailing wage act. – (Must list their hours and dates worked on the WH-347 Form and enter EXEMPT on the income brackets.). The Owner Operator must provide copies of “DBA” registration form confirming status as exempt from prevailing wage requirements.
Proof of Stored Materials – (Detailed Bill of Sale, certificate of insurance or endorsement page specifically insuring the stored materials, pictures, when large value. WSU reserves the right to on site verification of material. Stored material must be separated from ordinary inventory and labeled for WSU project.

Partial Unconditional Waivers – Must release the accumulated amount paid for work and be immediately provided, or provided with the subsequent application for payment. Waivers shall be provided for contractors, sub-contractors, and suppliers listed on the Sworn Statements. (This is required at all tiers)

Full Unconditional Waivers – Prime Contractor must deliver fully executed Full Unconditional Waiver upon receipt of final payment. Full Unconditional waivers may be required of sub-contractors and suppliers in advance of final Contractor payment on bonded projects. This requirement shall be determined on a project-by-project basis. Full Unconditional waivers shall be required in advance of or at the time of final payment on all non-bonded projects from all subcontractors and suppliers listed on Sworn Statements, or who have provided a notice of furnishing.

Partial Conditional Waivers – The Contractor shall provide a Partial Conditional Waivers covering the entire amount of the application for payment. For non-bonded Projects – A partial conditional waiver from all subcontractors must accompany any application for payment within which a subcontractor draw is included.

Sworn Statements – Required for all Sub Contractors, and Sub-subcontractors (etc.) with any contracts or purchases exceeding $1,000.

**FINAL PAYMENT EXCHANGE – Checklist:**

- Clear and concise As-Built drawings.
- Operation and Maintenance Manuals.
- Required training must be completed (if applicable).
- Warranty of work in accordance with project documents.
- Certificate of Substantial Completion.
- Full Unconditional Waiver

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

Revised 5-6-2011
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:**

**PO#:**

---

**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.

<table>
<thead>
<tr>
<th>Field Management</th>
<th>Score</th>
<th>Weight</th>
<th>Total</th>
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<td>1) Work Planning / Schedule:</td>
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<tr>
<td>2) Compliance with Construction Documents:</td>
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<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>8) Contractor Coordination with WSU Vendors:</td>
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**Administrative Management**

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<tr>
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<td>11) Contractor communication:</td>
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<td>13) Subcontractor Professionalism:</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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**Invoice and Change Management**

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<td>18) Applications for Payment</td>
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<td>19) Timely payment of Subs/Suppliers:</td>
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<tr>
<td>20) Level of Self-Performance:</td>
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<tr>
<td>21) Would you work with this Contractor again?</td>
<td>Yes No</td>
<td></td>
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<tr>
<td>22) Would you work with this team again?</td>
<td>Yes No</td>
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<td></td>
</tr>
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</table>

**One year follow up**

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

---

**Evaluator**

Signature: ____________________________ Date: ____________________________

Title: ____________________________

Name: ____________________________

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PAYMENT PACKAGE DOCUMENT REQUIREMENTS

Please Print

Rev. 2-17-2015 RGP

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WAYNE STATE UNIVERSITY Materials Science and Nanoengineering Lab

WSU Project No. 090-248124
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 (rev 6-2013)

Executed as of the _____ day of ________, 2014 by and between:

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

and

CONTRACTOR’S_NAME
CONTRACTOR’S_ADDRESS

regarding

Materials Science and Nano-engineering Lab
5050 Anthony Wayne Drive
WSU Project No. 090-248124
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 **Renovation of Lab 1335**, located at **5050 Anthony Wayne Drive**. 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 **June 22, 2015**.

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

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
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<tr>
<td>Alternate #1</td>
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<tr>
<td>Alternate #2</td>
<td></td>
</tr>
<tr>
<td>Alternate #3</td>
<td></td>
</tr>
</tbody>
</table>

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>
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<tbody>
<tr>
<td>1.</td>
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<tr>
<td>2.</td>
<td></td>
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<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)"

<table>
<thead>
<tr>
<th>i Design Solutions</th>
</tr>
</thead>
<tbody>
<tr>
<td>400 Water Street, Suite LL1</td>
</tr>
<tr>
<td>Rochester, MI 48307</td>
</tr>
<tr>
<td>(Architect Phone No / Fax No)</td>
</tr>
</tbody>
</table>

6.2 The University will appoint a Project Manager who will be the University's point of contact for all matters of contract administration including, but not limited to, interpretation of documents, defining the scope of work, approving work schedules, and approving contract payments.

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 pendancy 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 pendancy 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 United States Department of Labor. 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 construction.
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 (Revised 2-2015)

15.1 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.

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 $500.00, Five Hundred Dollars per day. Therefore, the Contractor shall pay as liquidated damages to the University the sum of $500.00, Five Hundred 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 **March 25, 2015**, and the following List of Drawings represents the scope of work as defined in the Contract Documents from Article 4.

**DRAWINGS**

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**ARCHITECTURAL DRAWINGS**

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<tr>
<td>A301</td>
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<td>A401</td>
<td>Legends, Architectural Sch A402</td>
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<td>A402</td>
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**ELECTRICAL DRAWINGS**

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**MECHANICAL DRAWINGS**

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<td>M2.1</td>
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<tr>
<td>M6.2</td>
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<tr>
<td>Temperature Controls</td>
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</tr>
</tbody>
</table>


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

Richard J. Nork, Vice President for Finance and Facilities

Date signed

Form Contract Approved by OGC 06/13 – LG File_reference_here

Sample
FORM OF GUARANTEE

PROJECT: Materials Science and Nano-engineering Lab

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:

Materials Science and Nano-engineering Lab (090-248124)

For: Board of Governors, Wayne State University

In conformity with drawings and specifications prepared by Architect or Engineer, i Design Solutions, 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 Contract 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

4.6.1 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.

4.7 PERMITS, FEES AND NOTICES

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

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

4.7.5 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

4.7.6 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.

4.9 SUPERINTENDENT

4.9.2 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.

4.9.3 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.

4.12 DRAWINGS AND SPECIFICATIONS AT THE SITE

4.12.1.1 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'."

4.12.2 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.

4.13 SHOP DRAWINGS AND SAMPLES
4.13.9 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>1. Commercial General Liability (CGL)</td>
<td>$1,000,000 combined single limit per occurrence $2,000,000 aggregate Umbrella Liability per occurrence and in the annual aggregate of $5,000,000.</td>
</tr>
<tr>
<td>2. Commercial Automobile Liability (CSL) (including hired and non-owned vehicles)</td>
<td>$1,000,000 combined single limit</td>
</tr>
<tr>
<td>3. Workers' Compensation (Employers' Liability)</td>
<td>Statutory-Michigan $500,000</td>
</tr>
<tr>
<td>4. Professional Liability insurance</td>
<td>$250,000 Per Occurrence and in the Aggregate annually.</td>
</tr>
</tbody>
</table>

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

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>
<tr>
<td>Comprehensive Automobile Liability</td>
<td>-0-</td>
</tr>
<tr>
<td>Workers' Compensation</td>
<td>-0-</td>
</tr>
<tr>
<td>Property - All Risk</td>
<td>$500</td>
</tr>
</tbody>
</table>

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 either 1) 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 12.1.4 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 contract 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 or 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 or 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 or 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 (29CFR, Part 3) which are herein incorporated by reference.

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 **March 25, 2015** and the following List of Drawings represent the scope of work as defined in the Contract Documents from Article 4.

### DRAWINGS

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#### ARCHITECTURAL DRAWINGS

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<td>Partial 1st Floor Laboratory E</td>
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<tr>
<td>A301</td>
<td>Partial 1st Floor Interior Eleva</td>
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#### ELECTRICAL DRAWINGS

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<tr>
<td>E2.1</td>
<td>First Floor Electrical Demolition Plan E2.1</td>
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<td>E3.1</td>
<td>First Floor Power and Auxiliary</td>
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#### MECHANICAL DRAWINGS

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<td>Temperature Controls Stan M8.2</td>
</tr>
<tr>
<td></td>
<td>Temperature Controls</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, Contractors 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.

GENERAL REQUIREMENTS 01000 - 1
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.

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 Builts", 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

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: The renovated Lab133 will be used for the BE 1300 coursework currently held in Manufacturing Engineering and processing approximately 120 students per semester as well as for the new Nano-engineering coursework starting in Fall 2015 semester.

3. The building is located at
   Wayne State University
   5050 Anthony Wayne Drive
   Detroit, Michigan 48202
PROJECT MANUAL
FOR

MATERIAL SCIENCE & NANOENGINEERING LAB RENOVATION

WAYNE STATE UNIVERSITY

DETROIT, MICHIGAN

WSU PROJECT NO. 090-248124

Design & Construction Services
Facilities Planning & Management
Wayne State University
5454 Cass Avenue
Detroit, MI 48202

iDesign Solutions, LLC
Architects Scientists and Planners
400 Water Street, Suite LL1
Rochester, Michigan 48307
iD Project No. 1156-1

February 9, 2015
100% BID ISSUE
SECTION 00 01 07

SEALS PAGE

PART 1 GENERAL

ARCHITECTURAL

I hereby certify this plan, specification, or report was prepared by myself or under my direct supervision and I am a duly Registered Architect under the laws of the State of Michigan.

___________________________________________________
Date: ________________  Registration No.: _______________

MECHANICAL

I hereby certify this plan, specification, or report was prepared by myself or under my direct supervision and I am a duly Registered Architect under the laws of the State of Michigan.

___________________________________________________
Date: ________________  Registration No.: _______________

ELECTRICAL

I hereby certify this plan, specification, or report was prepared by myself or under my direct supervision and I am a duly Registered Architect under the laws of the State of Michigan.

___________________________________________________
Date: ________________  Registration No.: _______________

PART 2 PRODUCTS - Not Applicable To This Section
PART 3 EXECUTION - Not Applicable To This Section

END OF SECTION
TABLE OF CONTENTS

INTRODUCTORY INFORMATION

00 01 01 Title Page
00 01 07 Seals Page
00 01 10 Table of Contents
00 01 15 List of Drawing Sheets

PROCUREMENT DOCUMENTS *(PROVIDED BY WAYNE STATE UNIVERSITY)*

DIVISION 00 00 00 - BIDDING REQUIREMENTS, CONTRACT FORMS, AND CONDITIONS OF THE CONTRACT

00 05 00 Information for Bidders
00 10 00 Instructions to Bidders
00 25 00 Notice of Pre-Bid Conference
00 30 00 Form of Proposal & Qualification Statement
00 42 00 Project Labor Agreements
00 43 00 Payment Package Document Requirements
00 50 00 Agreement Between Contractor and Owner for Construction
00 51 00 Form of Guarantee
00 70 00 General Conditions (A.I.A. A-201)
00 80 00 WSU Supplementary General Conditions of the Contract for Construction

SPECIFICATIONS

DIVISION 01 00 00 – GENERAL REQUIREMENTS

01 00 00 General Requirements *(Provided by Wayne State University)*
01 10 00 Summary of Work (Including Scope of Work) *(Provided by Wayne State University)*
01 40 00 Quality Requirements
01 50 00 Temporary Facilities and Controls
01 60 00 Product Requirements
01 70 00 Execution and Closeout Requirements

DIVISION 02 00 00 – EXISTING CONDITIONS

02 41 19.16 Selective Interior Demolition

DIVISION 07 00 00 - THERMAL AND MOISTURE PROTECTION

07 84 00 Firestopping
DIVISION 08 00 00 - DOORS AND WINDOWS
08 11 13 Hollow Metal Door and Door Frames
08 71 00 Door Hardware

DIVISION 09 00 00 - FINISHES
09 21 16 Gypsum Board Assemblies
09 22 16 Non-structural Metal Framing
09 65 13 Resilient Base and Accessories
09 91 00 Paints
09 96 00 High Performance Coatings

DIVISION 10 00 00 - SPECIALTIES
10 44 00 Fire Protection Specialties

DIVISION 11 – EQUIPMENT
11 53 13 Laboratory Fume Hoods
11 53 33 Laboratory Safety Equipment
11 53 43 Laboratory Service Fittings and Fixtures
11 53 43.10 Laboratory Accessories

DIVISION 12 – FURNISHINGS
12 56 53.13 Painted Metal Laboratory Casework

DIVISION 21 – FIRE SUPPRESSION
21 11 00 Fire Suppression

DIVISION 20 – COMMON MECHANICAL REQUIREMENTS
20 05 00 Mechanical General Requirements
20 05 10 Basic Mechanical Materials and Methods
20 05 19 Meters and Gages
20 05 23 Valves
20 05 29 Hangers and Supports
20 05 53 Mechanical Identification
20 07 00 Mechanical Insulation

DIVISION 22 00 00 – PLUMBING
22 11 16 Domestic Water Piping
22 11 19 Domestic Water Piping Specialties
22 13 16 Sanitary Waste and Vent Piping
## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Division</th>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Division 22</td>
<td>13 19</td>
<td>Drainage Piping Specialties</td>
</tr>
<tr>
<td>Division 22</td>
<td>42 00</td>
<td>Plumbing Fixtures</td>
</tr>
<tr>
<td>Division 22</td>
<td>61 13</td>
<td>Laboratory Air, Gas and Vacuum Piping</td>
</tr>
<tr>
<td>Division 22</td>
<td>66 53</td>
<td>Chemical Waste Piping</td>
</tr>
<tr>
<td>Division 23</td>
<td>00 00</td>
<td>Heating, Ventilating and Air Conditioning</td>
</tr>
<tr>
<td>Division 23</td>
<td>05 93</td>
<td>Testing, Adjusting and Balancing</td>
</tr>
<tr>
<td>Division 23</td>
<td>09 33</td>
<td>Temperature Controls</td>
</tr>
<tr>
<td>Division 23</td>
<td>31 13</td>
<td>Metal Ducts</td>
</tr>
<tr>
<td>Division 23</td>
<td>33 00</td>
<td>Duct Accessories</td>
</tr>
<tr>
<td>Division 23</td>
<td>37 13</td>
<td>Fan-Coil Units</td>
</tr>
<tr>
<td>Division 26</td>
<td>00 00</td>
<td>Electrical</td>
</tr>
<tr>
<td>Division 26</td>
<td>00 10</td>
<td>Electrical General Requirements</td>
</tr>
<tr>
<td>Division 26</td>
<td>05 19</td>
<td>Conductors and Cables</td>
</tr>
<tr>
<td>Division 26</td>
<td>05 26</td>
<td>Grounding and Bonding</td>
</tr>
<tr>
<td>Division 26</td>
<td>05 29</td>
<td>Hangers and Supports for Electrical Systems</td>
</tr>
<tr>
<td>Division 26</td>
<td>05 33</td>
<td>Raceways and Boxes</td>
</tr>
<tr>
<td>Division 26</td>
<td>05 53</td>
<td>Electrical Identification</td>
</tr>
<tr>
<td>Division 26</td>
<td>09 23</td>
<td>Lighting Control Devices</td>
</tr>
<tr>
<td>Division 26</td>
<td>09 99</td>
<td>Electrical Testing</td>
</tr>
<tr>
<td>Division 26</td>
<td>27 26</td>
<td>Wiring Devices</td>
</tr>
<tr>
<td>Division 26</td>
<td>28 13</td>
<td>Fuses</td>
</tr>
<tr>
<td>Division 26</td>
<td>28 16</td>
<td>Enclosed Switches and Circuit Breakers</td>
</tr>
<tr>
<td>Division 26</td>
<td>29 13</td>
<td>Enclosed Controllers</td>
</tr>
<tr>
<td>Division 26</td>
<td>51 00</td>
<td>Interior Lighting</td>
</tr>
<tr>
<td>Division 28</td>
<td>00 00</td>
<td>Electronic Safety and Security</td>
</tr>
<tr>
<td>Division 28</td>
<td>31 00</td>
<td>Fire Alarm</td>
</tr>
</tbody>
</table>

END OF TABLE OF CONTENTS
## DRAWING LIST

<table>
<thead>
<tr>
<th>Sheet Number</th>
<th>Sheet Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>G00</td>
<td>Cover Sheet</td>
</tr>
</tbody>
</table>

### ARCHITECTURAL DRAWINGS

<table>
<thead>
<tr>
<th>Sheet Number</th>
<th>Sheet Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>G01</td>
<td>Life Safety Plan and Code Review</td>
</tr>
<tr>
<td>A101</td>
<td>Partial 1st Floor Demo Plan and Partial 1st Floor Architectural Plan</td>
</tr>
<tr>
<td>A201</td>
<td>Partial 1st Floor Laboratory Equipment Plan and Partial 1st Floor Reflected Ceiling Plan</td>
</tr>
<tr>
<td>A301</td>
<td>Partial 1st Floor Interior Elevations</td>
</tr>
<tr>
<td>A401</td>
<td>Legends, Architectural Schedules and Details</td>
</tr>
<tr>
<td>A402</td>
<td>Laboratory Schedules and Details</td>
</tr>
<tr>
<td>A403</td>
<td>Laboratory Equipment Details</td>
</tr>
</tbody>
</table>

### ELECTRICAL DRAWINGS

<table>
<thead>
<tr>
<th>Sheet Number</th>
<th>Sheet Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>E0.1</td>
<td>Electrical Standards and Drawing Index</td>
</tr>
<tr>
<td>E0.2</td>
<td>Electrical Standard Schedules</td>
</tr>
<tr>
<td>E0.1.1</td>
<td>First Floor Electrical Demolition Plan</td>
</tr>
<tr>
<td>E2.1</td>
<td>First Floor Lighting Plan</td>
</tr>
<tr>
<td>E3.1</td>
<td>First Floor Power and Auxiliary Plan</td>
</tr>
<tr>
<td>E7.1</td>
<td>Electrical Details and Panel Schedule</td>
</tr>
</tbody>
</table>

### MECHANICAL DRAWINGS

<table>
<thead>
<tr>
<th>Sheet Number</th>
<th>Sheet Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>M0.1</td>
<td>Mechanical Standards and Drawing Index</td>
</tr>
<tr>
<td>MD1.1</td>
<td>First Floor Mechanical Demolition Plan</td>
</tr>
<tr>
<td>M1.0</td>
<td>Basement Plumbing New Work Plan</td>
</tr>
<tr>
<td>M1.1</td>
<td>First Floor Mechanical New Work Plan</td>
</tr>
<tr>
<td>M2.1</td>
<td>First Floor Plumbing New Work Plan</td>
</tr>
<tr>
<td>M6.1</td>
<td>Mechanical Details</td>
</tr>
<tr>
<td>M6.2</td>
<td>Mechanical Details</td>
</tr>
<tr>
<td>M7.1</td>
<td>Mechanical Schedules</td>
</tr>
<tr>
<td>M7.2</td>
<td>Mechanical Schedules</td>
</tr>
<tr>
<td>M8.1</td>
<td>Temperature Controls Standards and General Notes</td>
</tr>
<tr>
<td>M8.2</td>
<td>Temperature Controls</td>
</tr>
</tbody>
</table>

END OF DRAWING LIST
SECTION 01 40 00

QUALITY REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

A. Quality Monitoring: Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality. Perform quality control procedures and inspections during installation.

B. Standards: Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

C. Tolerances: Monitor fabrication and installation tolerance control of products to produce acceptable high quality Work. Do not permit tolerances to accumulate. Comply with manufacturers' tolerances and installation requirements.

D. Reference Standards:

1. Wayne State University, Construction Design Standards, Second Revision, September, 2012

2. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

E. Manufacturer's Field Services: When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to perform the following as applicable, and to initiate instructions when necessary.

1. Observe site conditions.
2. Conditions of surfaces, surface preparation and installation.
3. Quality of workmanship.
4. Start-up of equipment.
5. Test, adjust and balance of equipment.

PART 2 PRODUCTS - Not Applicable To This Section

PART 3 EXECUTION - Not Applicable To This Section

END OF SECTION
SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1  GENERAL

1.1  SUMMARY

A. Security and Protection: Coordinate with the Owner to provide security and protection requirements including the following:
   1. Fire extinguishers.
   2. Site enclosure, barricades, warning signs, and lights.
   3. Environmental protection and dust control.

PART 2  PRODUCTS - Not Applicable To This Section

PART 3  EXECUTION - Not Applicable To This Section

END OF SECTION
SECTION 01 60 00

PRODUCT REQUIREMENTS

PART 1  GENERAL

1.1  SUMMARY

A. Manufactures: Provide products from one manufacturer for each type or kind as applicable. Provide secondary materials as required by manufacturers of primary materials.

B. Product Selection: Provide products compliant with Wayne State University Construction Design Standards Approved Vendors List and as specified by Architect.

C. Substitutions: Request for substitution must be in writing and requires approval by Owner and Architect. Products submitted for substitution shall be submitted with complete documentation, and include construction costs of substitution including related work. Conditions for substitution include:
   1. Specified material cannot be coordinated with other work.
   2. Specified material is not acceptable to authorities having jurisdiction.
   3. Substantial advantage is offered to the Owner in terms of cost, time, or other valuable consideration.

D. Substitution Requests: Substitutions shall be submitted prior to award of contract, unless otherwise acceptable. Approval of shop drawings, product data, or samples containing substitutions is not an approval of a substitution unless an item is clearly presented as a substitution at the time of submittal.

PART 2  PRODUCTS - Not Applicable To This Section

PART 3  EXECUTION - Not Applicable To This Section

END OF SECTION
SECTION 01 70 00

EXECUTION AND CLOSEOUT REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

A. Substantial Completion: The following are prerequisites to substantial completion. Provide the following.
   1. Punch list completion report prepared by Contractor and subcontractors as applicable.
   2. Supporting documentation.
   3. Warranties.
   4. Certifications.
   5. Occupancy permit.
   6. Start-up and testing of building systems.
   7. Change over of locks.
   8. Commissioning documentation.

B. Final Acceptance: Provide the following prerequisites to final acceptance.
   1. Final payment request with supporting affidavits.
   2. Completed punch list.

C. As-Built Drawings: Provide a marked-up set of drawings including changes, which occurred during construction.

D. Project Closeout: Provide the following during project closeout.
   1. Submission of record documents.
   2. Submission of maintenance manuals.
   3. Training and turnover to Wayne State University’s personnel.
   4. Final cleaning and touch-up.
   5. Removal of temporary facilities.

PART 2 PRODUCTS - Not Applicable To This Section

PART 3 EXECUTION

3.1 CUTTING AND PATCHING

A. Cutting and Patching: Provide cutting and patching work to properly complete the work of the project, complying with project requirements for:
   1. Mechanical/electrical systems.
   2. Visual requirements, including detailing and tolerances.
   3. Operational and safety limitations.
   4. Fire resistance ratings.
   5. Inspection, preparation, and performance.
   6. Cleaning.
B. Means and Methods: Do not cut and patch in a manner that would result in a failure of the work to perform as intended, decrease energy performance, increase maintenance, decrease operational life, or decrease safety performance.

C. Inspection: Inspect conditions prior to work to identify scope and type of work required. Protect adjacent work. Notify Wayne State University of work requiring interruption to building services or Wayne State University's operations.

D. Performance of Operations: Perform work with workmen skilled in the trades involved. Prepare sample area of each type of work for approval.

E. Cutting: Use cutting tools, not chopping tools. Make neat holes. Minimize damage to adjacent work. Inspect for concealed utilities and structure before cutting.

F. Patching: Make patches, seams, and joints durable and inconspicuous. Comply with tolerances for new work.

G. Cleaning: Clean work area and areas affected by cutting and patching operations.

3.2 GENERAL REQUIREMENTS THAT APPLY TO ALL SPECIFICATION SECTIONS FOR DELIVERY, STORAGE, AND HANDLING

A. Deliver, store and handle materials in accordance with manufacturer's instructions.

B. Maintain environmental conditions and protect work during and after installation to comply with referenced standards and manufacturer's printed recommendations.

C. Protect adjacent surfaces during progress of the Work in this Section.

3.3 GENERAL REQUIREMENTS THAT APPLY TO ALL SPECIFICATION SECTIONS FOR PREPARATION, INSTALLATION AND PROTECTION

A. Execution: Examine substrate; report unsatisfactory conditions in writing. Do not begin installation until substrates are within manufacturer's specified tolerances and have been prepared in accordance with manufacturer's instructions. Beginning work means acceptance of substrates.

B. Installation:

1. Install materials and systems in accordance with manufacturer's instructions and approved submittals. Install materials and systems in proper relation with adjacent construction and with uniform appearance.
2. Coordinate with work of other sections.

3. Adjust operation, clean and protect.

C. Protection:

1. Protect, inspect and repair work until final acceptance.

2. Touch-up, repair or replace damaged products before Substantial Completion.

3. 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.

END OF SECTION
SECTION 02 41 19.16

SELECTIVE INTERIOR DEMOLITION

PART 1  GENERAL

1.1  SUMMARY

A. Provide demolition activities. Demolition shall not impact the building structure, building enclosure, building core functions or building egress. Demolition shall be limited to select interior elements, utilities and finishes.

1.2  SUBMITTALS

A. Schedule: Submit for approval selective interior demolition schedule, including schedule and methods for capping utilities to be abandoned and maintaining existing utility service.

1.3  QUALITY ASSURANCE

A. Codes and Regulations: Comply with governing codes and regulations. Use experienced workers.

1.4  PROJECT CONDITIONS

A. Occupancy: Immediate areas of work will not be occupied during selective interior demolition. Personnel and students may occupy adjacent areas.

B. Existing Conditions: No responsibility for buildings and structures to be demolished will be assumed by the Owner.

PART 2  PRODUCTS

2.1  DEMOLITION APPLICATIONS

A. Demolition:
   1. Application: Salvage of designated items identified in drawings.
   3. Application: Disconnection, capping, and removal of utilities.
   4. Application: Pollution control during building demolition, including noise control.
   5. Application: Removal and legal disposal of materials.
   7. Utilities: Interruption, capping or removal as applicable.
   8. Hazardous Materials: Not known to be present.

PART 3  EXECUTION
3.1 SELECTIVE DEMOLITION

A. Demolition Operations: Do not damage building elements and improvements indicated to remain. Items of salvage value, not included on schedule of salvage items to be returned to Owner, shall be removed to a storage facility as identified by the Owner. Storage or sale of items at project site is prohibited.

B. Utilities: Locate, identify, disconnect, and seal or cap off utilities in buildings to be demolished.

C. Occupied Spaces: Do not close or obstruct streets, walks, drives or other occupied or used spaces or facilities without the written permission of the Owner and the authorities having jurisdiction. Do not interrupt utilities serving occupied or used facilities without the written permission of the Owner and authorities having jurisdiction. If necessary, provide temporary utilities.

D. Operations: Cease operations if public safety or remaining structures are endangered. Perform temporary corrective measures until operations can be continued properly.

E. Security: Provide adequate protection against accidental trespassing. Secure project after work hours.

F. Restoration: Restore finishes of patched areas.

END OF SECTION
SECTION 07 84 00

FIRESTOPPING

PART 1 GENERAL

1.1 SUMMARY

A. Provide firestopping at all penetrations through existing fire-rated wall construction as well as all floor penetrations both above and below the area to be renovated. This include all new work as well as filling in any missing firestopping at penetrations by existing to remain.

B. Related Sections include the following:

1. Division 9, Section “Gypsum Board Assemblies” for wall reinforcing.
2. Division 22 - Plumbing.
3. Division 23 – Heating Ventilating and Air Conditioning.
4. Division 26 – Electrical.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.

B. Submit for approval test reports.

1.3 QUALITY ASSURANCE

A. Comply with governing codes and regulations. Provide products of acceptable manufacturers, which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.


PART 2 PRODUCTS

2.1 MATERIALS

A. Firestopping Systems:

1. Manufacturers: 3M Fire Protection Products; e.z. barrier; Henkel Corporation; Specified Technologies Inc..

2. Applications as Applicable to Assembly: Through-penetrations, fire-resistive joints, perimeter fire containment, smoke seals.
3. Types as Applicable to Assembly: Endothermic and intumescent sealants, pillows, putty and wrap strips.

PART 3 EXECUTION

3.1 INSTALLATION

A. Review extent of work with authorities having jurisdiction and obtain approval of installation thicknesses and methods.

B. Sequence work to avoid need for removal of firestopping by work of other trades.

C. Comply with manufacturers’ instructions and recommendations. Securely anchor insulation with safing clips. Install firestopping without gaps or voids.

D. Protect, inspect and repair work until final acceptance.

END OF SECTION
SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.1 SECTION INCLUDES
   A. Hollow metal doors.
   B. Hollow metal pressed frames.

1.2 RELATED SECTIONS
   A. Section 08710 - Door Hardware.

1.3 REFERENCES
   A. American National Standards Institute (ANSI):
      1. ANSI A250.8 - Recommended Specification for Standard Steel Doors and Frames
   
   B. American Society for Testing and Materials (ASTM):
      1. ASTM A 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

   C. National Fire Protection Association (NFPA).

   D. National Association of Architectural Metal Manufacturers (NAAMM):

   E. Steel Door Institute (SDI):
      1. SDI-100 - Recommended Specifications for Standard Steel Doors and Frames
      3. SDI-113 - Standard Practice for Determining the Steady State Thermal Transmittance of Steel Door and Frame Assemblies.

1.4 SUBMITTALS
   A. Product Data: Submit catalog cuts or other data indicating details of construction, gauges of metals, dimensions, hardware preparation, core, label compliance, profiles and specifications for shop priming.
B. Shop Drawings: Submit shop drawings showing fabrication and installation of steel doors and frames. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of door and frame hardware and reinforcements, and details of joints and connections. Show anchorage and accessory items.

C. Provide schedule of doors and frames using same reference numbers for details and openings as those indicated on drawings.

D. Templates: Secure templates from finish hardware supplier for specified hardware and mounting locations.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall have five years of experience manufacturing and fabricating products of similar type and scope as those specified in this section.

B. Installer Qualifications: Installer shall have five years of experience manufacturing and fabricating products of similar type and scope as those specified in this section.

C. Provide doors and frames meeting the requirements of ANSI A250.8 (ANSI/SDI-100).

D. Fire Rated Door Assemblies: Meet the requirements of California Code of Regulations (CCR) Title 24 Part 2, California Building Code, Chapter 7 - Fire Resistant Materials and Construction for the fire resistive ratings indicated, and which are labeled by Warnock Hershey International. Fire doors and frames to comply with UBC 7-2 (UL 10C) positive pressure.

1. Temperature Rise Rating: At stairwell enclosures, provide doors which are labeled for a maximum transmitted temperature end point not to exceed 250 degrees F (121 degrees C) above the ambient at the end of 30 minutes of fire exposure.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Provide packaging such as cardboard corner guards or other means to protect surfaces of hollow metal doors. Provide temporary spreader bars fastened to the bottom of each welded frame.

B. Inspection: Inspect doors and frames upon delivery. Minor damage may be repaired provided finish items are equal to new work and acceptable to the Architect; otherwise remove and replace damaged items as directed.

C. Storage: Store doors and frames on platforms under cover. Store doors and frames in dry storage spaces with adequate ventilation, free from dust, and which permits easy access for inspection and handling. Avoid using non-vented plastic or canvas shelters that create a humidity chamber. To promote air circulation, provide a 1/4 inch (6 mm) space between doors. Mark or tag each door and frame with the appropriate opening identification symbol.
1.7 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers:
   1. Ceco Door Products.
   2. Curries.
   4. Steelcraft.

2.2 DOOR CONSTRUCTION

A. General: Fabricate doors in accordance with ANSI A250.8 (SDI-100) or HMMA-860 (NAAMM).

B. Internal Construction: Fabricate doors with any of the internal construction methods specified herein and in accordance with ANSI A250.8 (SDI-100) except as specified below.
   1. Fire Rated Doors: Fabricate to the requirements of ASTM E 152 for the hourly ratings indicated. Fabricate labeled fire resistive doors at stairwells with mineral fiberboard composite core that will provide the specified maximum transmitted temperature end point.

C. Clearances: Provide doors and frames with clearances in accordance with SDI-100.

2.3 FINISH

A. Factory Primer: After fabrication, clean and spray coat all exposed surfaces of doors and frames with a rust inhibitive prime paint, of even consistency to provide a uniformly finished surface ready to receive finish paint.

B. Finish field painting is specified in Section 09900.

2.4 DOORS

A. Honeycomb Core Doors:
   1. Description: Economical, impact resistant, for interior or exterior usage with 1 inch (25 mm) hexcells for maximum strength, rigidity and flatness.
   2. Honeycomb Cells: 1 inch (25 mm) honeycomb cells permanently bonded to both face sheets. Impact resistance - 45 PSI crushing strength of honeycomb.
   4. R Factor: 2.4.
   5. U Factor: 0.41.
8. Top and Bottom Channels: 18-gauge top and bottom inverted channels spot welded to face sheets.
10. Hardware Reinforcement:
    a. Closers: 12 gauge.
    b. Locks: 10 gauge.
    c. Hinges: 7 gauge, 3/16 inch.
11. Hardware Reinforcement: Custom, as selected by Architect.
13. Door Thickness: Standard, 1-3/4 inches (44.5 mm).
15. Integral Louver/Lite Configuration: As per drawings and door schedule.
16. Fire Rating: As per drawings and door schedule.

2.5 FRAMES

A. Fabricate frames in accordance with SDI-100 except as modified herein. Provide metal frames for doors, transoms, sidelites, borrowed lites and other openings, of types and styles indicated and scheduled. Conceal fastenings, unless otherwise indicated.
1. Frames to have mitered corners, continuously welded, with welds ground smooth. Provide reinforcing at corners and hardware mounting locations. Provide stops a minimum of 5/8 inch (16 mm) deep.

B. Door Frames:
1. Frame Profiles: As per drawings and door schedule.
2. Frame Elevations: As per drawings and door schedule.

C. Anchors: Provide floor anchor and wall anchors welded into each jamb member; 16 gauge minimum. Loose anchors are not acceptable.
1. Compliance: Wall anchors shall comply with SDI 111, of the type indicated for the specific wall conditions. Head anchors welded into head member as recommended by frame manufacturer.
2. Anchoring System: As recommended by manufacturer for installation in existing 1-hour rated CMU walls.

PART 3 EXECUTION

3.1 EXAMINATION

A. Inspect conditions of substrate and other conditions which may affect installation of signage.

B. Do not begin installation until substrates are within manufacturer’s specified tolerances and have been prepared in accordance with manufacturer’s instructions.

C. If substrate preparation is the responsibility of another installer, do not proceed with

D. Commencement of work is deemed as acceptance of installation conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Set frames accurately in position and plumb, align and brace them securely until permanent anchors are set. Anchor the bottom of frames securely to floors with expansion bolts or with powder-driven fasteners.

C. Build in or secure wall anchors to adjoining construction as indicated or required by adjoining construction. Where frames require ceiling struts or other structural overhead bracing, anchor such struts securely above, as required. Fill frames solid with Portland cement grout where indicated or required by fire rating of opening. Remove temporary braces and spreaders, leaving surfaces smooth and undamaged.

D. Install fire rated doors and frames, including hardware and operational characteristics, in accordance with the requirements of the listing agency, NFPA-80, and manufacturer’s recommendations.

E. Doors and finish hardware shall operate smoothly, quietly, and free from bind.

3.3 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION
SECTION 08 71 00

DOOR HARDWARE

PART 1 GENERAL

1.1 SUMMARY

A. Provide door hardware.

B. Related Sections include the following:
   1. Division 8, Section “Hollow Metal Door and Door Frames”.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.

B. Samples: Submit two representative samples of each material specified indicating visual characteristics and finish. Include range samples if variation of finish is anticipated.

C. Submit for approval hardware schedule proposed for use based on Owner's requirements.

1.3 QUALITY ASSURANCE

A. Comply with governing codes and regulations. Provide products of acceptable manufacturers, which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

B. Hardware for Fire-Rated Openings: NFPA 80, and local requirements.

C. Materials and Application: ANSI A156 series standards.

D. Hardware shall comply with ADA requirements for handle and pull force.

PART 2 PRODUCTS

2.1 MATERIALS

A. Door Hardware: Provide door hardware as per building standard.

   1. Manufacturers:
      a. Hinges: Hager Hinge, McKinney/Parker and Stanley Hardware.
      b. Cylinder Locksets and Latchsets: Corbin/Russwin (2000 Series), Best 7-K.
      c. Closers: Corbin Russwin Architectural Hardware, LCN and Norton
Door Control.

d. Cylinder Locks and Deadbolts: Best (7A/9A Series) and Corbin/Russwin Architectural Hardware.
g. Accessories (Stops, coordinators, kick plates, etc.): Baldwin Hardware, Glynn-Johnson, Hager, Hiawatha, Ives, Rockwood Architectural.

2. Quality Level: Commercial.

3. Locksets and Latchsets: Mortise type.


5. Keying: Owner’s requirements 7-pin (SFIC) small format interchangeable core.

6. Hinges and Butts: Provide 3 steel hinges, full-mortise type at interior.

7. Closer: Provide hydraulic door closer with hold open.

8. Hardware Finishes: Satin stainless finish on exposed surfaces.

9. Auxiliary Materials:
   a. Stops and overhead door holders.
   b. Soundstripping.

PART 3 EXECUTION

3.1 INSTALLATION

A. Follow guidelines of DHI ‘Recommended Locations for Builder’s Hardware and hardware manufacturers’ instructions.

B. Contractor to provide construction cores at all lockable locations prior to substantial completion. Wayne State University shall provide a core combination schedule and key quantity requirement to the contractor. The contractor shall provide and install permanent cores at the time of substantial completion.

C. Adjust operation, clean and protect.

END OF SECTION
PART 1  GENERAL

1.1  SUMMARY

A. Provide gypsum board assemblies.

1.2  RELATED SECTIONS

A. Division 9, Section “Non-structural Metal Framing”.
B. Division 9, Section “Resilient Base and Accessories”.
C. Division 9, Section “Paints”.

1.3  SUBMITTALS

A. Product Data: Submit manufacturer’s product data and installation instructions for each material and product used.

1.4  QUALITY ASSURANCE

A. Provide products of acceptable manufacturers, which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer’s instructions.

B. Tolerances: Not more than 1/16-inch difference in true plane at joints between adjacent boards before finishing. After finishing, joints shall be not be visible. Not more than 1/8 inch in 10 feet deviation from true plane, plumb, level and proper relation to adjacent surfaces in finished work.

C. Performance: Fire, structural, and seismic performance meeting requirements of building code and local authorities.

PART 2  PRODUCTS

2.1  MATERIALS

A. Gypsum Board:
   1. Manufacturers:
      a. CertainTeed Gypsum, Inc.
      b. Lafarge North America Inc.
      c. Clark Dietrich Building Systems
4. Type: Board for tape and joint compound finish.
   a. Type: Regular and fire-rated types as required.
   b. Typical Thickness: 5/8 inch.
5. Joint Treatment: ASTM C474 and ASTM C840, 3-coat system, paper or fiberglass tape.
6. Auxiliary Materials:
   a. Cornerbead, edge trim and control joints.
   b. Gypsum board screws, ASTM C 1002.

PART 3 EXECUTION

3.1 INSTALLATION

A. Steel Framing: Install steel framing in compliance with ASTM C 754. Install with tolerances necessary to produce substrate for gypsum board assemblies with tolerances specified. Include wall reinforcing for casework, wall cabinets, wall mounted shelving and drying racks.

B. Tape and Joint Compound: Install gypsum board for tape and 3-coat joint compound finish in compliance with ASTM C 840 and GA 216, Level 4 finish. Install gypsum board assemblies true, plumb, level and in proper relation to adjacent surfaces.

C. Install boards vertically. Do not allow butt-to-butt joints and joints that do not fall over framing members.

D. Where new partitions meet existing construction, remove existing cornerbeads to provide a smooth transition.

E. Provide insulation full height and thickness in partitions where required.

F. Provide siliconized acrylic sealant at both faces at top and bottom runner tracks, wall perimeters, openings, expansion and control joints.

G. Install trim in strict compliance with manufacturer’s instructions and recommendations.

H. At areas to be patched and repaired, prepare surface to sound substrate, apply bonding agent and patching materials in accordance with manufacturer’s instructions.


END OF SECTION
SECTION 09 22 16
NON-STRUCTURAL METAL FRAMING

PART 1 GENERAL

1.1 SUMMARY
A. Provide non-structural metal framing for gypsum board assemblies.
B. Related Sections include the following:
   1. Division 9, Section "Gypsum Board Assemblies" for wall reinforcing.

1.2 SUBMITTALS
A. Product Data: Submit manufacturer’s product data and installation instructions for each material and product used.

1.3 QUALITY ASSURANCE
A. Comply with governing codes and regulations. Provide products of acceptable manufacturers, which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer’s instructions.
B. Tolerances: Not more than 1/8 inch in 10 feet deviation from true plane, plumb, level and proper relation to adjacent surfaces in finished work.
D. Comply with NFPA 101.
E. Performance: Fire, structural, and seismic performance meeting requirements of building code and local authorities.

PART 2 PRODUCTS

2.1 MATERIALS
A. Steel Framing for Walls and Partitions:
   1. Manufacturers: Brady Construction Corp., Chicago Metallic Corp.,
      Clark Dietrich, MBA Metal Framing, Ruskin Corp.
   5. Auxiliary Framing Components: Furring brackets, resilient furring channels, Z-furring members, and non-corrosive fasteners.
PART 3  EXECUTION

3.1  INSTALLATION

A.  Provide fire-rated systems where indicated and where required by authorities having jurisdiction.

B.  Where new partitions meet existing construction, remove existing cornerbeads to provide a smooth transition.

C.  Provide acoustical sealant at both faces at top and bottom runner tracks, wall perimeters, openings, expansion and control joints.

END OF SECTION
SECTION 09 65 13

RESILIENT BASE AND ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. Provide resilient wall base and accessories.

B. Related Sections include the following:
   1. Division 9, Section “Gypsum Board Assemblies”.
   2. Division 9, Section “High Performance Coatings”.
   4. Division 12, Section “Painted Metal Lab Casework”.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer’s product data and installation instructions for each material and product used.

B. Samples: Submit two representative samples of each material specified indicating visual characteristics and finish. Include range samples if variation of finish is anticipated.

C. Submit extra stock equal to 2% of total used.

1.3 QUALITY ASSURANCE

A. Comply with governing codes and regulations. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer’s instructions.

B. Performance: Fire performance meeting requirements of building code and local authorities.

PART 2 PRODUCTS

2.1 MATERIALS

A. Resilient Wall Base:
   1. Manufacturers:
      a. Armstrong World Industries.
      b. Nora Rubber.
      c. Flexco.
      d. Roppe.
      e. Johnsonite.
      f. Mannington.
      g. Commercial Resilient.
h. Mercer Products.
i. NAFCO.
j. VPI Floor Products.

2. Color: See schedule on architectural plans.
4. Type: TS (rubber, vulcanized thermoset).
5. Style: Straight.
6. Thickness: 0.125 inch
7. Height: 4 inches.

PART 3 EXECUTION

3.1 INSTALLATION

A. Comply with manufacturer’s instructions and recommendations. Install in proper relation to adjacent work.

B. Install base and accessories to minimize joints. Install base with joints as far from corners as practical.

C. Clean, polish, and protect.

END OF SECTION
SECTION 09 91 00

PAINTS

PART 1 GENERAL

1.1 SUMMARY

A. Provide painting and surface preparation.

B. Related Sections include the following:
   1. Division 8, Section “Hollow Metal Door and Door Frames”.
   2. Division 9, Section "Gypsum Board Assemblies" for wall reinforcing.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's product data and installation instructions for each material and product used.

B. Samples: Submit two representative samples of each material specified indicating visual characteristics and finish. Include range samples if variation of finish is anticipated.
   1. Include manufacturers full range of color and finish options if additional selection is required.

C. Extra Stock: Submit 1 unopened gallons of each paint and color used in the project.

1.3 QUALITY ASSURANCE

A. Comply with governing codes and regulations. Provide products of acceptable manufacturers, which have been in satisfactory use in similar service for three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

B. Regulations: Compliance with VOC and environmental regulations.

PART 2 PRODUCTS

2.1 MATERIALS

A. Painting – Walls and Ceiling: interior wall and ceiling surfaces.
   1. Manufacturers:
      a. Sherwin Williams.
      b. Pratt & Lambert.
      c. Benjamin Moore.
      d. ICI Paint Stores.

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PAINTS

09 91 00-1
e. PPG Architectural Finishes.

2. Primary Coating Type: Low VOC Latex based paints.
4. Gypsum Board Walls Color and Finish: Semi-gloss finish, see schedule on architectural plans.
5. CMU Walls Color and Finish: Eggshell finish, see schedule on architectural plans.

B. Painting – Interior Steel Doors and Frames:
   1. Manufacturers:
      a. Sherwin Williams.
      b. Pratt & Lambert.
      c. Benjamin Moore.
      d. ICI Paint Stores.
      e. PPG Architectural Finishes.
   2. Primary Coating Type: Alkyd based enamel paints.
   3. Primary Paint Systems: Rust-inhibiting primer plus two finish coats, sprayed application.
   4. Color and Finish: Satin finish, for color see schedule on architectural plans.

C. Fire Rated Assemblies: New and Existing.
   1. Paint “ONE HOUR RATED in stencil form with letters not less than 1.5” in height and the color red on a white or existing light contrasting background 12” below ceiling/floor deck every 10 feet of continuous wall surface and not less than once in each room adjoining the wall.

PART 3 EXECUTION

3.1 INSTALLATION

A. Inspect surfaces, report unsatisfactory conditions in writing; beginning work means acceptance of substrate.

B. Comply with manufacturer’s instructions and recommendations for preparation, priming and coating work. Coordinate with work of other sections.

C. At existing areas to be repainted, remove blistered or peeling paint to sound substrates. Remove chalk deposits and mildew and wash all surfaces with mild detergent. Perform related minor preparation including caulk and glazing compounds. Spot prime bare areas before priming and painting as specified.

D. Re-coat or remove and replace work which does not match or shows loss of adhesion. Clean up, touch up and protect work.

END OF SECTION
PART 1 – GENERAL

1.1 SUMMARY

A. Provide non-skid resinous flooring system as shown on the drawings and in schedules. The work shall consist of preparation of the substrate, the furnishing and application of a pigmented epoxy based floor coating system with urethane topcoat. The system shall have the color and texture as specified by the Wayne State University with a nominal thickness of 23 mils. It shall be applied to the prepared area(s) as defined in the plans strictly in accordance with the Manufacturer's recommendations.

1.2 RELATED SECTIONS

A. Division 9, Section “Resilient Base and Accessories”.

1.3 SUBMITTALS

A. Product Data: Latest edition of Manufacturer's literature including performance data and installation procedures.
B. Manufacturer’s Material Safety Data Sheet (MSDS) for each product being used.
C. Samples: A 3 x 3 inch square sample of the proposed system. Color, texture, and thickness shall be representative of overall appearance of finished system subject to normal tolerances.

1.4 QUALITY ASSURANCE

A. The Manufacturer shall have a minimum of 10 years experience in the production, sales, and technical support of epoxy and urethane industrial flooring and related materials.
B. The Applicator shall have experience in installation of the flooring system as confirmed by the manufacturer in all phases of surface preparation and application of the product specified.
D. System shall be in compliance with requirements of United States Department of Agriculture (USDA), Food, Drug Administration (FDA), and local Health Department.
E. Comply with NFPA 101.
F. A pre-installation conference shall be held between Applicator, General Contractor and the Wayne State University to review and clarification of this specification, application procedure, quality control, inspection and acceptance criteria and production schedule.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection

1. The Applicator shall be provided with a storage area for all components. The area shall be between 60 F and 90 F, dry, out of direct sunlight and in accordance with the Manufacturer's recommendations and relevant health and safety regulations.
2. Copies of Material Safety Data Sheets (MSDS) for all components shall be kept on site for review by the Engineer or other personnel.
C. Waste Disposal
   1. The Applicator shall be provided with adequate disposal facilities for non-hazardous waste generated during installation of the system.

1.7 PROJECT CONDITIONS

A. Site Requirements
   1. The Applicator shall ensure that adequate ventilation is available for the work area.
   2. The Applicator shall be supplied with adequate lighting equal to the final lighting level during the preparation and installation of the system.

C. Safety Requirements
   1. All open flames and spark-producing equipment shall be removed from the work area prior to commencement of application.
   2. "No Smoking" signs shall be posted at the entrances to the work area.
   4. Non-related personnel in the work area shall be kept to a minimum.

1.8 WARRANTY

A. Manufacturer shall warrant that material is substantially free from material defects and will perform substantially as per specification and published literature if installed in accordance with the manufacturer's recommended procedures.

PART 2 – PRODUCTS

2.1 FLOORING AND EPOXY COVE BASE

   1. System Materials:
      d. Cove Base: Dur-a-Glaze #4 Cove-Rez
      c. Cove Base: Plastic Adhesive Cove strip

   1. Patch Materials

2.2 MANUFACTURERS

A. Subject to compliance with requirements, provide system from one of the following:
   b. Sherwin Williams.
   c. Stonhard.

2.3 PRODUCT REQUIREMENTS

A. Primer
   a. Dur-A-Glaze #4 WB
1. Percent Solids 56%
2. VOC 2 g/L
3. Bond Strength to Concrete ASTM D 4541 550 psi, substrates fails
4. Hardness, ASTM D 3363 3H
5. Elongation, ASTM D 2370 9%
6. Flexibility (1/4: Cylindrical mandrel), ASTM D 1737 Pass
8. Abrasion Resistance ASTM D 4060, CS 17 wheel, 1,000 g Load 30 mg loss

**B. Base Coat**

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**C. Topcoat**

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<td>Hardness, ASTM D 3363</td>
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<td>60° Gloss ASTM D 523</td>
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<td>Abrasion Resistance, ASTM D4060 Gloss Satin CS 17 wheel (1,000 g load) 1,000 cycles</td>
<td>4  8 mg loss with grit 10 12 mg loss without grit</td>
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<tr>
<td>Pot Life, 70 F, 50% RH</td>
<td>2 Hours</td>
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<tr>
<td>Full Chemical Resistance</td>
<td>7 days</td>
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**PART 3 – EXECUTION**

3.1 GENERAL

A. As per Specification Section 01 70 00.

3.2 EXAMINATION

A. Examine substrates, areas and conditions, with Applicator present, for compliance with requirements for maximum moisture content, installation tolerances and other conditions affecting flooring performance.

1. Verify that substrates and conditions are satisfactory for flooring installation and comply with requirements specified.

3.2 PREPARATION
A. General

1. Existing concrete surfaces shall be free of oil, grease, curing compounds, loose particles, moss, algae growth, laitance, friable matter, dirt, and bituminous products.

2. Moisture Testing: Perform tests recommended by manufacturer and as follows.
   a. Perform relative humidity test using isitu probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75% relative humidity level measurement.
   b. If the relative humidity exceeds 75% then Dur-A-Flex, Inc Dur-A-Glaze MVP Primer moisture mitigation system must be installed prior to resinous flooring installation. Slab-on grade substrates without a vapor barrier may also require the moisture mitigation system.

3. There shall be no visible moisture present on the surface at the time of application of the system. Compressed oil-free air and/or a light passing of a propane torch may be used to dry the substrate.

4. Mechanical surface preparation
   a. Shot blast all surfaces to receive flooring system with a mobile steel shot, dust recycling machine (Blastrac or equal). All surface and embedded accumulations of paint, toppings hardened concrete layers, laitance, power trowel finishes and other similar surface characteristics shall be completely removed leaving a bare concrete surface having a minimum profile of CSP 3-4 as described by the International Concrete Repair Institute.
   b. Floor areas inaccessible to the mobile blast machines shall be mechanically abraded to the same degree of cleanliness, soundness and profile using diamond grinders, needle guns, bush hammers, or other suitable equipment.
   c. Where the perimeter of the substrate to be coated is not adjacent to a wall or curb, a minimum 1/8 inch key cut shall be made to properly seat the system, providing a smooth transition between areas. The detail cut shall also apply to drain perimeters and expansion joint edges.
   d. Cracks and joints (non-moving) greater than 1/8 inch wide are to be chiseled or chipped-out and repaired per manufacturer's recommendations.
   e. Expansion Joints (at column lines): Prior to coating application, thoroughly clean joint & remove existing joint material. Protect joint during coating applications to ensure joint remain free of coating product. Install new expansion joint material (sealant on backer rod) after finish coat application process.

5. At spalled or worn areas, mechanically remove loose or delaminated concrete to a sound concrete and patch per manufactures recommendations.

3.3 APPLICATION

A. General

1. The system shall be applied in four distinct steps as listed below:
   a. Substrate preparation
   b. Priming
   c. Base coat application.
   d. Topcoat application

2. Immediately prior to the application of any component of the system, the surface shall be dry and any remaining dust or loose particles shall be removed using a vacuum or clean, dry, oil-free compressed air.

3. The handling, mixing and addition of components shall be performed in a safe manner to achieve the desired results in accordance with the Manufacturer's recommendations.

4. The system shall follow the contour of the substrate unless pitching or other leveling work has been specified by the Architect.
5. A neat finish with well-defined boundaries and straight edges shall be provided by the Applicator.

B. Primer

1. The primer shall be Dur-A-Glaze #4 WB that is mixed at the ratio of 1 part resin to 4 parts hardener per the manufacturer’s instructions.
2. The primer shall be applied by 1/8 inch notched squeegee and back rolled at the rate of 200-250 sf/gal to yield a dry film thickness of 4 mils.

C. Base Coat

1. The base coat shall be comprised of two components, a resin, and hardener as supplied by the Manufacturer.
2. The resin shall be added to the hardener and thoroughly mixed by suitably approved mechanical means.
3. The base coat shall be applied over horizontal surfaces using “v” notched squeegee and back rolled at the rate of 100 sf/gal to yield a dry film thickness of 16 mils.

D. Topcoat

1. The topcoat of Armor Top shall be roller applied at the rate of 500 sf/gal to yield a dry film thickness of 3 mils.
2. The topcoat shall be comprised of a liquid resin, hardener and grit that is mixed per the manufacturer’s instructions.
3. The finish floor will have a nominal thickness of 23 mils.

3.4 FIELD QUALITY CONTROL

A. Tests, Inspection

1. The following tests shall be conducted by the Applicator:
   a. Temperature
      1. Air, substrate temperatures and, if applicable, dew point.
   b. Coverage Rates
      1. Rates for all layers shall be monitored by checking quantity of material used against the area covered.

3.5 CLEANING AND PROTECTION

A. Cure flooring material in compliance with manufacturer’s directions, taking care to prevent their contamination during stages of application and prior to completion of the curing process.

B. Remove masking. Perform detail cleaning at floor termination, to leave cleanable surface for subsequent work of other sections.

END OF SPECIFICATION
SECTION 10 44 00
FIRE EXTINGUISHERS, CABINETS, AND ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY
A. This Section includes the following:
   1. Portable fire extinguishers

1.02 REFERENCES
A. American Disability Act (ADA)
   ADA Accessibility Guidelines (ADAAG)
B. American Society for Testing and Materials (ASTM)
   A1008/A1008M Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
C. Federal Standard (FED-STD)
   FED-STD-795 Uniform Federal Accessibility Standards [UFAS]
D. National Fire Protection Association (NFPA)
   NFPA 10 Portable Fire Extinguishers
E. International Building Code (IBC)
F. International Fire Code (IFC)

1.03 SUBMITTALS
A. Submit brochure and product data

1.04 QUALITY ASSURANCE
A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10
B. Fire Extinguishers: Listed and labeled by Underwriter’s Laboratory [UL] or Factory Mutual [FM] for type, rating, and classification
PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. Ansul Inc.
2. Larsen’s Manufacturing Co.
3. Potter Romer
4. JL Industries

2.02 MATERIALS

A. Cold-Rolled Steel Sheet: Carbon steel, complying with ASTM A1008/A1008M, commercial quality, stretcher leveled, temper rolled.

2.03 PORTABLE FIRE EXTINGUISHERS

A. General: Provide fire extinguishers of type, size, and capacity for each cabinet and other locations indicated.

1. Product: A 10-lb, multi-purpose, UL listed, dry chemical fire extinguisher with a minimum rating of 4-A:40-B:C.

B. Mounting Brackets: Manufacturer’s standard steel bracket, designed to secure extinguisher, of sizes required for types and capacities of fire extinguisher indicated, with plated or baked-enamel finish.

C. Fire extinguishers installed outside shall be located in approved weather-tight fire extinguisher cabinets.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging. Remove and replace damaged, defective, or undercharged units.

3.02 INSTALLATION OF FIRE EXTINGUISHERS

A. Comply with manufacturer’s written instructions for installing fire extinguishers and mounting brackets.

B. Mounting Height: Install extinguishers at heights indicated below.
1. Install fire extinguishers mounted on hangers or brackets attached to a wall so that the top of the fire extinguisher is not more than 3½ ft. above the floor.

2. In no case shall the clearance between the bottom of the fire extinguisher and the floor be less than 4 inches.

C. Locations: Install extinguishers at locations indicated below.

1. Install fire extinguishers at locations specified on the drawings or as directed by the authority having jurisdiction.

2. Fire extinguishers shall be conspicuously located along normal paths of travel, including exits from areas. Extinguishers shall not be obstructed or obscured from view.

D. Verify that the extinguisher operating instructions face outward.

3.03 SIGNAGE

A. Identify bracket-mounted extinguishers with the words “FIRE EXTINGUISHER” in red letter decals applied to wall surface.
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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. Work includes providing laboratory fume hoods complete with factory installed wired and piped service fixtures, installation of fume hood controls, as indicated on Drawings and coordinated with laboratory casework specified in Division 12.

B. Related Sections:

1. Division 11, Section "Laboratory Service Fixtures" for service fixtures indicated on the Drawings shall be factory supplied and installed as part of the work of this Section, including all internal piping, pipe insulation, pipe sizing, pipe types, and wiring to termination points approximately 2 inches above ceiling.

2. Division 12, Section "Painted Metal Laboratory Casework".

3. Divisions 20, 22, 23, and 26 for connecting service utilities at indicated point and final connections to Building Services.

4. Division 23, Section "Heating Ventilating and Air Conditioning" for furnishing fume hood controls.

5. Division 26, Sections for electrical connections of fume hoods.

6. Drawings for "Finish Schedule" for color and material selections as listed in Laboratory Component.

1.3 PERFORMANCE REQUIREMENTS

A. Containment: Provide fume hoods with the following performance ratings at a face velocity of 100 fpm (0.51 m/s) and a tracer gas release rate of 4.0 L/min. when tested according to ASHRAE 110:

1. As-Manufactured Rating: AM 0.05 (0.05 ppm) (shade as default standard).
2. As-Installed Rating: A1 0.05 (0.05 ppm).
B. Structural Performance: Provide fume hood components capable of withstanding the following loads without permanent deformation, excessive deflection, or binding of cabinet drawers and doors:

1. Fume Hood Base Cabinets and Stands: refer to Division 12, Section “Painted Metal Laboratory Casework” for structural performance requirements.

C. Fume hoods shall function as ventilated, enclosed workspaces, designed to capture, confine and exhaust fumes, vapors and particulate matter produced or generated within the enclosure. Design fume hoods so that, when connected to exhaust system that provides proper exhaust volume under normal laboratory conditions, fume hoods will operate in a safe, efficient manner, within acceptable tolerances for face velocities specified. Dead air pockets and reverse air currents will not be permitted along surface of hood interiors.

D. Fume hood shall be designed to minimize static pressure loss with adequate slot area and bell shaped exhaust collar configuration. Maximum average static pressure loss readings taken three diameters above the hood outlet from four points, 90 degrees apart, shall not exceed the following maximums with sash in full open safe operating position:

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<th>Measured S.P.L. (W.G.)</th>
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<td>100 F.P.M.</td>
<td>.30 inches</td>
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E. Average Illumination of Work Area: Minimum 80 foot-candles. Work area shall be defined as the area inside the superstructure from side to side and from face of baffle to the inside face of the sash, and from the working surface to a height of 28 inches.

1.4 SUBMITTALS

A. Product Data: For each type of laboratory fume hood specified. Submit manufacturer’s data for each component. Include component dimensions, configurations, construction details, joint details, and attachments, utility and service requirements and locations.

B. Shop Drawings: For laboratory fume hoods. Include plans, elevations, sections, details, and attachments to other work.

1. Indicate locations of blocking and other supports required for installing fume hoods.
2. Indicate locations and types of service fittings, together with associated service connections required.
3. Indicate plumbing connections, duct connections, electrical connections, and locations of access panels.
4. Include roughing-in information for mechanical, plumbing, and electrical connections.
5. Show adjacent walls, doors, windows, other building components, laboratory casework, and other laboratory equipment. Indicate clearances from above items.
6. Coordinate shop drawings with other work involved.

C. Samples: Submit 3 x 6 inch samples of finish for fume hoods, work surfaces and for other pre-finished equipment and accessories.
D. Operation and Maintenance Manuals: Submit bound manual with operating and maintenance instructions, parts listing, recommended parts inventory listing, purchase source listing for major and critical components, emergency instructions, and similar information.

E. Instructions to be inscribed on instruction plate to be attached to hood, as specified in Part 2 of this Section.

F. Professional quality video - minimum 15 minutes in length on proper hood usage.

G. Test Reports: Submit test reports on each size and type of hood verifying conformance to test performances specified. Test report must accompany each hood as part of installation and usage package. Submit independent test reports as required by specification.

1. Provide fume hood face areas and volume of exhaust air at indicated face velocity, at hood sash stop position, and maximum sash opening. Also, provide fume hood face area and volume at sash minimum (closed) position.

H. Noise Criteria: Test data of octave band analysis verifying hood is capable of a 50 NC value when connected to a 50 NC HVAC source. Reading taken 3' in front of open sash at 110 fpm face velocity.

1.5 QUALITY ASSURANCE

A. Manufacturer shall identify and designate a full time factory representative for on-site supervision and coordination during the installation of fume hoods and all components.

B. Except for products specified to be manufactured by specific manufacturers, all other fume hoods shall be from the same manufacturer.

C. Provide and install service fixtures in laboratory fume hoods, manufactured or furnished by laboratory fume hood company for single responsibility.

D. Fume hood construction and performance including all electrical and mechanical components shall be designed in accordance with all applicable IBC, OSHA, NFPA and NEC.

E. Fume Hood Standard: Provide fume hoods complying with the requirements of SEFA 1.1, "Laboratory Fume Hoods - Recommended Practices".

F. Installer's Qualifications: Factory certified by the manufacturer.

G. Safety Glass: Products complying with ANSI Z97.1 and testing requirements of 16 CFR, part 1201 for Category II materials.

1. Subject to compliance with requirements, permanently mark safety glass with certification label of SGCC or another certification agency acceptable to authorities having jurisdiction.
H. Manufacturer's Qualifications: Modern plant with proper tools, dies, fixtures and skilled workmen to produce high quality laboratory casework and fume hoods, and shall meet the following minimum requirements:

1. Five years or more experience in manufacture of laboratory casework and fume hoods of type specified.
2. Ten installations of equal or larger size and requirements.

I. Demonstrate fume hood performance before shipment by testing according to ASHRAE 110. Provide testing facility, instruments, equipment, and materials needed for tests.

1. Submit test reports as specified under Submittals.

1.6 PRODUCT HANDLING

A. Coordinate delivery of fume hoods with delivery of other laboratory casework components.

B. Schedule delivery of equipment so that spaces are sufficiently complete that equipment can be installed immediately following delivery.

C. Protect finished surfaces from soiling and damage during handling and installation. Keep covered with polyethylene film or other protective covering.

1.7 COORDINATION

A. Coordinate installation of fume hoods with laboratory casework, fume hood exhaust ducts, and plumbing and electrical work.

B. Do not deliver or install equipment until the following conditions have been met:

1. Windows and doors are installed and the building is secure and weather tight.
2. Ceiling, overhead ductwork and lighting are installed.
3. All painting is completed and finished flooring located below casework is installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide fume hoods from one of the following:

1. Labconco Corporation.
3. BMC National Products.
2. 1 FUME HOOD MATERIALS

A. Fabricate laboratory fume hoods from materials specified herein and as indicated on drawings.

B. Fume Hood Materials:

1. Steel Sheet: Commercial-quality, cold-rolled, carbon-steel sheet, complying with ASTM A 1008/A (ASTM A1008M); matte finish; suitable for exposed applications; and stretcher leveled or roller leveled to stretcher-leveled flatness.

2. Stainless-Steel Sheet: ASTM A 666, Type 302 or Type 304, stretcher leveled, No. 4 finish.

3. Metal Finish: Manufacturers standard electrostatically applied urethane baked-on powder coating. Metal finish shall be acid and alkali resistant with a hard smooth satin furniture quality finish. Color selections shall be as listed in the Laboratory Component Finish Schedule on drawings.

4. Interior Liners: Provide fume hood interior liner panels as specified herein and as indicated on drawings.

   a. Glass-Fiber-Reinforced Polyester (Poly-Resin): Polyester laminate complying with ASTM D 4357, with a chemical-resistant gel coat on the exposed face, and have a flame-spread index of 25 or less when tested according to ASTM E 84. The finish shall be smooth and have a white color in appearance. Thickness not less than ¼ inch.

5. Work Surfaces: Provide fume hood work surfaces as specified herein and as indicated on drawings.

   a. Unless otherwise indicated on drawing, work surfaces (tops) shall be epoxy resin as specified in Section 11622, "Laboratory Accessories".

6. Laminated Safety Glass: ASTM C 1172, Kind LT; Kind FT; Condition A, Type 1, Class 1, Quality q3 lites with clear, polyvinyl butyryl interlayer. Thickness 7/32".


2. 2 FUME HOOD COMPONENTS

A. Fabricate laboratory fume hoods from components specified herein and as indicated on drawings.

B. Bypass Grilles: Low resistant type, 18 gauge steel, upward directional louvers.

C. Sash Cables: Stainless steel, uncoated, 1/8" diameter military spec. quality. (MIL-W-83420D-3)
D. Sash Guides: Corrosion resistant poly-vinyl chloride.

E. Pulley assembly for sash cable: 2” diameter, zinc dichromate finish, ball bearing type, with cable retaining device. (Nylon tired-not acceptable).

F. Sash Pull: Full width corrosion resistant plastic, stainless steel or steel with chemical resistant powder coating.

G. Gaskets: 70 durometer PVC for interior access panels. Gasket interior access panels to eliminate air leakage and to retain liquids inside hood.

H. Instruction Plate: Corrosion resistant or plastic plate attached to the fume hood exterior with condensed information covering recommended locations for apparatus and accessories, baffle settings and use of sash.

I. Piping: All fume hood piping and insulation materials, and construction methods are to conform to the Mechanical Specifications, Division 15.

J. Filters and Housings: Where called for, a filter housing shall be provided as an accessible component within the exhaust duct. The housing shall form a ridged, self-supporting assembly and have a gasketed front cover to allow the replacement of the filters without disturbing the ductwork. The design and installation of the filter and housing is to conform to the Mechanical Specifications, Division 15.

K. Fume Hood Face Velocity Sensors and Safety Monitor Alarms:

1. Provide fume hood manufacturers standard safety monitor/alarm system which monitors face velocity and provides audible and visual alarm if face velocity drops below safe levels. The technology shall be based on thermally compensated thermistor based in the alarm module. As the internal fume hood pressure changes as the sash opening is closed and opened, the flow passing over the thermistor is calibrated to a face velocity which is displayed on the front of the monitor.

2. General VAV Fume Hood Control System Requirements

   1) Airflow sensors and quick response (three seconds or less) pressure independent valves shall be installed in each exhaust duct, desirably at roof level, to maintain face velocity and to prevent backflow or air volume fluctuations.

3. Safety Monitor: UL listed, tamper proof, with all alarm circuits, electric components, external tubing, and manifolds furnished complete and factory installed. The monitor shall have light emitting diode and digital LCD display which provides clear indication of airflow conditions.

4. Calibration shall not accrue until the hood is stationed and the hood exhaust and room supply systems are balanced. A secondary calibration has been factory set into the alarm’s memory only to determine that the alarm is functional and ready for shipment. The primary calibration must be completed in the field.
5. Airflow Sensor: Thermally compensated glass-beaded thermistor, factory connected to a side-wall port on the interior of the fume hood.

   
   a. Mute pushbutton, which disables the audible alarm, shall be accessible on the front of the safety monitor.
   
   b. Provide alternate mode in which audible alarm is silenced indefinitely but visual alarm remains activated until the alarm condition is corrected.
   
   c. When alarm condition is corrected and face velocity and volume return to specified levels, then the Safety Monitor will automatically reset and begin routine monitoring.

7. Provide test circuit to verify proper Safety Monitor operation.

8. Electrical Rating: Maximum 12 VDC, and maximum current rating of 200MA.

L. Lights: Provide each hood with a two-tube, fluorescent light fixture of longest practicable length with lamps maximum 4'-0" and ballasts included. Shield light fixture from hood interior by 1/8" thick tempered glass panel, sealed air tight into hood body with chemical resistant rubber channels. Set units so that fluorescent tubes are easily replaceable from outside hood through access panel. Provide only fixtures with components which carry UL label.

1. Interior of Fixture: White, high reflecting plastic enamel.

2. Provide two 36" fixtures for hoods with eight foot superstructures.

3. Include lamps with fixtures.

4. Illumination: Per performance values, Part 1 of this Section.

5. Fluorescent Ballasts: Energy saving, 120 volt, high power factor, non-PCB, Class "P" approved. Individually fuse with Bussmann Type GMF fuses in HLR holders. Fuses shall be accessible from outside the fixture chassis. Use fuse rating as recommended by fixture manufacturer. Furnish fixtures with ballasts having a NEMA sound rating of "A" or better. All ballasts shall match the lamps specified.

   a. Acceptable Manufacturers: Subject to compliance with requirements, provide products of one of the following:

      1) Advance
      2) Valmont
      3) Fyrnetics
      4) Magnetek

6. Fluorescent Lamps: Type F32T8/SP35, 32 watt lamps with 2850 initial lumen output, T-8 rapid start, unless otherwise indicated or specified in the fixture specification.

   a. Provide fluorescent tubes with a color temperature of 3500 K and a minimum color rendering index of 85.
b. Acceptable Manufacturers: Subject to compliance with requirements, provide products of one of the following:

1) General Electric Trimline
2) Sylvania - Octron

M. Electrical Services: Three wire grounding type receptacles rated at 120 V.A.C. at 20 amperes.

N. Service Fittings: Comply with requirements of Division 11, "Laboratory Service Fittings and Fixtures".

1. Provide service fittings with exposed surfaces, including fittings, escutcheons, and trim, finished with acid- and solvent-resistant, baked-on coating.

2.3 FUME HOOD CONSTRUCTION

A. General: Design hoods to be highly fume resistant, for collection, retention and disposal of hazardous fumes with complete safety, minimum purging of air from room supply and minimum turbulence within hood chamber.

B. General: Provide benchtop fume hoods utilizing moveable sash configurations as indicated on drawings. Hoods shall operate on a variable or constant volume of exhaust air and incorporate a by-pass above the sash and at the sill to avoid dead air pockets at min-flow.

C. Framework: Heavy-gage steel members, reinforced, braced, assembled, and of sufficient size to insure strength and rigidity. Framework shall support exterior sheet metal cover, sash, hood liner, and all piping and wiring.

D. Body Construction: Fabricate exterior of minimum 18 ga. cold-rolled steel with component parts screwed together to allow removal of end panels, front end fascia pieces, top fascia and air foil, and to allow access to plumbing lines, service fixtures and light fixtures (for relamping). Apply manufacturer's standard acid and alkali resistant baked-on finish to interior and exterior surfaces of component parts prior to final assembly. Color selections shall be as listed in the Laboratory Component Finish Schedule on drawings.

E. Ends: Double-wall end panels without projecting corner posts or other obstructions to interfere with smooth, even flow of air. Enclose area between double walls for housing sash counter-balance weights, utility lines, and remote control valves, access ports, as required. Nominal and panel thickness shall be 5".

F. Interior Lining: Use polyresin for exposed interior surfaces unless otherwise specified. Use stainless steel for fasteners and other exposed metal. Furnish end panels, back panel, and top of not less than ¼” thick material, screwed together with cleats or steel angles to form a completely rigid assembly to which exterior cold-roller steel panels are mounted.

1. Back-up joints with angles or cleats and coat joints with chemical resistant mastic before assembly to prevent open joints or spaces. Use stainless steel truss head screws or rivets
(not countersunk) for assembly of panels and to provide maximum strength joints. Secure hood baffle to cleats at rear of hood with stainless steel screws.

2. Punch hood side panels to receive remote controls and service fixtures at side of hood, as indicated. Furnish removable plug buttons for holes not used for indicated fixtures.

G. Provide access panels in face of hood to permit relamping of light fixtures.

H. Working Surface: Unless otherwise specified, provide a working surface (counter) of epoxy resin. All working surfaces shall be provided with a ¼" thick raised edge across front, sides, and rear of hood, to make a watertight retaining ledge.

I. Rear Baffle: Provide baffle at rear of hood for normal or average operation.

J. Fume Hood Opening: The top and sides of fume hood openings shall be provided with splayed or radius face to provide a smooth, aerodynamic flow of air into the fume hood. The bottom of the opening shall be provided with the manufacturer’s standard airfoil or flush sill incorporating by-pass air functions, as indicated on Drawings. The flush sill shall be mounted on the fume hood and shall extend under the sash line. Sills shall be designed to direct exhaust air flow across the work surface to prevent backflow and eddy currents. Sill shall be provided with a nominal 1” linear opening to facilitate air flow and for passage of electrical chords from hood interior to electrical receptacles on side rails.

K. Exhaust Connection: The fume hood shall be provided with an integral exhaust plenum and a single connection for exhaust air. Provide 304SS transition piece from hood plenum to building exhaust ductwork, unless otherwise noted. Coordinate exhaust connections with mechanical trades.

1. Plenum Chamber: Adequate volume for hood dimensions, extending full width of hoods to equalize air flow, of corrosion resistant material.

L. Sash: Provide manufacturers standard sash frame for sash type indicated on drawings. Glaze with safety glass set into chemical resistant rubber glazing channels, held in place by removable stops.

1. Fabricate horizontal sliding sash with adjustable nylon-tired, ball-bearing sheaves on stainless-steel track. Sash shall by-pass and be removable. Provide flush finger pulls and rubber bumpers at both stiles of each sash.

2. Fabricate vertical sliding, independently operable, double-hung sashes with concealed counterbalance to hold sashes in place regardless of position. Counterbalance vertical sliding sash with weight and stainless-steel cable system. Provide ball-bearing sheaves, plastic glides in stainless-steel guides, and stainless-steel lift handles. Provide rubber bumpers at top and bottom of each sash unit. Pull required to raise or lower sash shall be less than 7 pounds. Provide rubber bumpers at top and bottom of each sash unit. Vertical sash glides and guides shall be Accuride.

3. Fabricate combination sash configurations as specified for horizontal and vertical sliding sash, and as indicated on drawings.
M. Sash Stops: Provide fume hoods with sash stops integral with hood frame to limit hood opening as indicated on drawings. Sash stops can be manually released to open sash fully for cleaning hood and for placing large apparatus within hood.

N. Utility Preparation: Fume hoods shall be completely prepiped and prewired with all vacuum breakers, valves and outlet fittings factory mounted. Prewiring of the hood shall terminate in junction boxes mounted on the top of the fume hood. Prepiping of the hood shall include extension of piping from the top of each side of the fume hood to the service valve and then to the service outlet and also include waste vent piping for cup sinks fitted in hoods.

O. Fume Hood Face Velocity Sensors and Safety Monitor Alarms:

1. Fume hoods shall be fitted with factory mounted alarm and face velocity sensors, whether supplied by the fume hood manufacturer or supplied by the Laboratory Controls Supplier. The hoods shall be fabricated and equipped with all wiring, conduits, and electrical boxes required. Provide wiring in accordance with control unit manufacturer's instructions to a junction box at top of hood. The alarm units shall be flush mounted.

P. Closure Strips: Wood or metal, as applicable, to match adjoining surfaces. Provide where required to close openings between fume hood base cabinet and superstructure and adjacent building wall or ceiling construction.

Q. Holes: Provide holes as indicated and as required for passage of piping, ducts, and conduit, and for fixtures furnished under other Division-12 sections.

R. Fasteners: Provide stainless steel for fasteners wherever exposed to fumes in hood.

S. Cup Sink: Furnish for each hood having water supply, provide of same material as hood working surface, size and configuration as indicated.

T. Vacuum Breakers: All required vacuum breakers shall be visible and be mounted outside of the working space on the front of fume hood above the level of the sash opening.

U. Service Fittings: Provide in accordance with fitting schedule. No valve operator shall be located inside the fume hood working space. Valves shall align vertically and horizontally with outlets where possible.

1. The color of Service Fitting Outlets in the hood interior shall match the color of the valve handle on hood exterior.

V. Access Panels: Provide interior gasketed, access panels in fume hood side walls for access to concealed piping. Access panels area to be of same material as hood liner.

2.4 FUME HOOD PHYSICAL STYLES

A. Fabricate and provide laboratory fume hoods in the physical styles as specified herein and as indicated on drawings. Fume hoods are located, identified, described and detailed on the drawings. The physical style of each fume hood is indicated on drawings.
B. The following lists fume hood physical styles of fume hoods for this project:

1. Benchtop: Benchtop fume hoods shall be designed to accommodate laboratory activities at normal benchtop height.

2. Accessible: Accessible fume hoods shall be designed to accommodate physically handicapped users. The hood shall comply with the criteria of the Americans with Disabilities Act and the code requirements of the applicable local or state accessibility codes.

2.5 FUME HOOD OPERATING TYPES

A. Fabricate laboratory fume hoods that operate as specified herein and as indicated on drawings. Fume hoods are located, identified, described, and detailed on the drawings. The operating type of each fume hood is indicated on Drawings.

B. Variable Air Volume: Provide fume hoods that maintain a constant face velocity as the sash height changes. It shall be capable of varying the exhaust air volume in proportion to the hood face opening by either changing the speed of the exhaust blower or by adjusting a damper in the exhaust duct for general laboratory fume hood operations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Install fume hoods according to Shop Drawings and manufacturer’s written instructions. Install plumb, level, aligned, and securely anchored to building and adjacent laboratory casework. Securely attach access panels but provide for easy removal and secure reattachment. Where hoods abut other finished work, apply filler strips and scribe for accurate fit with fasteners concealed where practical.

B. Comply with requirements of Divisions 11, 15 and 16 Sections for factory installation of water and laboratory gas service fittings, piping, electrical devices, and wiring. Install according to Shop Drawings and manufacturer’s written instructions. Securely anchor fittings, piping, and conduit to fume hoods and casework, unless otherwise indicated.

3.2 FIELD QUALITY CONTROL

A. Field Test: Field test 10% of installed units as selected by Architect after completion of installation to verify proper operation of hoods in accordance with specified requirements. Perform tests in accordance with ASHRAE Standard 110 after balancing of building air handling system is completed. The maximum allowable leakage rate during the tracer gas test is 0.05 parts-per-million (ppm) at a release rate of 4.0 liters per minute (1 pm) at the breathing zone. If the fume hood leakage rate is less than or equal to 0.05 ppm at 4.0 lpm release rate, then its performance is acceptable.
1. Notify Owner's Representative a minimum of one week prior to start of testing to make arrangements to have Owner's Representative present during testing.

2. In addition to the basic 10% of units tested, test one hood selected by Architect, for each type of hood installed, according to ASHRAE 110 to verify performance. If any hood tested for performance fails to perform as specified, field test additional hoods as directed by Architect.

3. Field adjust fume hoods, in conjunction with a tuned building exhaust and HVAC system, or replace hoods and make other corrections until tested hoods perform as specified.

4. After making corrections, retest fume hoods that failed to perform as specified.

3.3 ADJUSTING AND CLEANING

A. Adjust moving parts for smooth, near-silent, accurate sash operation with one hand. Adjust sashes for uniform contact of rubber bumpers. Verify that counterbalances operate without interference.

B. Repair or remove and replace defective work as directed on completion of installation.

C. Clean finished surfaces, including both sides of glass; touch up as required; and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.
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

This Section includes laboratory safety equipment including emergency eyewashes, showers and other related products.

A. Extent and types of safety equipment as indicated on Laboratory Equipment drawings.

B. Provide safety equipment as specified herein and as indicated on Laboratory Equipment drawings.

C. Related Sections include the following:
   1. Division 11, Section "Fume Hoods'.
   2. Division 11, Section 116622 "Laboratory Accessories'.
   3. Division 12, Section 12352, "Painted Metal Laboratory Casework".
   4. Divisions 22 and 26 for plumbing and electrical requirements.
   5. Divisions 20, 22, 23, and 26 for final connections to building services and systems.

1.3 PERFORMANCE REQUIREMENTS

A. General Performance and Chemical Resistance: Provide certification that fixtures and fittings have been tested in accordance to and meet the performance requirements as described in SEFA 7.

1.4 SUBMITTALS

A. Product Data: Submit manufacturer's data and installation instructions for each type of emergency fixture.
   1. Include independent laboratory certification that applied finish complies with specified chemical and physical resistance requirements.
   2.
1.5 EXTRA MATERIALS

A. Provide to Owner a complete touch-up kit for surface repair of emergency 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 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, NFPA and OSHA 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.

E. ADA fixtures shall comply with the requirements of Section 309.4 of ANSI/ICC A117.1, where a fixture is to be ADA compliant, the maximum force required to open or close a manually activated fitting shall not exceed 5 lbs.

F. 

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. All mechanical laboratory service fixtures shall be the product of one of the following:

1. Water Saver Faucet Co.
2. Chicago Faucet
3. Far Laboratory Faucets Ltd.

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 on the Laboratory Equipment drawings and fixture details as an attachment to this specification.

B. Emergency Fixtures: Provide all emergency fixtures factory assembled, including the assembly of all valves, flanges, and other mounting accessories. Individually factory test each fixture and provide all fixtures complete with washers, locknuts, unions, nipples and other accessories.

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. Safety equipment as follows:
   
a. Satin Chrome Finish with Clear Epoxy Coating: Emergency eyewash. All components shall be polished and electroplated with one layer of nickel. Exposed surfaces shall then be further polished to an AISI No. 6 brushed finish which is fine-grained and uniform. Components shall then be electroplated with one layer of chrome. Following chrome plating, surfaces to be coated shall be cleaned and degreased. Following plating and cleaning a clear epoxy coating shall be applied to all exposed surfaces and fully baked to permit curing. Surfaces shall have a minimum coating thickness of 2 mils.


D. Safety Equipment:

1. Signage: Provide signage identifying shower location.

2. Dual Purpose Eye Wash/Drench Hose Units: Deck mounted eye wash/drench hose units shall be capable of use as a fixed eye wash with hands-free operation or as a drench hose. Units shall have two Gentle Spray outlet heads mounted parallel and angled forward, each with a self-regulating volume control, reticulated polyurethane filter and removable spray cover. Dust covers shall be hinged swing-away style and shall be permanently attached to the spray head with a stainless steel pin. Units shall be furnished with a deck flange with locator guide to hold the unit facing forward and an 8 ft. reinforced PVC hose.

3. Emergency eyewash units shall have the following:
   
a. Controlled, low velocity flow completely rinses eyes and face and is not injurious to user.
   b. Hands free stay open ball valve activating within one second or less.
   c. Eyewash unit must be capable of delivering at least 0.4 gpm for 15 minutes.
   d. The nozzles must be protected from airborne contaminants.

4. Emergency eyewash and shower combination units shall have the following:
   
a. Controlled, low velocity flow completely rinses eyes and face and is not injurious to user.
   b. Hands free 1” IPS brass stay open ball valve activating within one second or less.
   c. Eye/face wash unit must be capable of delivering 3.0 gpm for 15 minutes.
   d. The nozzles must be protected from airborne contaminants.
   e. The height from the floor to the nozzles must be between 33 inches and 45 inches.
   f. The distance from the wall (or an obstruction) to the nozzles must be a minimum of 6 inches.

5. Accessories and Options: Provide a shower curtain and track as part of the shower fixture.
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. Follow the manufacturer’s recommended test and working pressures for fittings. Testing or using a fitting at pressure for which it is not designed can result in leakage or failure.

C. 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 Laboratory 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 11 53 33
AP250-015 Modesty Curtain for Horizontal Showers and Safety Stations

Application: In an emergency, it is imperative that contaminated clothing be removed as quickly as possible. However, employees may be reluctant to remove their clothing in the presence of co-workers. A modesty curtain will protect the privacy of the user and permit disrobing while the shower unit is in operation. The curtain has a pocket in which a smock can be stored.

Installation: Unit is designed for use with horizontally mounted emergency showers and free-standing combination safety stations. Furnished complete with stainless steel track assembly for mounting on vertical and horizontal piping. All necessary mounting brackets and clamps are included.

Curtain: White UV-resistant nylon curtain with ring hangers. Curtain has tie-back so it can be neatly stored when shower is not in use. Curtain has interior pocket for storing a smock to be used after contaminated clothing is removed.

Additional Models
○ APBF250-015 Same as above except for installation on barrier-free horizontal showers and safety stations.
AP250-015 Modesty Curtain for Horizontal Showers and Safety Stations

Ø37" (INSIDE) (940mm)

STAINLESS STEEL TOP SUPPORT BRACE

STAINLESS STEEL CURTAIN TRACK

NOTE: TIE-BACK IS INCLUDED FOR STORING CURTAIN WHEN NOT IN USE.

(2) U-BOLTS FOR VERTICAL 1 1/4" PIPE

(2) U-BOLTS FOR 1" HORIZONTAL PIPE (SEE DETAIL "A")

(2) NYLON CURTAINS (72"x 72") (1829mm x 1829mm) WITH POCKET AND RING HANGERS

DETAIL "A"

NUT

BACK PLATE

SPACER

U-BOLT

DETAIL "B"

NUT

B

SEE DETAIL "B"

THIS SPACE FOR ARCHITECT/ENGINEER APPROVAL

Due to continuing product improvement, the information contained in this document is subject to change without notice. All dimensions are ± 1/4" (6mm).
**APPLICATION:** Dual purpose eyewash/drench hose unit for deck mounting. Unit meets the provisions of ANSI Z358.1-2004 as both an eyewash and a drench hose. Unit may be left in the deck flange for use as a fixed eyewash, leaving user’s hands free. Alternatively, unit may be removed for use as a drench hose to rinse any part of user’s eyes, face or body.

**SPRAY HEAD ASSEMBLY:** Two GS-Plus™ spray heads mounted side-by-side. Each head has a “flip top” dust cover, internal flow control and filter to remove impurities from the water flow.

**VALVE:** 1/2” IPS brass stay-open ball valve. EW1028 has valve mounted above counter and activated by flag handle.

**HOSE:** 8’ reinforced PVC hose. 300 PSI maximum working pressure.

**MOUNTING:** Eyewash assembly has deck flange for countertop mounting. Flange has handle locator guide to position spray heads facing forward at all times.

**SUPPLY:** 1/2” NPT male inlet.

**SIGN:** ANSI-compliant identification sign.

**QUALITY ASSURANCE:** Unit is completely assembled and water tested prior to shipment.

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**Available Options**

- **DC** Stainless steel dust cover for each spray head.
- **FSH** 8 ft. flexible stainless steel hose in place of PVC hose.
- **HG** Undercounter hose guide bracket to prevent hose from tangling or binding.
- **BP** In-line dual check backflow preventer installed on inlet of hose. *Note: Check with code authority for compliance with local plumbing code.*
- **VB** Atmospheric vacuum breaker installed on outlet of ball valve (EW1028VB).
- **TMV** AP3600 thermostatic mixing valve precisely blends hot and cold water to deliver warm (tepid) water as provided by ANSI Z358.1 - 2004. Refer to “Tempering Units” section for complete technical and product selection information.
Eyewash / Drench Hose Units

- **EW1028** Eyewash/Drench Hose Unit, Deck Mounted, Ball Valve with Flag Handle
- **EW1028VB** Eyewash/Drench Hose Unit, Deck Mounted, Ball Valve with Flag Handle, Vacuum Breaker

**NOTES:**

1. EACH GS-PLUS SPRAY HEAD HAS A "FLIP-TOP" DUST COVER, INTERNAL FLOW CONTROL AND FILTER TO REMOVE IMPURITIES FROM THE WATER FLOW.
2. HOSE SHOULD NOT BE USED IN APPLICATIONS WHERE WATER PRESSURE EXCEEDS 90 PSI. HOSE SHOULD BE INSPECTED PERIODICALLY FOR DETERIORATION.
3. UNIT FURNISHED FOR MOUNTING ON COUNTERTOPS FROM 1/8" UP TO 1-1/2" THICK.

Due to continuing product improvement, the information contained in this document is subject to change without notice. All dimensions are ± 1/4" (6mm). rev. 0308
SSBF994 All-Stainless Steel Handicapped Accessible Safety Station with WideArea™ Eye/Face Wash

Application: All-stainless steel handicapped accessible combination WideArea™ eye/face wash and shower safety station. Shower head and pull rod are extended for improved access. Bowl is lowered and extended to permit access by wheelchair user. Profile of unit is “flattened” to comply with maximum height and knee clearance requirements. Stainless steel construction is ideal for highly corrosive environments and clean room applications.

ADA Compliance: Unit complies with ADA requirements for accessibility by handicapped persons (maximum height and reach, minimum knee clearance and distance from obstructions).

Shower Head: 10” diameter stainless steel.

Shower Valve: 1” IPS Type 316 stainless steel stay-open ball valve. Valve has stainless steel ball and Teflon® seals. Furnished with stainless steel actuating arm and 47-1/2” stainless steel pull rod.

Spray Head Assembly: Four GS-Plus spray heads. Each head has a “flip top” dust cover, internal flow control and filter to remove impurities from the water flow.

Eye/face Wash Bowl: 11-1/2” stainless steel.

Eye/face Wash Valve: 1/2” IPS Type 316 stainless steel stay-open ball valve. Valve has stainless steel ball and Teflon® seals.

Pipe and Fittings: Schedule 40 brushed stainless steel.

Supply: 1-1/4” NPT female top or side inlet.

Waste: 1-1/4” NPT female outlet.

Sign: Furnished with ANSI-compliant identification sign.

Quality Assurance: Valve and spray head assemblies are factory assembled and water tested prior to shipment.

Available Options
- **BC** Stainless steel cover for eye/face wash bowl.
- **FC20** Regulates shower flow rate to 20 GPM.
- **HS** Auxiliary drench hose unit for rinsing eyes, face or body.
- **APBF250-015 Modesty Curtain**
  Modesty curtain for mounting on Handicapped Accessible safety station.
- **AP275-200 Electric Light and Alarm Horn**
  Flashing light and alarm horn for mounting on safety station.
- **TMV** AP3800 thermostatic mixing valve precisely blends hot and cold water to deliver warm (tepid) water as required by ANSI Z358.1-2009.
SSBF994  All-Stainless Steel Handicapped Accessible Safety Station with WideArea™ Eye/Face Wash

Units have been tested to and comply with ANSI Z358.1-2009.

Due to continuing product improvement, the information contained in this document is subject to change without notice. All dimensions are ± 1/4” (6mm).

rev. 0513
SECTION 11 53 43
LABORATORY SERVICE FITTINGS AND FIXTURES

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 laboratory service fittings and fixtures, also known as valves, for water,
      vacuum and compressed gas.

   B. Extent and types of laboratory service fixtures and safety equipment as indicated on
      Laboratory Equipment drawings.

   C. Provide service fittings and fixtures as specified herein and as indicated on Laboratory
      Equipment drawings.

   D. Related Sections include the following:

      1. Division 11, Section "Fume Hoods".

      2. Division 11, Section 116622 "Laboratory Accessories".

      3. Division 12, Section 12352, "Painted Metal Laboratory Casework".

      4. Divisions 22 and 26, Sections for plumbing and electrical requirements.

      5. Divisions 20, 22, 23, and 26 for final connections to building services and systems.

1.3 PERFORMANCE REQUIREMENTS

   A. General Performance and Chemical Resistance: Provide certification that fixtures and fittings
      have been tested in accordance to and meet the performance requirements as described in
      SEFA 7.

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 complies with specified
         chemical and physical resistance requirements.
2. Submit samples of plumbing and electrical service fixtures when requested by Laboratory 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 water, vacuum and compresses gas services listed.

1.5 EXTRA MATERIALS

A. Provide to Owner a complete touch-up kit for surface repair of service fittings and 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, NFPA and OSHA 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. Atmospheric vacuum breakers shall be certified by the American Society of Sanitary Engineers (ASSE) under Standard 1001 and faucet fixture breakers shall be certified to comply with ANSI/ASSE Standard 1035.

E. ADA fittings shall comply with the requirements of Section 309.4 of ANSI/ICC A117.1, where a faucet or fitting will be used in an application that is intended to be ADA compliant, the maximum force required to open or close a manually activated fitting shall not exceed 5 lb. (22 N) at 80 PSI (550 kPa) static pressure.

F. Natural gas service, ball valves shall be certified by the American Gas Association (AGA) under ANSI Z21.15 and the Canadian Gas Association (CGA) 9.1 under CAN/CGA-3.16-M88 (CLIR 36).

PART 2 - PRODUCTS

2.1 APPROVED MANUFACTURERS

A. All mechanical laboratory service fixtures shall be the product of one of the following:

1. Water Saver Faucet Co.
2. Chicago Faucet
3. Far laboratory Faucets Ltd.
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 on the Laboratory Equipment drawings and fixture details as an attachment to this specification.

B. Service Fixtures: Provide all service fixtures factory assembled, including the assembly of all valves and shanks to turrets, flanges, and other mounting accessories. Individually factory test each fixture and provide all fixtures complete with washers, locknuts, unions, nipples and other accessories.

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: Polished Chrome Finish with Clear Epoxy Coating.

   a. Fittings Inside Fume Hoods: shall have an epoxy finish color-coded to match the fixture service index color. Following base preparation and cleaning, coating material shall be electrostatically applied to all exposed surfaces. After application, coating shall be fully baked to permit curing. Surfaces shall have a minimum coating thickness of 2 mils.

D. Handles: Except as otherwise indicated, provide forged brass four-arm style handles on all fixtures with a color coded screw-on index disc.

E. Service Outlet Identification: The handle of each laboratory fitting, except pressure regulators, shall be marked to indicate the particular liquid or gas that is delivered by or through such fitting. The handle or the index button fastened to the handle shall be color coded, and the index button shall be embossed with identification letters to designate the service. Letters used to designate the service or symbol shall be legible and easy to read. Color code index discs as follows:

<table>
<thead>
<tr>
<th>Basic Air &amp; Water Indexing</th>
<th>Index Color</th>
<th>Letter Color</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compressed Air</td>
<td>Orange</td>
<td>Black</td>
<td>CA</td>
</tr>
<tr>
<td>Cold Water</td>
<td>Dk. Green</td>
<td>White</td>
<td>CW</td>
</tr>
<tr>
<td>Hot Water</td>
<td>Red</td>
<td>White</td>
<td>HW</td>
</tr>
<tr>
<td>Tempered Water</td>
<td>Green</td>
<td>White</td>
<td>TW</td>
</tr>
<tr>
<td>Vacuum</td>
<td>Yellow</td>
<td>Black</td>
<td>VAC</td>
</tr>
</tbody>
</table>

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. Follow the manufacturer’s recommended test and working pressures for fittings. Testing or using a fitting at pressure for which it is not designed can result in leakage or failure.

END OF SECTION
Laboratory Mixing Faucets

- **L2221VB**: Laboratory Mixing Faucet, Deck Mounted, 6" Rigid Vacuum Breaker Gooseneck, Aerator, Wrist Blade Handles
- **L2222VB**: Same as Above Except with 6" Swing Vacuum Breaker Gooseneck
- **L2224VB**: Same as Above Except with 6" Rigid/Swing Vacuum Breaker Gooseneck

**NOTE:**
1. FIXTURE IS CERTIFIED BY CSA INTERNATIONAL TO COMPLY WITH ASME A112.18.1M AND CSA B125.1.
2. VALVES AND GOOSENECK FITTING ARE FULLY ASSEMBLED AND FACTORY TESTED PRIOR TO SHIPMENT.
3. VACUUM BREAKER IS CERTIFIED TO COMPLY WITH ASSE 1001.
4. FIXTURE HAS A POLISHED CHROME PLATED FINISH.

Measurements may vary ± 1/4".
(SF-3) Cup Sink Fixture, Cold Water

Laboratory Single Faucets

- **L611VB** Laboratory Single Faucet, Deck Mounted, 6" Rigid Vacuum Breaker Gooseneck
- **L612VB** Same as Above Except with Swing Vacuum Breaker Gooseneck
- **L614VB** Same as Above Except with Rigid/Swing Vacuum Breaker Gooseneck

---

**NOTES:**
1. Fixture is fully assembled and factory tested prior to shipment.
2. Vacuum Breaker is certified to comply with ASSE 1001.
3. Fixture is certified by CSA International to comply with ASME A112.18.1M and CSA B125.1.
4. Fixture has a polished chrome plated finish.

---

Measurements may vary ± 1/4".
**Gooseneck Outlet Fittings**

- **L081WSA** Gooseneck Outlet Fitting, Deck Mounted, 6" Rigid Gooseneck
- **L082WSA** Same as Above Except with Swing Gooseneck
- **L084WSA** Same as Above Except with Rigid/Swing Gooseneck

**NOTES:**
1. IF VACUUM BREAKER IS REQUIRED, ADD SUFFIX "VB." IF AERATOR IS REQUIRED IN PLACE OF HOSE END, ADD SUFFIX "55."
2. FITTING IS FURNISHED WITH EITHER A POLISHED CHROME PLATED OR A POWDER COATED FINISH ( COLOR-CODED PER SERVICE INDEX COLOR ) AS STANDARD. OTHER FINISHES ARE AVAILABLE UPON REQUEST.

**Measurements may vary ± 1/4".**
L3185N Remote Control Needle Valve, Angle Pattern with Guide Plate, Rod and Handle

3/8" IPS FEMALE OUTLET

3/8" IPS FEMALE INLET

1" (25 mm)

1" (25 mm)

"L" DIMENSION (2O" STANDARD)

FORGED BRASS FOUR-ARM HANDLE

GUIDE PLATE

COLORED PLASTIC INDEX DISC

BRASS COUPLING

FORGED BRASS VALVE BODY

ø3/8" ALUMINUM ROD

REPLACEABLE STAINLESS STEEL SEAT

STAINLESS STEEL REPLACEABLE FLOATING CONE

NOTES:
1. VALVE IS FACTORY ASSEMBLED AND TESTED AT 225 PSI. MAXIMUM WORKING PRESSURE IS 150 PSI.
2. REMOTE CONTROL VALVE IS FURNISHED COMPLETE WITH GUIDE PLATE, ROD AND HANDLE WHEN ORDERING, SPECIFY TYPE OF GUIDE PLATE DESIRED; "L" DIMENSION AND SERVICE.

Measurements may vary ± 1/4".
**L3185 REMOTE CONTROL VALVES**

**FINE CONTROL NEEDLE VALVE CONSTRUCTION**

- **L3185FCN** Remote Control Fine Control Needle Valve, Rod-Type, Angle Pattern

**STEAM VALVE CONSTRUCTION**

- **L3185S** Remote Control Steam Valve, Rod-Type, Angle Pattern

**WATER VALVE CONSTRUCTION**

- **L3185W** Remote Control Water Valve, Rod-Type, Angle Pattern

**TIN-LINED WATER VALVE CONSTRUCTION**

- **L3185WTL** Remote Control Pure Water Valve, Rod-Type, Angle Pattern

Measurements may vary ± 1/4".
L112WSA
PANEL MOUNTED ATMOSPHERIC VACUUM BREAKER WITH 3/8" IPS MOUNTING SHANKS

MEASUREMENTS MAY VARY ±1/4".

NOTE:
- ASSE CERTIFIED UNDER STANDARD 1001.
- CSA CERTIFIED UNDER CAN/CSA B64.
NOTES:
1. VALVE IS CERTIFIED BY CSA INTERNATIONAL TO COMPLY WITH ANSI 2112 AND CGA 9.1.
2. FIXTURE IS FULLY ASSEMBLED AND FACTORY TESTED AT 225 PSI NITROGEN PRESSURE. MAXIMUM WORKING PRESSURE IS 150 PSI.
3. SPECIFY IF CLEANING FOR OXYGEN AND HIGH PURITY GASES IS REQUIRED.

Measurements may vary ± 1/4"
Remote Control Ball Valve, Angle Pattern with Guide Plate, Rod and Handle

**L4285**

**NOTES:**

1. VALVE IS FACTORY ASSEMBLED AND TESTED AT 125 PSI. MAXIMUM WORKING PRESSURE IS 75 PSI.
2. VALVE IS SUITABLE FOR WATER AND GAS SERVICES.
3. VALVE IS CERTIFIED FOR GAS SERVICE BY THE AMERICAN GAS ASSOCIATION AND THE CANADIAN GAS ASSOCIATION.

**LABEL SUPPLIED FOR FRONT OF PANEL**

Measurements may vary ± 1/4".

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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. Laboratory benchtops.
2. Laboratory sinks.
4. Laboratory adjustable wall shelving.
5. Service chases.
6. Overhead Service Carrier.
7. Miscellaneous Unistrut framing.
8. Gas cylinder restraint straps and racks.
10. CPU holder.
11. Cable Management.

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, Fume Hoods".
3. Division 11, Section "Laboratory Service Fixtures and Safety Equipment".
4. Division 12, Section “Painted Metal Laboratory Casework”.

1.1 PERFORMANCE REQUIREMENTS

C. Seismic Performance: Provide assemblies and systems capable of withstanding the effects of earthquake motions determined according to the building code in effect for this Project or ASCE 7, "Minimum Design Loads for Buildings and Other Structures", Section 9, "Earthquake Loads", whichever is more stringent.

1.3 SUBMITTALS
A. Product Data: Submit product data for manufactured items.

B. Samples: Submit samples of the following:
   1. Benchtop materials.
   2. Phenolic Resin.
   3. Painted metal finishes.

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. Benchtops showing joint locations and fixture holes and cut outs.
   2. Laboratory adjustable wall shelving.
   4. Service drops.
   5. Overhead service carriers.
   7. Gas cylinder restraint straps and racks.
   8. Keyboard tray.
   9. CPU holder.
  10. Cable Management.

D. Product Test Reports: Based on tests performed by a qualified independent testing agency, indicate compliance with SEFA 3 and 8 for 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. Keep covered with polyethylene film or other protective covering.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install laboratory accessories 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 laboratory 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 FABRICATION

A. Laboratory Benchtops, General:

1. Provide and install type and configuration of laboratory benchtops as indicated on drawings.

2. Fabricate benchtops in as large components as practicable to minimize field jointing.

3. Provide separate box curbs and splash trims with benchtops.

4. Field Jointing: Where possible, make in the same manner as shop jointing using dowels, splines, adhesives, and fasteners recommended by manufacturer. Prepare edges to be joined in shop so Project site processing of top and edge surfaces is not required. Locate field joints where shown on approved Shop Drawings.

5. Abut top and edge surfaces in one true plane, with internal supports placed to prevent deflection. Provide flush hairline joints in tops using clamping devices.

   a. Where necessary to penetrate tops with fasteners, countersink heads approximately 1/8 inch (3 mm) and plug hole flush with material equal to top in chemical resistance, hardness, and appearance.

6. Provide required holes and cutouts for service fittings.

7. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

8. Provide scribe moldings for closures at junctures of top, curb, and splash, with walls as recommended by manufacturer for materials involved. Match materials and finish to adjacent casework. Use chemical-resistant, permanently elastic sealing compound where recommended by manufacturer.

2.4 (E-#) EPOXY RESIN BENCHTOPS

A. Benchtop Thickness: Maintain 1" thickness, except as otherwise specified with tolerance not exceeding plus or minus 1/32". Provide front and end overhang of 1" beyond face of base cabinets, formed with continuous drip groove on under surface ½" from edge.

B. Backsplash, side splashes and curbs: Same material as top, 4" high back and side splashes unless noted and detailed otherwise. Provide back and side splashes where tops abut wall surfaces, tall cabinets and fume hoods.

C. Factory molded of modified epoxy-resin formulation, uniform mixture throughout full thickness with smooth, non-glare and non-specular finish.
D. Physical Properties: Comply with the following minimum requirements:

1. Flexural Strength: 15,000 psi (100 Mpa).
2. Compressive Strength: 30,000 psi (200 Mpa).
3. Tensile Strength: 10,000 psi (69 Mpa).
4. Flexural Modulus: $2 \times 10^6$
5. Density: 2.03 g/cc
6. Hardness (Rockwell M): 100.
7. Water Absorption (24 hours): 0.02 % (maximum).

E. Chemical Resistance: Epoxy-resin material has the following ratings when tested with indicated reagents according to NEMA LD 3, test procedure 3.9.5:

<table>
<thead>
<tr>
<th>CHEMICAL - ACIDS</th>
<th>RATING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Hydrochloric Acid, 20%</td>
<td>No Effect</td>
</tr>
<tr>
<td>2. Hydrochloric Acid, 37%</td>
<td>No Effect</td>
</tr>
<tr>
<td>3. Nitric Acid, 20%</td>
<td>Excellent</td>
</tr>
<tr>
<td>4. Nitric Acid, 70%</td>
<td>Good</td>
</tr>
<tr>
<td>5. Sulfuric Acid, 30%</td>
<td>No Effect</td>
</tr>
<tr>
<td>6. Sulfuric Acid, 77%</td>
<td>No Effect</td>
</tr>
<tr>
<td>7. Sulfuric Acid, 96%</td>
<td>Poor</td>
</tr>
<tr>
<td>8. Phosphoric Acid, 85%</td>
<td>No Effect</td>
</tr>
<tr>
<td>9. Perchloric Acid, 60%</td>
<td>No Effect</td>
</tr>
<tr>
<td>10. Aqua Regia</td>
<td>No Effect</td>
</tr>
<tr>
<td>11. Chromic Acid, 60%</td>
<td>Good</td>
</tr>
<tr>
<td>12. Acetic Acid, 98%</td>
<td>No Effect</td>
</tr>
<tr>
<td>13. Formic Acid, 90%</td>
<td>No Effect</td>
</tr>
<tr>
<td>14. Boric Acid, Sat.</td>
<td>No Effect</td>
</tr>
<tr>
<td>15. Citric Acid, Sat.</td>
<td>No Effect</td>
</tr>
<tr>
<td>16. Oxalic Acid, Sat.</td>
<td>No Effect</td>
</tr>
<tr>
<td>17. Hydrobromic Acid, 48%</td>
<td>No Effect</td>
</tr>
<tr>
<td>18. Hydrofluoric Acid, 48%</td>
<td>Good</td>
</tr>
<tr>
<td>19. Vinegar</td>
<td>No Effect</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHEMICAL - BASES</th>
</tr>
</thead>
<tbody>
<tr>
<td>20. Ammonium Hydroxide, 28%</td>
</tr>
<tr>
<td>21. Sodium Hydroxide, 10%</td>
</tr>
<tr>
<td>22. Sodium Hydroxide, 40%</td>
</tr>
<tr>
<td>23. Sodium Hydroxide, Flake</td>
</tr>
<tr>
<td>24. Potassium Hydroxide, 10%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHEMICAL - SALTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>25. Zinc Chloride, Sat.</td>
</tr>
<tr>
<td>26. Calcium Hypochlorite, Sat.</td>
</tr>
<tr>
<td>27. Chlorox Bleach</td>
</tr>
<tr>
<td>28. Silver Nitrate, 10%</td>
</tr>
<tr>
<td>29. Sodium Sulfide, Sat.</td>
</tr>
<tr>
<td>30. Sodium Chloride, Sat.</td>
</tr>
</tbody>
</table>
31. Iodine, Tincture  
32. Hydrogen Peroxide  
33. Phenol, 80%  
34. Cresol  
35. Formaldehyde, 40%  
36. Mineral Oil, 100%  
37. Glycerin, 100%  

**CHEMICAL - SOLVENTS**

38. Methyl Alcohol, 100%  
39. Ethyl Alcohol, 100%  
40. Buty Alcohol, 100%  
41. Naphtha, 100%  
42. Turpentine, 100%  
43. Kerosene, 100%  
44. Heptane, 100%  
45. Gasoline, 100%  
46. Benzene, 100%  
47. Toluene, 100%  
48. Xylene, 100%  
49. Acetone, 100%  
50. Methyl Ethyl Ketone, 100%  
51. Methyl Isobutyl Ketone, 100%  
52. Ethyl Acetate, 100%  
53. Ethyl Ether, 100%  
54. Chloroform, 100%  
55. Methyl Chloride, 100%  
56. Trichlroethylene, 100%  
57. Carbon Tetrachloride, 100%  
58. Monochloro Benzene, 100%  
59. Dioxane, 100%  
60. Furfural  

**CHEMICAL - DYES**

61. Congo Red, 1%  
62. Eosin Y, 0.5%  
63. Gentian Violet, 1%  
64. Indigo Carmen, 0.5%  
65. Methyl Green, 0.5%  
66. Wrights Blood Stain, 0.35%  

F. Colors: Provide products that result in colors complying with the following requirements:

1. Color: Color to be selected from manufacturers’ standard by laboratory architect.

G. Top Fabrication: Fabricate with factory cutouts for lab and cup sinks.

1. Top Configuration: Square edge with drip groove and separate backsplashes. Ease outside corners and edges to prevent sharp edges to the touch.
2. Assemble with plain butt-type joints and fill with epoxy adhesive and pre-fitted, concealed metal splines.
a. Exception: Where fume hoods are identified on plan as “future” provide breakable seams filled with an acid resistant sealant.

H. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Durcon Company, Inc.
2. Epoxyn, Products
3. Laboratory Tops, Inc.

2.5 (P-#) PHENOLIC RESIN:

A. Phenolic Resin tops are 1” thick, composed of a cellulose fiber reinforced with resins to form a core with a highly crosslinked polyurethane copolymer surface. The top shall have a black core and a matte surface finish.

B. Physical Properties:

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>ASTM</th>
<th>PSI</th>
<th>MKPa</th>
<th>PSI</th>
<th>MKPa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Compressive Strength:</td>
<td>D685</td>
<td>M.D. 31,000</td>
<td>193</td>
<td>C.D. 25,000</td>
<td>172</td>
</tr>
<tr>
<td>2. Flexural Strength:</td>
<td>D790</td>
<td>M.D. 23,000</td>
<td>159</td>
<td>C.D. 15,000</td>
<td>103</td>
</tr>
<tr>
<td>3. Tensile Strength:</td>
<td>D638</td>
<td>M.D. 22,000</td>
<td>152</td>
<td>C.D. 16,000</td>
<td>110</td>
</tr>
<tr>
<td>4. Rockwell Hardness:</td>
<td>D785</td>
<td>M Scale 95-115</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 5. Water Absorption:      | D570 | 1” (25.4 mm) | 0.35% |
| 6. Specific Gravity:      |      | Approx weight 1.40 - 1.52 |

C. Chemical Resistance: The following according to the testing methods established by the American National Standards Institute/ National Electrical Manufacturers Association (ANSI/NEMA) LD3-1995:

<table>
<thead>
<tr>
<th>TEST METHOD TYPICAL</th>
<th>TEST RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1 - APPEARANCE</td>
<td>NO DEFECTS, COMPLIES</td>
</tr>
<tr>
<td>3.3 - LIGHT RESISTANCE</td>
<td>SLIGHT EFFECT</td>
</tr>
<tr>
<td>3.4 - CLEANABILITY (cycles)</td>
<td>10</td>
</tr>
<tr>
<td>STAIN RESISTANCE</td>
<td></td>
</tr>
<tr>
<td>REAGENTS 1-10</td>
<td>NO EFFECT</td>
</tr>
<tr>
<td>REAGENTS 11-15</td>
<td>NO EFFECT</td>
</tr>
<tr>
<td>3.5 BOILING WATER RESISTANCE</td>
<td>NO EFFECT</td>
</tr>
<tr>
<td>3.6 HIGH TEMPERATURE RESISTANCE</td>
<td>NO EFFECT</td>
</tr>
<tr>
<td>3.8 BALL IMPACT RESISTANCE</td>
<td>&gt;78” (1981 mm)</td>
</tr>
<tr>
<td>3.13 WEAR RESISTANT</td>
<td>(cycles) &gt;700</td>
</tr>
</tbody>
</table>

D. Joints: Joints are to be strong level, strong and easy to clean. Do not locate joints at sinks or above equipment and knee openings. Provide tight joints with spline and sealant appropriate to clinical laboratories.

E. Edges: Provide radius edge with drip groove that is free from saw marks, jagged edges and polished.

F. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Duratop, Resistop
2. Trespa, Top Lab
3. Colors: Color to be selected from manufacturers’ standard by laboratory architect.

2.6 (LS-#) LABORATORY SINKS and (CS-#) CUP SINKS

A. Laboratory and Cup Sinks: Provide and install laboratory sinks in materials and sizes as indicated on laboratory equipment drawings. Provide sizes as indicated or manufacturers’ closest stock size of equal or greater volume. Provide all sinks complete with strainers, tail pieces, traps, stops and escutcheons.

B. Outlets: 1-1/2” diameter, manufacturer’s standard length, fabricated of silicon iron, cast epoxy resin, stainless steel, glass, or lead; of same material as sink wherever possible, or as otherwise acceptable to laboratory architect.

C. Overflows: For each sink, except cup sinks, provide overflow of standard beehive or open top design and with separate strainer. Height 2” less than sink depth. Provide in same material as sink.

D. Material:
   1. Cast Epoxy Resin Sinks: Non-glare molded in one piece with surfaces smooth, corners, coved and bottom sloped to outlet. Minimum physical properties, chemical resistance and color as specified for cast epoxy resin tops. Thickness, ½” minimum.

E. Installation of Sinks:
   1. Flush Drop-in Installation for Epoxy Resin and Plastic Cupsinks: Rout groove in top to receive sink rim if not prepared in shop. Set sink in adhesive and fill remainder of groove with sealant or adhesive. Use procedures and products recommended by sink and top manufacturers. Remove excess adhesive and sealant while still wet and finish joint for neat appearance.

2.7 (PB-#) GLASS DRYING RACKS

A. Provide and install Glass Drying Racks as described here and as indicated on drawings. Unless otherwise indicated on drawings the size shall be:

   30’’ W x 24’’ H.

B. Glass drying rack assemblies shall include the following components:
1. Front Panel: 1" thick epoxy resin or 1" stainless steel with No. 4 finish.

2. Glassware Pegs: Replaceable stainless steel or solid white polypropylene with glassware protector bases.

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.

2.8 (ALS#-#) LABORATORY ADJUSTABLE WALL SHELVING

A. Fabricate and install adjustable wall shelving as described here and as indicated on drawings. The maximum length of shelving shall be 36". Shelves shall be fabricated and installed to typical common lengths to facilitate interchangeability by the Owner from lab to lab.

B. Provide the following types of adjustable shelving, in locations as indicated on drawings.

1. (ALS#-#) Adjustable Laboratory Shelving: Shelves supported by 6" high end closure shelf brackets bolted to wall mounted vertical Unistrut P3300 channels.

   a. Shelf End Brackets:
      1) 6" high end bracket with angled edge and flange with bolt holes.

C. Finish: Standards and shelf brackets to be steel with epoxy powder-coated finish. Color as identified on the finish schedule on the laboratory equipment drawings.

D. Shelves:

1. Phenolic Resin Shelving: Shelves are 1” thick phenolic resin meeting the requirements above for benchtops of the same material. Provide a polished radius edge. A front edge seismic lip of 1/4” plexiglass when indicated on the lab equipment drawings.

2. Steel Shelving: Shelves are 16 gauge steel, formed down 1” then returned back and up into a channel formation. Shelves of 12” depth and greater are further reinforced with a 20 gauge hat channel welded to the underside. Steel shelves are available with a steel front edge seismic lip when specified by model number or indicated on the drawings.

3. Color, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed shelf surfaces, as listed on the finish schedule on the laboratory equipment drawings.

E. Preparation: Examine areas, with Installer present, for compliance with requirements for installation tolerances, locations of reinforcement, and other conditions affecting performance of adjustable shelving installation.
F. Installation: 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.

2.9 (SC-#) SERVICE CHASES

A. Fabrication: Fabricate and install painted sheet metal service chases in configurations as detailed on drawings consisting of removable and fixed panels.

1. Removable and fixed service chase panels are to fit together flush showing a minimum joint where they join.

2. Removable access panels are to have concealed-to-view pins, catches, clips, strikes, etc., that allow removal of panel with an upward motion.

3. Fabricate and install service chase 1” 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 chase panel are flush, unless otherwise detailed on laboratory equipment drawings.

5. Fixed service chase panels 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 in on center to facilitate the internal fastening and support of mechanical piping and ductwork.

6. Welds shall be continuous, ground smooth, and finished to match adjacent surfaces.

B. Finish: Service chase shall be shop prime painted with corrosion resisting primer and receive shop finish coating. Provide color as listed in the Laboratory Component Finish Schedule on the drawings.

C. Installation: Install service chases plumb, level and true.

2.10 (OSC-#) OVERHEAD SERVICE CARRIER

A. General requirements for “Wing” style overhead service carriers:

1. Overhead service carrier is to be pre-wired and pre-piped for services as indicated on laboratory equipment drawings.

2. Carrier body and inside/outside access covers shall be fabricated from 16-gauge cold rolled steel.

3. Carrier body shall incorporate UL approved, factory installed junction boxes for electrical and tele/data outlets. Junction boxes shall be inset and flush to the exterior of the carrier body. Electrical and tele/data outlets to be field installed.

4. Carrier body shall also incorporate factory punched and plugged service ports. Service fixtures to be field installed.

5. Exhaust system to be constructed of 3” PVC duct collar that fasteners to the carrier body to accept specified local extraction device.
B. Carrier Body:
   1. Carrier body shall incorporate a slim-line eclipse radiused carrier body.
   2. Interior service bracket: Utility support bracket of 11-gauge cold rolled steel that can accept attachment brackets for copper and conduit service lines.
   3. Carrier body end covers shall include a set of two end covers to enclose exposed ends of the carrier body.
   4. Load bearing capabilities:
      a. Total overhead service carrier plus 400 pounds (evenly distributed) per unit.

C. General requirements for ceiling umbilical assemblies, extension assemblies’ structures:
   1. Vertical structural support: 16-gauge cold rolled vertical shall integrate removable end and side panels.
   2. Umbilical chase shall incorporate support members that utilize standard pipe and conduit supports.
   3. Umbilicals uprights shall ship separately from the carrier body and mechanically fastened at the jobsite.

D. Finish: Service chase shall be shop prime painted with corrosion resisting primer and receive shop finish coating. Provide color as listed in the Laboratory Component Finish Schedule on the drawings.

E. Installation:
   1. Install system in strict accordance with manufacturer's instructions.
   2. Set system components plumb, square, and straight with no distortion and securely anchored to building structure.
   3. Umbilical supports shall be spaced properly as to provide adequate support to each section.
   4. Assembly shall be stable and properly reinforced to prevent lateral movement during normal usage.
   5. Carrier shall be installed in the location as shown on drawings.

2.11 (CR-#) GAS CYLINDER RESTRAINT RACKS AND STRAPS

A. Fabrication: Fabricate and install gas cylinder storage racks in locations as indicated and detailed on laboratory equipment drawings. Fabricate and install with Unistrut components complete with all nuts, bolts, fittings, and accessories indicated and required.

B. Finish: 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. Manufacturer: 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. Installation: Install cylinder restraint racks plumb, level and square to walls unless otherwise indicated on drawings. Brace rack assemblies to walls to prevent sway.
2.12 MISCELLANEOUS UNISTRUT FRAMING

A. Provide, fabricate and install metal, FRP and stainless steel Unistrut framing:
   1. Provide as detailed and indicated on drawings.
   2. Provide as required to support fixed benches, service chases, overhead service carriers and utility support for conduit and piping.

B. The following lists Unistrut framing integral with the installation of laboratory casework, fume hoods, service fittings and accessories.
   1. Overhead service carriers.
   2. Pipe and service drop supports.
   3. Shelving standards, Type B.
   4. Suspended equipment supports.
   5. Exhaust snorkel support framing.
   6. 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.

2.13 (CA-1) Keyboard Tray

A. Provide under-bench mounted keyboard trays as indicated on laboratory equipment plans at computer stations.

B. Manufacturer: Human Scale, 5G Mechanism Standard Platform with 8” Swivel Mouse and gel support as the design standard.
   1. Adjustable up, down, sideways and tilt.
   2. Built-in mouse pad, reversible right or left hand.
   3. Finished in Black.

2.14 (CA-2) CPU HOLDER

A. Provide under-bench mounted CPU holder as indicated on laboratory equipment plans at computer stations.

B. Human Scale model CPU 600 as the design standard.
   1. Provide protection from dirt, dust, bumps and accidental spills.
   2. CPU holder offers 360-degree swivel and horizontal glides.
   3. Mounted on a track under the work surface
   4. Finished in Black.
2.15 (CA-4) J-MOLD CABLE MANAGEMENT

A. Mockett “J” molding model #WM2A.
B. Finished in black.
C. Provide J-molding along the full length of the rear support rail of all tables.

2.16 (LC-1) COAT RACK, SHELF AND HOOKS

A. Manufacturer: The design standard for the lab coat racks is Glaro Modular Racks, solid rustproof aluminum construction model #501 and Glaro wall mounted coat hooks #236 SA for coats and backpacks.

B. Finish: Racks shall be manufacturer’s standard satin aluminum finish.

C. Installation: Install coat racks plumb, level and square to walls unless otherwise indicated on drawings. Brace rack assemblies to walls to prevent sway. Fabricate and install with all components for a complete assembly.

1. Wall mounted coat hook unit to be installed 24 inches directly below and in alignment with the coat rack and shelf unit.

D. Accessories: Hangers.

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
(CR-1) Cylinder Restraint

Wall mount holders attach to any wall. Fasteners are not included. The base of style H must rest on the floor in addition to being secured to the wall.

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<th>Overall Size</th>
<th>Mounting 1 Holes</th>
<th>Each</th>
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<tr>
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Steel with Steel Chain—Zinc-Plated Finish

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Steel with 1 1/2" Wide Polypropylene Strap—Light Gray

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Polyethylene with 1" Wide Nylon Strap—Yellow

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* Made of 3/32" thick steel channel
† Made of 5/16" thick steel channel. Color is green.
‡ One side holds a cylinder up to 9 1/4" dia.; the other side holds a cylinder up to 12 7/8" dia.
Mod-Rack™ Pegboards: Victoria and Baron Style

The Victoria or “V” pegboard is constructed of lightweight stainless steel, offered in a range of sizes and variety of mounting options. Along the bottom is a drip trough that funnels water away to a drain, allowing equipment to dry quickly and remain sanitized. Each “V” style pegboard includes an integral drip trough, wall bracket, standard 6” white pegs and 3 ft. of clear plastic drain hose.

The “B” Baron is also made of lightweight stainless steel. It is offered in three sizes and a variety of mounting options. A drip deflector at the bottom diverts water away from walls and directs it to a sink or drain. Each “B” style pegboard includes a wall bracket and standard 6” white pegs.

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<td>B3630</td>
<td>36” x 30”</td>
<td>50</td>
<td>21 lbs.</td>
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Glaro Professional Strength, Modular
Wall Mounted Coat Rack with Shelf
— Including Solid Aluminum Hangers —

SATIN ALUMINUM  or  ANODIZED BRASS

For those who demand the best, these wall mounted coat racks are superior to all other coat racks at any price.

Glaro all satin aluminum, professional strength clothing / coat racks are visually appealing so that they can be used in places that are not enclosed. Any length can be created easily. These standard coat racks are supplied in 24", 30", and 36" sections to construct one continuous rack. There is no limit to the overall length that can be created and the interlocking modular design makes the longest lengths just as sturdy and strong as our shortest 24" model. The convenient top shelf adds extra storage space and its tubular design prevents items from becoming air locked, discouraging mold or mites from forming in enclosed areas. All racks extend approximately 13 inches from the wall and the solid aluminum wall brackets are approximately 10 inches tall. Glaro wall racks are designed to mount on any type of wall surface. Standard lengths are 24", 30", 36", 48" and 6" increments thereafter. Please call us for any size not listed below.

Glaro Solid Aluminum, Riveted Coat Hangers ARE included with Open Loops unless Closed Loops are otherwise specified (at no additional cost). All racks can hold up to 6 coats per foot, so additional hangers are available with open or closed loops here.

Glaro Solid Aluminum Hangers and the extremely durable wall mounted coat racks will last for many years under constant use. You've seen them everywhere from your Doctor's Office, your Favorite Restaurants, your place of Worship and the Hotels or Motels you may have visited. Busy places like these can't be bothered hanging up new coat racks each year ... Can you?

MORE CHOICES BELOW!

Glaro Satin Aluminum Modular Coat Racks with Tubular Top Shelf and Solid Aluminum Hangers
30” Wall Mounted Coat Rack
Including 6 Solid Aluminum Hangers
List Price $215.00
SALE PRICE $157.00

36” Wall Mounted Coat Rack
Including 6 Solid Aluminum Hangers
List Price $234.00
SALE PRICE $172.00

48” Wall Mounted Coat Rack
Including 8 Solid Aluminum Hangers
List Price $301.00
SALE PRICE $221.00

60” Wall Mounted Coat Rack
Including 10 Solid Aluminum Hangers
List Price $357.00
SALE PRICE $261.50

72” Wall Mounted Coat Rack
Including 12 Solid Aluminum Hangers
List Price $396.00
SALE PRICE $289.50

84” Wall Mounted Coat Rack
Including 14 Solid Aluminum Hangers
List Price $468.00
SALE PRICE $342.00

96” Wall Mounted Coat Rack
Including 16 Solid Aluminum Hangers
List Price $494.00
SALE PRICE $361.00

108” Wall Mounted Coat Rack
Including 18 Solid Aluminum Hangers
List Price $557.00
SALE PRICE $407.00

http://www.glaro-products.com/wall_racks.htm
**Glaro Coat Trees and Glaro Coat Hooks**  
Rugged All Aluminum Coat Hanging Products

View Product Details  
Glaro Products Home Page  
Main Menu

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**To Place Your Order by Phone, Call:**  
1-832-476-4560

http://www.glaro.net/Shop/Coat_Tree_Hooks.htm  
8/3/2010
Mouse Platforms
From our original Swivel Mouse to our best-in-class Clip Mouse — which features height, depth and lateral adjustability, and can easily be moved to support left- or right-handed mousing — Humanscale’s mouse options will keep you mousing in comfort.

Keyboard Platforms
Made of 1/4” phenolic resin, which combines strength, durability and a slim profile, Humanscale’s wide range of keyboard platform options will accommodate any need. Available with Technogel or foam palm supports.

Mechanisms
Humanscale offers nine award-winning negative-tilt mechanism options, from our original standard-bearer, the 2G, to our latest 5G, which combines easy dial-a-tilt and height adjustability with the strongest, most stable arm on the market. All of our mechanisms encourage low-risk typing postures and feature easy and intuitive adjustability.

Desk Configuration Compatibility Guide
Humanscale Keyboard Systems offer mix-and-match components for a custom solution to virtually any desk situation. Here are a few recommended platform options for some of the most common desk configurations. Consult your Humanscale rep for the Keyboard System solution that’s right for you.

Keyboard Components

Diagonal Desk Configuration
Recommended Platforms
- 700 Diagonal keyboard platform with Clip Mouse shown
- 400 Diagonal Big keyboard platform shown
- 500 Standard keyboard platform with Clip Mouse
- 950 Standard Compact keyboard platform with Clip Mouse

Radiused Desk Configuration
Recommended Platforms
- 800 Radiused keyboard platform with Clip Mouse shown
- 550 Big Compact keyboard platform shown
- 900 Standard keyboard platform with Clip Mouse
- 950 Standard Compact keyboard platform with Clip Mouse

90-Degree Desk with DE200 Corner Sleeve Configuration
Recommended Platforms
- 950 Standard Compact keyboard platform with Clip Mouse shown
- 600 Extender keyboard platform with Clip Mouse shown
- 700 Diagonal keyboard platform with Clip Mouse
- 900 Standard keyboard platform with Clip Mouse

Straight Desk Configuration
Recommended Platforms
- 900 Standard keyboard platform with Clip Mouse shown
- 500 Big keyboard platform shown
- 950 Standard Compact keyboard platform with Clip Mouse
- 550 Big Compact keyboard platform

(CA-1) Keyboard Tray

Recommended Platforms
- 700 Diagonal keyboard platform with Clip Mouse shown
- 400 Diagonal Big keyboard platform shown
- 500 Standard keyboard platform with Clip Mouse
- 950 Standard Compact keyboard platform with Clip Mouse

Radiused Desk Configuration
Recommended Platforms
- 800 Radiused keyboard platform with Clip Mouse shown
- 550 Big Compact keyboard platform shown
- 900 Standard keyboard platform with Clip Mouse
- 950 Standard Compact keyboard platform with Clip Mouse

90-Degree Desk with DE200 Corner Sleeve Configuration
Recommended Platforms
- 950 Standard Compact keyboard platform with Clip Mouse shown
- 600 Extender keyboard platform with Clip Mouse shown
- 700 Diagonal keyboard platform with Clip Mouse
- 900 Standard keyboard platform with Clip Mouse
CPU Holder

The CPU Holder offers a unique storage solution for the variety of CPUs found in today’s workplace. It’s clear and flexible design accommodates horizontal and vertical CPUs of most any size, and it can either be direct or track-mounted to horizontal or vertical surfaces.

CPU5500

- CPU5500 offers a feature that makes it perfect for small and mid-sized CPUs.
- CPU5300

CPU300

- CPU300 is the perfect choice for a stand-alone CPU holder.

CPU Dolly

- CPU Dolly is the perfect choice for moving hardware from one location to another.

Features and Specifications

- CPU5500: Designed to easily support CPUs weighing up to 25 lbs.
- CPU5300: Designed to easily support CPUs weighing up to 35 lbs.
- CPU300: Designed to easily support CPUs weighing up to 45 lbs.
- CPU Dolly: Designed to easily support CPUs weighing up to 55 lbs.

Dimensions

- Height: CPU Holders are 6" tall.
- Width: CPU Holders are 17" wide.
- Depth: CPU Holders are 10" deep.
- CPU Dolly: 6" tall.

Materials

- Aluminum frame, polystyrene base.
- Recyclable: 90% plastic, 10% metal.
- Recycled content: 30%.
- Color: Black.

Warranty

- 5-year limited warranty on all CPU Holders.
**WM2A - Large 1 Piece J-Shape Wire Manager**

**DESCRIPTION**

The larger version of our popular WM2, WM2A is ideal for operations where cords must be moved often, or have to be kept neatly out of harm's way. The WM2A is a clean design, modern in appearance, easy to install and use on a daily basis. Secures to the back or sides of desk or work surface with optional double-sided tape or staples. Easy to use, too. Just open the top of the "J" a bit and slip wires inside. Sold in one foot lengths up to six feet. Custom lengths available.

Size: 3 ¼" high by 1" wide; 1 to 6 ft long.

**Contact us** to order any custom cut length up to 12 ft. Maximum length for ground freight is 8 ft. Larger lengths from 8 ft - 12 ft require special freight.

Optional double-sided tape factory installed or sold by the roll (216').


Note: Colors: Black, Walnut Brown and Light Grey.

**Surcharges:**

- 25 per box maximum.
- Oversize Package Charge: $6.50 per box for 1 to 4 ft lengths, $20.00 per box for 5' and 6' lengths.

**COLOR**

- Black (90)

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**Technical Drawing**

**Click to Enlarge**
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. Painted metal laboratory casework.
2. Provide and install painted metal casework in locations listed and as indicated on laboratory equipment drawings.

B. Related Sections include the following:

1. Division 9 Section "Gypsum Board Assemblies" for sheet metal fastening ground in gypsum board partitions for anchoring laboratory casework.
2. Division 9 Section "Resilient Wall Base and Accessories" for resilient base applied to metal laboratory casework.
4. Division 11 Section 11 53 43, "Laboratory Service Fittings and Fixtures".
5. Division 11 Section 11 53 33, "Laboratory Safety Equipment".
6. Division 11, Section 1153 43.10, "Laboratory Accessories", for benchtops, sinks, service chases, drying racks, adjustable shelving, cylinder restraints, etc.

1.3 PERFORMANCE REQUIREMENTS

A. General Performance: Provide certification that casework, components and hardware has been tested in accordance to and meet the structural performance requirements as described in SEFA 8.

B. Structural Performance: Provide metal laboratory casework capable of withstanding the following minimum loads without permanent deformation, excessive deflection, or binding of drawers and doors:

1. Shelves of Base, Wall, and Storage Cabinets: 100 lbs (45 kg).
2. Drawers: 150 lb (68 kg).
3. Wall Cabinets: 150 lb/ft (224 kg/m) along the width of the cabinet.
4. Floor-Supported Base Cabinets: 250 lb/ft (373 kg/m) along the width of the cabinet.

C. Seismic Performance: Provide metal laboratory casework system capable of withstanding
the effects of earthquake motions determined according to the building code in effect for this Project or ASCE 7, "Minimum Design Loads for Buildings and Other Structures," Section 9, "Earthquake Loads," whichever is more stringent.

1.4 SUBMITTALS

A. Product Data: For each type of product specified.

B. Shop Drawings: For metal laboratory casework. Include plans, elevations, sections, details, and attachments to other work.

   1. Indicate locations of blocking and other supports required for installing casework.
   2. Indicate locations and types of service fittings, together with associated service supply connection required.
   3. Include details of utility spaces including service chases showing supports for conduits and piping.
   4. Show adjacent walls, doors, windows, other building components, and other laboratory equipment. Indicate clearances from above items.
   5. Include coordinated dimensions for laboratory equipment, fume hoods and laboratory accessories specified in other Sections.

C. Samples for Verification: 6-inch- (150-mm-) square samples for each type of finish, including top material.

D. Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience.

E. Product Test Reports: Based on tests performed by a qualified independent testing agency, indicate compliance with SEFA 3 and 8 for laboratory casework finishes and countertops with requirements specified for chemical and physical resistance.

F. Coordinate shop drawings with other work involved.

1.5 QUALITY ASSURANCE

A. Manufacturer shall identify and designate a full time factory representative for on-site supervision and coordination during the installation of laboratory casework and all components.

B. Single Source Responsibility: Provide laboratory casework with tops, sinks, accessories, fume hoods and service fixtures, manufactured or furnished by same laboratory furniture company for single responsibility.

C. Product Designations: Drawings indicate sizes and configurations of casework. Manufacturers' of casework of similar sizes, similar door and drawer configurations, and complying with the Specifications may be considered.

D. Acid Storage: Provide units with the following features:
1. Cabinets shall have a minimum 2 inch deep liquid tight pan in bottom of same size as cabinet.
2. All acid cabinets shall be labeled in conspicuous lettering: “ACID”.
3. Corrosion resistant hardware plastic door roller catch.
4. Provide a fusion welded threaded vent connection using standard plastic pipe fittings.
5. Provide vent kit with flexible plastic hose to connect between the cabinet and the fume hood above.

E. Flammable Liquid Storage: Provide units that are listed and labeled as complying with the requirements of NFPA 30 for design, construction, and capacity of storage cabinets by UL, Warnock Hersey, or another testing and inspection agency acceptable to authorities having jurisdiction.
   1. Cabinets shall be grounded.
   2. Coordinate with Electrical Contractor grounding lug locations.
   3. Cabinets shall have a minimum 2 inch deep liquid tight pan in bottom of same size as cabinet.
   4. All OSHA cabinets shall be labeled in conspicuous lettering: “FLAMMABLE – KEEP FIRE AWAY”.
   5. Cabinets shall have an auto-closer and a latch handle with a lock.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver laboratory casework until painting, utility roughing-in, and similar operations that could damage, soil, or deteriorate casework have been completed in installation areas. If casework 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. Keep covered with polyethylene film or other protective covering.

1.7 PROJECT CONDITIONS

A. Existing Conditions: Verify casework dimensions with field measurements. Entry ways, corridors, and door openings shall be verified to ensure casework and equipment can be properly installed.

1.8 COORDINATION

A. Coordinate layout and installation of metal framing, reinforcement and sheet metal fastening grounds in gypsum board assemblies for support of metal laboratory casework.

1.9 EXTRA MATERIALS

A. Furnish to Owner complete touchup kit for each type and color of laboratory casework
provided. Include fillers, primers, paints, and other materials necessary to perform permanent repairs to damaged casework finish.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Metal Laboratory Casework:
   a. CiFLab Solutions.
   b. Labcase.
   c. Kewaunee Scientific Corp.
   d. Mott Manufacturing.

2. Substitutions: are subject to the review and approval of the architect. All products for consideration require documentation of equivalent performance to be submitted by the contractor.

2.2 MATERIALS

A. 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.

B. Minimum Metal Thickness: Provide metal laboratory furniture components of the following minimum thicknesses:

1. Fixed Panels including sides, ends, backs, bottoms, tops, soffits, and items not otherwise indicated: 18 ga., 0.0478 in (1.2 mm). Except for flammable liquid storage cabinets, bottoms may be 20 ga., 0.0359 in (0.9 mm) if reinforced.
2. Removable access panels, doors, drawer fronts and cabinet bodies, security panels, sloped tops and shelves: 20 ga., 0.0359 in (0.9 mm). For back panels and doors for flammable storage cabinets, use 18 ga., 0.0478 in (1.2 mm) thick metal. For shelves more than 36 in (900 mm) long, use 18 ga., 0.0478 in (1.2 mm) thick metal or provide suitable reinforcement.
3. Top, front and intermediate horizontal rails, aprons, stretchers, cross rails, table legs, center posts, frames and gussets: 16 ga., 0.0598 in (1.5 mm).
4. Drawer suspensions, L-shaped front corner gussets sink supports, and hinge reinforcements: 14 ga., 0.0747 in (1.9 mm).
5. Table leg corner brackets and leveler gussets: 12 ga., 0.1046 in (2.7 mm).

C. Acid and Ventilated Storage-Cabinet Lining: Acid Cabinets are supplied with a one piece molded polyethylene liner with radiused corners and a 2” raised lip for spill containment. The liner shall be removable to provide access to the back of the cabinet. The liner shall
have integral shelf supports so that the shelf is adjustable to several positions. The shelf is a ridged phenolic resin.

D. Clear Tempered Glass for Glazed Doors: with ground edges ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality q3, 7/32 in (5.5 mm) thick or Clear Laminated Safety Glass for Doors: ASTM C 1172, Kind LT; Kind FT, Condition A, Type I, Class I, Quality q3 lites with clear, polyvinyl butyryl interlayer.

2.3 FABRICATION

A. General: Complete assembly and finish work at point of manufacture. Perform assembly on precision jigs to provide units which are square; fully reinforced with angles, gussets, and channels; and integrally framed and welded to form a dirt and vermin-retardant enclosure. 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).

B. Fabricate units on precision dies for interchangeability of like-size drawers, doors, and similar parts.

C. Flat Panel Doors: Outer and inner pans formed and telescoped into box formation, with channel reinforcement’s full height on center of each pan. Fill doors solid with noncombustible, sound-deadening material.

D. Glazed Doors: Hollow-metal stiles and rails of similar construction as flat panel doors and welded corners, with glass held in resilient channels or gasket material.

E. Hinged Doors: Mortise at flanges for hinges and reinforce with angles, welded inside inner pans at hinge edge.

F. Flat Panel Drawers: Assemble fronts from telescoping outer and inner pans, designed to eliminate raw edge of steel at top. Fabricate sides, back, and bottom of one piece with rolled or formed top of sides for stiffening and comfortable grasp for drawer removal. Weld drawer front to sides, back, and bottom to form a single, integral unit. Provide drawers with rubber bumpers, runners, and positive stops to prevent metal-to-metal contact or accidental removal.

G. Adjustable Shelves: Front, back, and ends formed down with returned lip at front and back.

H. Toe Space: Provide an adjustable height metal toe space, fully enclosed, adjustable in height from a minimum 4in to a maximum 6 in high set 3 inches (75 mm) back from the face of the cabinet, with no open gaps or pockets. The adjustable height shall provide backing for the resilient base in the event of varying floor elevations.

I. Base Molding: 4 in high, to be provided around the base of fixed cabinets along sides, toe kicks, side panels and access panels.

J. Tubular Frames: Table supports.

1. Table supports to be adjustable height in 1" increments.
2. Table support frames to have levelers equipped.

K. Tubular Table Legs:

1. 2” outside diameter, 12ga. powder coated cold rolled steel or stainless steel outer leg.

2. 1-¾” outside diameter, 11ga. powder coated cold rolled steel or stainless steel inner telescoping leg.

3. 2” diameter nylon leveling glide 3/8” x 2-1/2” long.

4. Capable of vertical height adjustment in 1” increments.

5. Leveling Bolt: Frame shall be fitted with a leveling bolt which will allow the legs to be adjusted for proper alignment of work surface height.

6. Load Capacity: Table frame shall support the work surface plus 100lbs/linear ft. of table length up to a maximum load rating of 800lbs.

L. Utilities: Provide space, cutouts, and holes for pipes, ductwork, conduits, and fittings in cabinet bodies to accommodate utility services and their support-strut assemblies.

M. Service Chase Framing: Manufacturer’s standard steel framing units consisting of 2 cold-rolled C-channel uprights, not less than 1-5/8 inches (41 mm) square by 0.10 inch (2.5 mm) thick, connected together at the top and bottom by U-shaped brackets made from 1-1/4-by-1/4-inch (32-by-6-mm) flat bars. Framing units may be made by welding C-channel material specified for uprights into rectangular frames instead of using U-shaped brackets.

N. Filler Strips: Provide as needed to close space between cabinets and walls, ceilings, and indicated equipment. Fabricate from the same material and with the same finish as cabinets. Hem exposed edges.

O. Closure Panels: Closure panels shall be fabricated from the same material and with the same finish as cabinets, and shall mount flush with the front edge of the cabinet, self supporting and extend vertically to underside of finished ceiling.

2.4 FINISH FOR METAL LABORATORY CASEWORK

A. Cleaning and Pretreatment: After assembly, thoroughly clean surfaces of grease, dirt, oil, flux, and other foreign matter by physical and chemical means. Treat entire unit with metallic phosphate process, leaving surfaces with uniform, fine-grained, crystalline phosphate coating to provide bond for finish.

B. 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.

C. Chemical and Physical Resistance of Finish System: Provide metal laboratory casework
with finish system complying with the following requirements for chemical and physical resistance:

1. Chemical Resistance, Moisture Resistance, Cold Crack and Adhesion and Flexibility: Compliant testing and performance requirements as outlined by with SEFA 3 and SEFA 8 standards.

2. Chemical Resistance: Capable of withstanding application of not less than 5 drops (0.25 mL) of the following reagents applied to finish surface; covered with a watch glass for 60 minutes, rinsed, and dried; with no permanent change in gloss, color, film hardness, adhesion, or film protection.

   1) Acetic acid (98%)
   2) Acetone
   3) Acid Dichromate (5%)
   4) Ammonium hydroxide (28 %)
   5) Amyl Acetate
   6) Benzene
   7) Carbon tetrachloride
   8) Chloroform
   9) Chromic Acid (60%)
  10) Cresol
  11) Dichlor Acetic Acid
  12) Dimethylformanide
  13) Dioxane
  14) Ethyl acetate
  15) Ethyl alcohol
  16) Ethyl ether
  17) Formaldehyde (37 %)
  18) Formic acid (90%)
  19) Furfural
  20) Hydrochloric acid (37 %)
  21) Hydrofluoric Acid (48%)
  22) Hydrogen peroxide (5%)
  23) Iodine
  24) Methyl ethyl ketone
  25) Methylene chloride
  26) Mono chlorobenzene
  27) Napthhalene
  28) Nitric acid (60 %)
  29) Phenol (90%)
  30) Phosphoric acid (85 %)
  31) Potassium hydroxide (40 %)
  32) Silver nitrate
  33) Sodium carbonate (saturated)
  34) Sodium chloride (saturated)
  35) Sodium hydroxide (40 %)
  36) Sodium sulfide (saturated)
  37) Sulfuric acid (85 %)
38) Toluene  
39) Trichloroethylene  
40) Xylene  
41) Zinc chloride (saturated)

3. Moisture Resistance: No visible effect when exposed to the following:
   a. Hot water at a temperature of 190 to 205 deg F (88 to 96 deg C), trickled down the surface at a 45-degree angle for 5 minutes.
   b. Constant moisture using a 2 in x 3 in x 1 in (51 mm x 76 mm x 25 mm) cellulose sponge, soaked with water, in contact with surface for 100 hours.

4. Cold Crack: No effect when subjected to 10 cycles of temperature change from 20 deg F (minus 7 deg C) for 60 minutes to 125 deg F (52 deg C) for 60 minutes.

5. Adhesion and Flexibility: No peeling or cracking or exposure of metal when metal is bent 180 degrees over a ½ in (13 mm) diameter mandrel.

D. Colors: Comply with the following requirements for colors of metal laboratory casework finish:
   1. Colors: Provide manufacturer's full range of standard colors and finishes for selection by laboratory architect.

2.5 CASEWORK HARDWARE

A. Hardware, General: Provide manufacturer's standard satin-finish, commercial-quality, heavy-duty hardware complying with requirements indicated for each type.

B. Hinges: Stainless-steel, 5-knuckle hinges complying with BHMA 156.9, Grade 1, with antifriction bearings and rounded tips. Provide 2 for doors less than 48 inches (1200 mm) high and 3 for doors more than 48 inches (1200 mm) high.

C. Pulls: Stainless steel, fastened from back with 2 screws. For sliding doors, provide stainless-steel recessed flush pulls. Provide 2 pulls for drawers more than 24 inches (600 mm) wide.

D. Door Catches: Nylon-roller spring catch or dual, self-aligning, permanent magnet catch with strike. Provide 2 catches on doors more than 48 inches (1200 mm) high.

E. Drawer Guides: Metal-channel, self-closing drawer guides, designed to prevent rebound when drawers are closed, with nylon-tired, ball-bearing rollers for self centering operation, capable of supporting 100 lbs. (45 kg.) and complying with BHMA A156.9, Type B05091.

F. Full Extension Interior Drawer Guides: Accuride or equivalent drawer guide all ball bearing, rail mount, clear zinc finish and capable of supporting 100 lbs. (45 kg.) at 33 inches wide or less or 200 lbs (90 kg) for 42 inches wide or less.

1. Provide where indicated on drawings.
G. Shelf Clips: Die-formed steel, zinc plated or 14 ga steel. They are to be adjustable vertically in 1 in increments.

H. Number Plates and Label Holders: Stainless steel or chrome plated, sized to receive standard label cards approximately 1 by 2 ½ inches (25 by 63 mm), attached with screws or rivets.
   1. Provide where indicated on drawings.

I. Drawer and Cupboard Locks: Half-mortise or cylindrical type, 5-pin tumbler and dead bolt or cam, only cylinder exposed, brass with chrome-plated finish, complying with BHMA A156.11, Grade 1.
   1. Provide minimum of 2 keys per lock and 6 master keys.
   2. Provide where indicated on drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of reinforcement, and other conditions affecting performance of metal laboratory casework installation.
   1. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 CASEWORK INSTALLATION

A. Install plumb, level, 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.

B. Utility-Space Framing: Secure to floor with 2 fasteners at each frame. Fasten to partition framing, wood blocking, or metal reinforcements in partitions and to base cabinets.

C. Base Cabinets: Set cabinets straight, plumb, and level. Adjust subtops within 1/16 inch (1.5 mm) of a single plane. Fasten cabinets to utility-space framing, partition framing, wood blocking, or reinforcements in partitions with fasteners spaced 24 inches (600 mm) o.c. Bolt adjacent cabinets together with joints flush, tight, and uniform. Align similar adjoining doors and drawers to a tolerance of 1/16 inch (1.5 mm).
   1. Where base cabinets are not installed adjacent to walls, fasten to floor at toe space with concealed fasteners spaced 24 inches (600 mm) o.c. Secure sides of cabinets to floor, where they do not adjoin other cabinets, with not less than 2 fasteners.

D. Wall Cabinets: Hang cabinets straight, plumb, and level. Adjust fronts and bottoms within 1/16 inch (1.5 mm) of a single plane. 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. Align similar adjoining doors to a tolerance of 1/16 inch (1.5 mm).

E. Install hardware uniformly and precisely. Set hinges snug and flat in mortises, unless otherwise indicated. Adjust and align hardware so moving parts operate freely and contact points meet accurately. Allow for final adjustment after installation.

F. Adjust casework and hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

3.3 INSTALLATION OF ACCESSORIES

A. Install accessories according to approved Shop Drawings and manufacturer’s written instructions. Coordinate locations and installation at all laboratory accessories specified in Section 11622.

B. Securely fasten all casework, service chase frames, shelving, to metal fastening grounds or walls.

3.4 CLEANING AND PROTECTING

A. Repair or remove and replace defective work as directed on completion of installation.

B. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.

C. Protection: Provide 6-mil (0.15-mm) plastic or other suitable water-resistant covering over countertop surfaces. Tape to underside of countertop at minimum of 48 inches (1200 mm) o.c.

END OF SECTION
SECTION 20 05 00
MECHANICAL GENERAL REQUIREMENTS

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 work of this Section.

1.2 SUMMARY
A. This Section includes mechanical general administrative and procedural requirements. The following requirements are included in this Section to supplement the requirements specified in Division 1 Specification Sections.

1.3 REFERENCES
A. The mechanical and physical properties of all materials, and the design, performance characteristics, and methods of construction of all items of equipment, shall be in
accordance with the latest issue of the various, applicable Standard Specifications of the following recognized authorities:

1. AABC – Associated Air Balance Council.
2. ABMA – American Boiler Manufacturers Association.
4. ASHRAE – American Society of Heating, Refrigeration and Air Conditioning Engineers.
7. CGA – Compressed Gas Association.
8. CSA – Canadian Standards Association.
9. FMG – Factory Mutual Global Technologies LLC.
10. HI – Hydraulic Institute.
11. ITSNA – Intertek Testing Services NA.
16. NEMA – National Electrical Manufacturer’s Association.
17. SMACNA – Sheet Metal and Air Conditioning Contractors National Association.
18. UL – Underwriter’s Laboratories, Inc.

1.4 PERFORMANCE REQUIREMENTS

A. Systems Components Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

1.5 QUALITY ASSURANCE

A. Scope of Work: Furnish all labor, material, equipment, technical supervision, and incidental services required to complete, test and leave ready for operation the mechanical systems as specified in the Mechanical; Fire Suppression; Plumbing; and Heating, Ventilating, and Air Conditioning Sections and as indicated on Drawings.

B. Ordinances and Codes: Perform all Work in accordance with applicable Federal, State and local ordinances and regulations, the Rules and Regulations of ASHRAE, NFPA, SMACNA and UL, unless otherwise indicated.

1. Notify the Architect/Engineer in writing before submitting a proposal should any changes in Drawings or Specifications be required to conform to the above codes, rules or regulations.
2. If the Contractor performs any work knowing it to be contrary to such laws, ordinances, rules and regulations, and without notice to A/E, the Contractor shall bear all costs arising from corrective measures.
3. No contract sum adjustments or contract time extensions will be made for Contractor claims arising from conditions which were or could have been
observable, ascertainable or reasonable foreseeable from a site visit or inquiry into local conditions affecting the execution of the work.

C. Source Limitations: All equipment of the same or similar systems shall be by the same manufacturer.

D. Tests and Inspections: Perform all tests required by state, city, county and/or other agencies having jurisdiction. Provide all materials, equipment, etc., and labor required for tests.

E. Performance Requirements: Perform all work in a first class and workmanlike manner, in accordance with the latest accepted standards and practices for the trades involved.

F. Sequence and Schedule: Work so as to avoid interference with the work of other trades. Be responsible for removing and relocating any work which in the opinion of the Owner’s Representatives causes interference.

G. Labeling Requirement for Packaged Equipment: Electrical panels on packaged mechanical equipment shall bear UL label or label of other Nationally Recognized Testing Laboratory (NRTL) (ITSNA, CSA, etc.).

1.6 CODES, PERMITS AND FEES

A. Unless otherwise indicated, all required permits, licenses, inspections, approvals and fees for Mechanical Work shall be secured and paid for by the Contractor. All Work shall conform to all applicable codes, rules and regulations.

B. All work shall be executed in accordance with the rules and regulations set forth in local and state codes. Prepare any detailed drawings or diagrams which may be required by the governing authorities. Where the drawings and/or specifications indicate materials or construction in excess of code requirements, the drawings and/or specifications shall govern.

1.7 DRAWINGS

A. The drawings show the location and general arrangement of equipment, piping and related items. They shall be followed as closely as elements of the construction will permit.

B. Examine the drawings of other trades and verify the conditions governing the work on the job site. Arrange work accordingly, providing such fittings, valves and accessories as may be required to meet such conditions.

C. Deviations from the drawings, with the exception of minor changes in routing and other such incidental changes that do not affect the functioning or serviceability of the systems, shall not be made without the written approval of the Architect/Engineer.
D. The Architectural and Structural Drawings take precedence in all matters pertaining to the building structure, Mechanical Drawings in all matters pertaining to Mechanical Trades and Electrical Drawings in all matters pertaining to Electrical Trades. Where there are conflicts or differences between the drawings for the various trades, report such conflicts or differences to the Architect/Engineer for resolution.

E. Drawings are not intended to be scaled for rough-in or to serve as shop drawings. Take all field measurements required to complete the Work.

1.8 MATERIAL AND EQUIPMENT MANUFACTURERS

A. Equipment: All items of equipment shall be furnished complete with all accessories normally supplied with the catalog items listed and all other accessories necessary for a complete and satisfactory operating system. All equipment and materials shall be new and shall be standard products of manufacturers regularly engaged in the production of plumbing, heating, ventilating and air conditioning equipment and shall be the manufacturer’s latest design.

B. If an approved manufacturer is other than the manufacturer used as the basis for design, the equipment or product provided shall be equal in size, quality, durability, appearance, capacity, and efficiency through all ranges of operation, shall conform with arrangements and space limitations of the equipment shown on the plans and/or specified, shall be compatible with the other components of the system and shall comply with the requirements for Items Requiring Prior Approval specified in this section of the Specifications. All costs to make these items of equipment comply with these requirements including, but not limited to, piping, sheet metal, electrical work, and building alterations shall be included in the original Bid. Similar equipment shall be by one manufacturer.

C. All package unit equipment and skid mounted mechanical components that are factory assembled shall meet, in detail, the products named and specified within each section of the Mechanical and Electrical Specifications.

D. Changes Involving Electrical Work: The design of the mechanical systems is based on the equipment scheduled on the Drawings. Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified with no additional cost to project. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1. Where equipment changes are made that involve additional Electrical Work (larger size motor, additional wiring of equipment, etc.) the Mechanical Trades involved shall compensate the Electrical Trades for the cost of the additional Work required.
1.9 INSPECTION OF SITE

A. Visit the site, examine and verify the conditions under which the Work must be conducted before submitting Proposal. The submitting of a Proposal implies that the Contractor has visited the site and understands the conditions under which the Work must be conducted. No additional charges will be allowed because of failure to make this examination or to include all materials and labor to complete the Work.

1.10 ITEMS REQUIRING PRIOR APPROVAL

A. Bids shall be based upon manufactured equipment specified. All items that the Contractor proposes to use in the Work that are not specifically named in the Contract Documents must be submitted for review prior to bids. Such items must be submitted in compliance with Division 1 specifications. Requests for prior approval must be accompanied by complete catalog information, including but not limited to, model, size, accessories, complete electrical information and performance data in the form given in the equipment schedule on the drawings at stated design conditions. Where items are referred to by symbolic designations on the drawings, all requests for prior approval shall bear the same designations.

1. Equipment to be considered for prior approval shall be equal in quality, durability, appearance, capacity and efficiency through all ranges of operation, shall fulfill the requirements of equipment arrangement and space limitations of the equipment shown on the plans and/or specified and shall be compatible with the other components of the system.

2. All costs incurred to make equipment comply with other requirements, including providing maintenance, clearance, piping, sheet metal, electrical, replacement of other components, and building alterations shall be included in the original bid.

B. Voluntary alternates may be submitted for consideration, with listed addition or deduction to the bid, but will not affect the awarding of the contract.

1.11 SUBMITTALS

A. Submit project specific submittals for review in compliance with Division 1.

B. Prepare shop drawings to scale for the Architect/Engineer for review. Equipment and material submittals required are indicated in the Mechanical; Fire Suppression; Plumbing; and Heating, Ventilating and Air Conditioning Sections. Refer to Division 1 for submittal quantities.

C. All submittals shall be submitted in groupings of similar and/or related items. Plumbing fixture submittals shall be submitted as one package including all fixtures intended to be used for this project. Incomplete submittal groupings will be returned “Rejected”. Submit shop drawing with identification mark number or symbol numbers as specified or scheduled on the Mechanical Drawings.
D. All submittals shall be project specific. Standard detail drawings and schedule not clearly indicating which data is associated with this Project will be returned “Rejected”.

E. Shop drawings shall be reviewed by the Mechanical Contractor for completeness and accuracy prior to submitting to the Architect/Engineer for review. The shop drawings shall be dated and signed by the Mechanical Contractor prior to submission.

F. No equipment shall be shipped from stock or fabricated until shop drawings for them have been reviewed by the Architect/Engineer. By the review of shop drawings, the Architect/Engineer does not assume responsibility for actual dimensions or for the fit of completed work in position, nor does such review relieve Mechanical Trades of full responsibility for the proper and correct execution of the work required.

G. If deviations (not substitutions) from Contract Documents are deemed necessary by the Contractor, details of such deviations, including changes in related portions of the project and the reasons therefore, shall be submitted with the submittal for approval.

1.12 COORDINATION DRAWINGS

A. Submit project specified coordination drawings for review in compliance with Division 1 Specification Sections.

1.13 OPERATION AND MAINTENANCE INSTRUCTIONAL MANUALS

A. Submit project specific Operation and Maintenance Instructional Manuals for review in compliance with Division 1 Specification Sections.

B. Provide complete operation and maintenance instructional manuals covering all mechanical equipment herein specified, together with parts lists. Maintenance and operating instructional manuals shall be job specific to this project. Generic manuals are not acceptable. Four (4) copies of all literature shall be furnished for Owner and shall be bound in ring binder form. Maintenance and operating instructional manuals shall be provided when construction is approximately 75% complete.

C. The operating and maintenance instructions shall include a brief, general description for all mechanical systems including, but not limited to:

1. Routine maintenance procedures.
2. Lubrication chart listing all types of lubricants to be used for each piece of equipment and the recommended frequency of lubrication.
3. Trouble-shooting procedures.
4. Contractor's telephone numbers for warranty repair service.
5. Submittals.
6. Recommended spare parts lists.
7. Names and telephone numbers of major material suppliers and subcontractors.
8. System schematic drawings on 8-1/2" x 11" sheets.
1.14 RECORD DRAWINGS
   
   A. Submit record drawings in compliance with Division 1.
   
   B. Contractor shall submit to the Architect/Engineer, record drawings on electronic media or mylar which have been neatly marked to represent as-built conditions for all new mechanical work.
   
   C. The Contractor shall keep accurate note of all deviations from the construction documents and discrepancies in the underground concealed conditions and other items of construction on field drawings as they occur. The marked up field documents shall be available for review by the Architect, Engineer and Owner at their request.

1.15 INSTRUCTION OF OWNER PERSONNEL
   
   A. Before final inspection, instruct Owner’s designated personnel in operation, adjustment, and maintenance of mechanical equipment and systems at agreed upon times. A minimum of 24 hours of formal instruction to Owner’s personnel shall be provided for each building. Additional hours are specified in individual specification sections.
   
   B. For equipment requiring seasonal operation, perform instructions for other seasons within six months.
   
   C. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
   
   D. In addition to individual equipment training provide overview of each mechanical system. Utilize the as-built documents for this overview.
   
   E. Prepare and insert additional data in operation and maintenance manual when need for such data becomes apparent during instruction.

1.16 WARRANTY
   
   A. Warranty: Comply with the requirements in Division 1 Specification Sections. Contractor shall warranty that the mechanical installation is free from defects and agrees to replace or repair, to the Owner’s satisfaction, any part of this mechanical installation which becomes defective within a period of one year (unless specified otherwise in other Mechanical; Fire Suppression; Plumbing; or Heating, Ventilating and Air Conditioning Sections) from the date of substantial completion following final acceptance, provided that such failure is due to defects in the equipment, material, workmanship or failure to follow the contract documents.
   
   B. File with the Owner any and all warranties from the equipment manufacturers including the operating conditions and performance capacities they are based on.
PART 2 - PRODUCTS

A. Not Applicable

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION WORK

A. All demolition of existing mechanical equipment and materials shall be done by the Contractor unless otherwise indicated. Include all items such as, but not limited to, existing piping, draining of piping, pumps, ductwork, supports and equipment where such items are not required for the proper operation of the modified system.

B. In general, demolition work is indicated on the Drawings. However, the Contractor shall visit the job site to determine the full extent and character of this Work.

C. Unless specifically noted to the contrary, removed materials shall not be reused in the work. Salvaged materials that are to be reused shall be stored safe against damage and turned over to the appropriate trade for reuse. Salvaged materials of value that are not to be reused shall remain the property of the Owner unless such ownership is waived. Remove items from the systems and turn over to the Owner in their condition prior to removal. The Owner shall move and store these materials. Items on which the Owner waives ownership shall become the property of the Contractor, who shall remove and legally dispose of same, away from the premises.

D. Work that has been cut or partially removed shall be protected against damage until covered by permanent construction.

E. Clean and flush the interior and exterior of all existing relocated equipment and its related piping, valves, and accessories that are to be reused of all mud, debris, pipe dope, oils, welding slag, loose mill scale, rust and other extraneous material so that the existing equipment and all accessories can be repainted and repaired as required to place in first-class working condition.

F. Where existing equipment is to be removed, cap piping under floor, behind face of wall, above ceiling or at mains.

G. Provide sheet metal caps on ductwork and cap piping immediately adjacent to demolition as soon as demolition commences in order to allow existing systems to remain in operation. Caps shall be of same material as service requiring such.

3.2 WORK IN EXISTING BUILDINGS

A. The Owner will provide access to existing buildings as required. Access requirements to occupied buildings shall be identified on the project schedule. The Contractor, once
Work is started in the existing building, shall complete same without interruption so as to return work areas as soon as possible to Owner.

B. Adequately protect and preserve all existing and newly installed Work. Promptly repair any damage to same at Contractor's expense.

C. Consult with the Owner's Representative as to the methods of carrying on the Work so as not to interfere with the Owner's operation any more than absolutely necessary. Accordingly, all service lines shall be kept in operation as long as possible and the services shall only be interrupted at such time as will be designated by the Owner's Representative.

D. Prior to starting work in any area, obtain approval for doing so from a qualified representative of the Owner who is designated and authorized by the Owner to perform testing and abatement, if necessary, of all hazardous materials including but not limited to, asbestos. The Contractor shall not perform any inspection, testing, containment, removal or other work that is related in any way whatsoever to hazardous materials under the Contract.

3.3 TEMPORARY SERVICES

A. Provide temporary service as described in Division 1.

B. The existing building will be occupied during construction. Maintain mechanical services and provide necessary temporary connections and their removal at no additional expense.

3.4 WORK INVOLVING OTHER TRADES

A. Certain items of equipment or materials specified in the Mechanical Division may have to be installed by other trades due to code requirements or union jurisdictional requirements. In such instances, the Contractor shall complete the work through an approved, qualified subcontractor and shall include the full cost for same in proposal.

3.5 ACCEPTANCE PROCEDURE

A. Upon successful completion of start-up and recalibration, but prior to building acceptance, substantial completion and commencement of warranties, the Architect/Engineer shall be requested in writing to observe the satisfactory operation of all mechanical control systems.

B. The Contractor shall demonstrate operation of equipment and control systems, including each individual component, to the Owner and Architect/Engineer.

C. After correcting all items appearing on the punch list, make a second written request to the Owner and Architect/Engineer for observation and approval.
D. After all items on the punch list are corrected and formal approval of the mechanical systems is provided by the Architect/Engineer, the Contractor shall indicate to the Owner in writing the commencement of the warranty period.

E. Operation of the following systems shall be demonstrated:

1. Air Handling Systems
2. Chilled Water Systems
3. Heating Systems
4. Compressed Air Systems
5. Purified Water Systems
6. Space Temperature Controls
7. Lab Airflow Controls
8. Exhaust Systems

END OF SECTION 20 05 00
SECTION 200510
BASIC MECHANICAL MATERIALS AND METHODS

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 include the following:

1. Division 20 Section “Mechanical General Requirements.”

iDesign Solutions, LLC
LABORATORY EQUIPMENT SPECIFICATIONS
BASIC MECHANICAL MATERIALS AND METHODS
1.2 SUMMARY

A. This section includes mechanical materials and installation methods common to mechanical piping systems, sheetmetal systems and equipment. This section supplements all other Division 20 Mechanical Sections, and Division 01 Specification Sections.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:

2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.
1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code—Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

D. Soldering: Qualify processes and operators according to AWS B2.3/2.3M, "Specification for Soldering Procedure and Performance Qualification."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Storage and Protection: Provide adequate weather protected storage space for all mechanical equipment and materials deliveries to the job site. Storage locations will be designated by the Owner’s Representative. Equipment stored in unprotected areas must be provided with temporary protection.

1. Protect equipment and materials from theft, injury or damage.
2. Protect equipment outlets, pipe and duct openings with temporary plugs or caps.
3. Materials with enamel or glaze surface shall be protected from damage by covering and/or coating as recommended in bulletin “Handling and Care of Enameled Cast Iron Plumbing Fixtures”, issued by the Plumbing Fixtures Manufacturer Association, and as approved.
4. Electrical equipment furnished by Mechanical Trades and installed by the Electrical Trades: Turn over to Electrical Trades in good condition, receive written confirmation of same.
5. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations. Coordinate with other trades to ensure accurate locations and sizes of mechanical spaces, chases, slots, shafts, recesses and openings.
B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Install Work to avoid interference with work of other trades including, but not limited to, Architectural and Electrical Trades. Remove and relocate any work that causes an interference at Contractor’s expense.

D. Coordinate requirements for and provide access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section “Access Doors and Frames.”

E. The mechanical trades shall be responsible for all damage to other work caused by their work or through the neglect of their workers.

1. All patching and repair of any such damaged work shall be performed by the trades which installed the work. The cost shall be paid by the Mechanical Trades.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 15 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 20, 22, and 23 piping Sections for special joining materials not listed below.

B. Unions: Pipe Size 2 Inches and Smaller:

1. Ferrous pipe: Malleable iron ground joint type unions.
2. Unions in galvanized piping system shall be galvanized.
3. Copper tube and pipe: Bronze unions with soldered joints.
C. Flanges: Pipe Sizes 2-1/2 Inch and Larger:

2. Copper tube and pipe: Slip-on bronze flanges.

D. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
   a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

E. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated. Square head bolts and nuts are not acceptable.

F. Solder Filler Metals: ASTM B 32, lead-free, antimony-free, silver-bearing alloys. Include water-flushable flux according to ASTM B 813.

G. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

H. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

I. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

2.4 PIPE THREAD COMPOUNDS

A. Pipe thread compounds for the fluid service compatible with piping materials provided.

B. Compounds for potable water service and similar applications acceptable to U.S. Department of Agriculture (USDA) or Food and Drug Administration (FDA). Compounds containing lead are prohibited.

C. Inorganic zinc-rich coatings or corrosion inhibited proprietary compounds for galvanized carbon steel systems to coat raw carbon steel surfaces, in lieu of subsequent painting.

1. Manufacturers:
   a. Carboline "Carbo-Zinc 12."
   b. Tnemec.
   c. Koppers.
D. Graphite and oil or proprietary corrosion inhibited compounds suitable for system temperatures for steam or condensate.
   
   1. Manufacturers:
      
      a. WKM; Division of Cooper Industries, Inc., Key "Graphite Paste."
      b. Other approved.

E. Use tetrafluoroethylene (Teflon) tape 2 to 3 mils thick for natural gas system threaded joints.
   
   1. Manufacturers:
      
      b. Permacel.
      c. Other approved.

2.5 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Brass Unions, Brass Nipples, Brass Couplings: For systems up to 286 deg F.

D. Dielectric-Flange Kits: Include full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   
   1. Manufacturers:
      
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Capitol Manufacturing Co.
      d. Central Plastics Company.
      e. Epco Sales, Inc.
      f. Pipeline Seal and Insulator, Inc.
      g. Watts Water Technologies, Inc.; Watts Regulator Co.
      h. Zurn Industries, Inc.; Wilkins Div.

   2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; female NPT threaded ends; and 300-psig minimum working pressure at 225 deg F.
   
   1. Manufacturers:
      
      a. Lochinvar Corp.; V-Line Insulating Couplings.
F. Dielectric Nipple/Waterway Fittings: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, male NPT threaded, or grooved ends; and 300-psig minimum working pressure at 230 deg F.

1. Manufacturers:
   b. Elster Group; Perfection Corp.; ClearFlow.
   d. Sioux Chief Manufacturing Co., Inc.
   e. Tyco Fire & Building Products; Grinnell Mechanical Products; Figure 407 ClearFlow.
   f. Victaulic Co. of America; Style 47 ClearFlow.

2.6 MODULAR MECHANICAL SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve or pipe and core drilled hole.

1. Manufacturers:
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.; Thunderline Link Seal.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: Plastic. Include two for each sealing element.

4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, and 0.375 inch wall black.

B. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, and 0.375 inch wall galvanized, plain ends.

C. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

1. New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
   b. Chrome-Plated Piping or Piping in High Humidity Areas: One-piece, cast-brass type with polished chrome-plated finish.
   c. Insulated Piping: One-piece, stamped-steel type with spring clips.
   d. Bare Piping in Finished Spaces: One-piece, stamped-steel type.
   e. Bare Piping in Unfinished Service Spaces or Equipment Rooms: Split-plate, stamped-steel type with concealed hinge and set screw.

2. Existing Piping: Use the following:
   a. Chrome-Plated Piping or Piping in High Humidity Areas: Split-casting, cast-brass type with chrome-plated finish.
   b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.
   c. Bare Piping: Split-plate, stamped-steel type with set screw or spring clips.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

2. Design Mix: 5000-psi, 28-day compressive strength.

2.10 EPOXY BONDING COMPOUND

A. Two-component system suitable for bonding wet or dry concrete to each other and to other materials.

B. Manufacturers:

1. Euco 452 #450; Euclid Chemical Co.
2. Epobond; L & M Construction Chemicals.
3. Sikadur 87; Sika Corp.

2.11 LEAK DETECTOR SOLUTION

A. Commercial leak detector solution for pipe system testing.
PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 20, 22, and 23 Sections specifying piping systems, and in accordance with manufacturer’s instructions.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. The Drawings shall be followed as closely as elements of construction will permit.

C. During the progress of construction, protect open ends of pipe, fittings, and valves to prevent the admission of foreign matter. Place plugs or flanges in the ends of all installed work whenever work stops. Plugs shall be commercially manufactured products.

D. Prior to and during laying of pipe, maintain excavations dry and clear of water and extraneous materials. Provide minimum 4 inches of clearance in all directions for pipe passing under or through building grade beams.

E. Weld-o-lets and thread-o-lets can be used for annular flow measuring devices, temperature control components, and thermal wells. Pipe taps shall be drilled and deburred. Torch cutting is not acceptable.

F. Clean and lubricate elastomer joints prior to assembly.

G. Clean damaged galvanized surfaces and touch-up with a zinc rich coating.

H. Install piping to conserve building space and not interfere with use of space.

I. Group piping whenever practical at common elevations.

J. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

K. Slope piping and arrange systems to drain at low points.

L. Slope horizontal piping containing noncondensible gases 1 inch per 100 feet, upward in the direction of the flow.
M. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

N. 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.

O. In concealed locations where piping, other than black steel, cast-iron, or galvanized steel, is installed through holes or notches in studs, joists, rafters or similar members less than 1-1/2 inches from the nearest edge of the member, the pipe shall be protected by shield plates. Protective shield plates shall be a minimum of 1/16 inch thick steel, shall cover the area of the pipe where the member is notched or bored, and shall extend a minimum of 2 inches above sole plates and below top plates.

P. Do not penetrate building structural members unless specifically indicated on drawings.

Q. Install piping above accessible ceilings to allow sufficient space for ceiling panel and light fixture removal.

R. Install valves with stems upright or horizontal, not inverted.

S. Provide clearance for installation of insulation and access to valves and fittings.

T. Install piping to permit valve and equipment servicing. Do not install piping below valves and/or terminal equipment. Do not install piping above electrical equipment.

U. Install piping at indicated slopes. Provide drain valves with hose end connections and caps at all piping low points, where piping is trapped and at all equipment.

V. Install piping free of sags and bends.

W. Install fittings for changes in direction and branch connections.

X. Unless otherwise indicated or specified, install branch connections to mains using tee fittings in main pipe:

1. Branch connected to bottom of main pipe for HVAC systems. Side connection is acceptable. Connection above centerline of main is unacceptable. For up-feed risers, connect branch to top of main pipe.
2. Branch connected to top of main for steam and condensate, plumbing systems, compressible gasses, and vacuum.

Y. Install piping to allow application of insulation.

Z. Select system components with pressure rating equal to or greater than system operating pressure.

AA. After completion, fill, clean, and treat systems. Refer to Division 22 Sections “Hydronic Piping,” “Piping Systems Flushing and Chemical Cleaning,” and “HVAC Water Treatment.”
BB. Install escutcheons for penetrations of walls below ceiling, and ceilings.

CC. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Specification Sections for materials.

DD. Seal openings around pipes in sleeves and around duct openings through walls, floors and ceilings, and where floors, fire rated walls and smoke barriers are penetrated. Fire and/or smoke barriers shall be UL listed firestopping and shall have a fire rating equal to or greater than the penetrated barrier. Refer to Division 07 Specification Sections for materials.

EE. Verify final equipment locations for roughing-in.

FF. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 20, 22, and 23 Sections specifying piping systems.

B. Cut piping square.

C. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

D. Remove scale, slag, dirt, oil, and debris from inside and outside of pipe and fittings before assembly.

E. Clean damaged galvanized surfaces and touch-up with a zinc rich coating.

F. Use standard long sweep pipe fittings for changes in direction. No mitered joints or field fabricated pipe bends will be permitted. Short radius elbows may be used where specified or specifically authorized by the Architect.

G. Make tee connections with screwed tee fittings, soldered fittings or specified welded connections. Make welded branch connections with either welding tees or forged branch outlet fittings in accordance with ASTM A234, ANSI B16.9 and ANSI B16.11. For forged branch outlets, furnish forged fittings flared for improved flow where attached to the run, reinforced against external strains and to full pipe-bursting strength requirements. "Fishmouth" connections are not acceptable.

H. Use eccentric reducers for drainage and venting of pipe lines; bushings are not permitted.

I. Provide pipe openings using fittings for all systems control devices, thermometers, gauges, etc. Drilling and tapping of pipe wall for connections is prohibited.

J. Provide temperature sensing device thermal wells and similar piping specialty connections.
K. Provide instrument connections except thermal wells with specified isolating valves at point of connection to system.

L. Locate instrument connections in accordance with manufacturer’s instructions for accurate read-out of function sensed. Locate instrument connections for easy reading and service of devices.

M. 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.


O. 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.

P. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

1. Weld-o-lets and thread-o-lets can be used for annular flow measuring devices, temperature control components, and thermal wells. Pipe taps shall be drilled and deburred. Torch cutting is not acceptable.

Q. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on gaskets and bolt threads.

1. Assemble flanged joints with fresh-stock gasket and hex head nuts, bolts or studs. Make clearance between flange faces such that the clearances can be gasketed and bolted tight without strain on the piping system. Align flange faces parallel and bores concentric; center gaskets on the flange faces without projection into the bore.
2. Lubricate bolts before assembly to insure uniform bolt stressing. Draw up and tighten bolts in staggered sequence to prevent unequal gasket compression and deformation of the flanges. Do not mate a flange with a raised face to a companion flange with a flat face; machine the raised face down to a smooth matching surface and use a full face gasket. After the piping system has been tested and is in service at its maximum temperature, check bolting torque to provide required gasket stress.

R. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with both piping materials. Refer to Application Schedules on the Drawings.
S. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

T. Remake joints which fail pressure tests with new materials including pipe, fittings, gaskets and/or a filler.

3.3 ACCESS DOORS

A. Provide access doors for installation by architectural trades. Provide access doors in the walls, as required to make all valves, controls, coils, motors, air vents, filters, electrical boxes and other equipment installed by the Contractor accessible. Minimum size 12 inches x 12 inches. Provide access doors in the ceiling, for accessibility as mentioned above, 24 inches x 24 inches minimum size. Areas with accessible ceilings (ceilings where lay-in panels are not fastened in place and can be individually removed without removal of adjacent tiles) will not require access doors. Refer to Division 08 Section “Access Doors and Frames” for manufacturers and model numbers and additional information.

B. When access doors are in fire resistant walls or ceilings, they shall bear the Underwriters’ Laboratories, Inc., Label, with time design rating equal to or greater than the wall or ceiling unless they were a part of the tested assembly.

3.4 EQUIPMENT CONNECTIONS

A. Make connections to equipment, fixtures, and other items included in the work in accordance with the submittals and rough-in measurements furnished by the manufacturers of the particular equipment furnished.

1. Any and all additional connections not shown on the drawings but shown on the equipment manufacturer’s submittal or required for the successful operation of the equipment shall be installed as part of this Contract at no additional charge to the Owner.

B. All piping connections to pumps, coils, and other equipment shall be installed without strain at the pipe connection of this equipment. When directed, remove the bolts in flanged connections or disconnect piping to demonstrate that piping has been so connected.

3.5 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, where indicated on Drawings, at final connection to each piece of equipment and at all control valves.
2. Install flanges, in piping NPS 2-1/2 and larger, where indicated on Drawings, at final connection to each piece of equipment and at all control valves.

### 3.6 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated. Housekeeping pad locations and sizes shall be coordinated by mechanical contractor prior to the placement of concrete slabs.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

E. For suspended equipment, furnish and install all inserts, rods, structural steel frames, brackets and platforms required. Obtain approval of Architect for same including loads, locations and methods of attachment.

F. The Contract Documents indicate items to be purchased and installed. The items are noted by a manufacturer's name, catalog number and/or brief description. The catalog number may not designate all the accessory parts for a particular application. Arrange with the manufacturer for the purchase of all items required for a complete installation.

### 3.7 PAINTING

A. Painting of mechanical systems, equipment, and components is specified in Division 09.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

### 3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

C. Where pipe and/or equipment support members must be welded to structural building framing, Contractor shall seek prior approval from Architect and structural engineer. Scrape, brush clean, and apply one coat of zinc rich primer after welding.

D. Field Welding: Comply with AWS D1.1.
3.9 EPOXY BONDING TO EXISTING MATERIALS
   A. Use epoxy bonding compound to set sleeves or pipes in existing concrete to bond new concrete and/or grout to existing materials or to bond dissimilar materials.
   B. The compound, when applied in accordance with the manufacturer's instructions, shall be capable of initial curing within 48 hours at temperatures as low as 40 deg F and shall be capable of bonding any combination of the following properly prepared materials: Wet or dry, cured or uncured concrete or mortar; vitrified clay; cast iron and carbon steel.

3.10 JACKING OF PIPE
   A. Do not jack pipe in place except upon prior approval of proposed materials and complete details of methods.

3.11 GROUTING
   A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.
   B. Clean surfaces that will come into contact with grout.
   C. Provide forms as required for placement of grout.
   D. Avoid air entrapment during placement of grout.
   E. Place grout, completely filling equipment bases.
   F. Place grout on concrete bases and provide smooth bearing surface for equipment.
   G. Place grout around anchors.
   H. Cure placed grout.

3.12 CUTTING, CORING AND PATCHING
   A. Refer to Division 01 Specification Sections for requirements for cutting, coring, patching and refinishing work necessary for the installation of mechanical work.
   B. All cutting, coring, patching and repair work shall be performed by the Contractor through approved, qualified subcontractors. Contractor shall include full cost of same in bid.
3.13 LUBRICATION

A. Provide all lubrication for the operation of the equipment until acceptance by the Owner. Contractor is responsible for all damage to bearings up to the date of acceptance of the equipment. Protect all bearings and shafts during installation. Thoroughly grease steel shafts to prevent corrosion. Provide covers as required for proper protection of all motors and other equipment during construction.

3.14 FILTERS

A. Provide and maintain filters in air handling systems throughout the construction period and prior to final acceptance of the building. Do not run air handling equipment, without all prefilters and final filters as specified.

B. Immediately prior to final building acceptance by the Owner, Contractor shall:

1. Replace all disposable type air filters with new units.

3.15 CLEANING

A. Each Mechanical Trade shall be responsible for removing all debris daily as required to maintain the work area in a neat, orderly condition.

B. Prior to connection of new HVAC piping to existing HVAC piping systems, all new piping shall be subject to initial flushing, cleaning and final flushing. Refer to Division 22 Section "Piping Systems Flushing and Chemical Cleaning" for requirements. Provide temporary bypass piping and fittings, temporary valves and strainers, temporary water make-up piping with approved means of backflow prevention, and temporary pumps as needed to perform specified flushing and cleaning requirements.

C. Flushing, cleaning, and disinfection of domestic water piping is specified in Division 22 Section “Domestic Water Piping.”

D. Exterior surfaces of all piping, ductwork and equipment shall be wiped down to remove excess dirt and debris prior to concealment by Architectural Trades work.

E. Upon completion of work in each respective area, clean and protect work. Just prior to final acceptance, perform additional cleaning as necessary to provide clean equipment and areas to the Owner.

END OF SECTION 20 05 10
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 include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”
   3. Division 22 Section "Domestic Water Piping" for domestic and fire-protection water service meters inside the building.

1.2 DEFINITIONS
A. CR: Chlorosulfonated polyethylene synthetic rubber.
B. EPDM: Ethylene-propylene-diene terpolymer rubber.
C. FPR: Fiberglass reinforced plastic.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated; include performance curves.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 THERMOWELLS

A. Manufacturers: Same as manufacturer of thermometer being used.

B. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer. Brass for compatible services less than 353 degrees F (178 degrees C); ANSI 18-8 stainless steel for all others to suit service. Furnish extension neck to accommodate insulation where applicable.

2.3 TEST PLUGS

A. Manufacturers:
   1. Peterson Equipment Co., Inc.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F for cold services, and 500 psig at 275 deg F for hot services.

D. Core Inserts: One or two self-sealing rubber valves.
   1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be Neoprene.
   2. Insert material for air or water service at minus 30 to plus 275 deg F shall be Nordel.

E. Test Kit: Furnish test kit(s) containing one pressure gage and adaptor, thermometer(s), and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.
   1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be 0 to 200 psig.
   2. Low-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 125 deg F.
   3. Carrying case shall have formed instrument padding.
PART 3 - EXECUTION

3.1 INSTALLATIONS

A. Install thermowells with socket extending a minimum of 2 inches into fluid and in vertical position in piping tees where thermometers are indicated.

B. Install test plugs in tees in piping.

END OF SECTION 20 05 19
SECTION 20 05 23
VALVES

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 include the following:
      1. Division 20 Section "Mechanical Identification" for valve tags and charts.
      2. Division 20, 22, and 23 piping Sections for specialty valves applicable to those
         Sections only.
      3. Division 23 Section "Temperature Controls" for control valves and actuators.

1.2 SUMMARY
   A. This Section includes valves for general HVAC and plumbing applications. Refer to piping
      Sections for specialty valve applications.

1.3 DEFINITIONS
   A. The following are standard abbreviations for valves:
      1. CWP: Cold working pressure.
      2. EPDM: Ethylene-propylene-diene terpolymer rubber.
      3. NBR: Acrylonitrile-butadiene rubber.
4. NRS: Nonrising stem.
5. OS&Y: Outside screw and yoke.
6. PTFE: Polytetrafluoroethylene plastic.
7. RPTFE: Reinforced polytetrafluoroethylene plastic.
8. SWP: Steam working pressure.
9. TFE: Tetrafluoroethylene plastic.
10. WOG: Water, oil, and gas.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.

1.5 QUALITY ASSURANCE

A. ASME Compliance: ASME B31.9 for building services piping valves.
   1. Exceptions: Domestic hot- and cold-water piping valves unless referenced.

B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set angle, gate, and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.

B. Use the following precautions during storage:
   1. Maintain valve end protection.
   2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
PART 2 - PRODUCTS

2.1 VALVES, GENERAL

A. Isolation valves are scheduled on the Drawings. For other general HVAC and plumbing valve applications, use the following:

1. Throttling Service: Angle, ball, butterfly, or globe valves.
2. Pump Discharge: Spring-loaded, lift-disc check valves; and bronze lift check valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.

D. For valves not indicated in the Application Schedules, select valves with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Solder-joint or threaded ends, except provide valves with threaded ends for condenser water, heating hot water, steam, and steam condensate services.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged, solder-joint, or threaded ends.
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 or threaded ends.
6. For Steel Piping, NPS 5 and Larger: Flanged ends.
7. For Grooved-End Systems: Valve ends may be grooved. Do not use for steam or steam condensate piping.

E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

F. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

G. Valve Actuators:

1. Chainwheel: For attachment to valves, of size and mounting height, as indicated in the "Valve Installation" Article in Part 3.
2. Gear Drive Operator: For quarter-turn valves NPS 8 and larger.
3. Handwheel: For valves other than quarter-turn types.
4. Lever Handle: For quarter-turn valves NPS 6 and smaller.

H. Extended Valve Stems: On insulated valves.


J. Solder Joint: With sockets according to ASME B16.18.
1. Caution: Disassemble valves when soldering, as recommended by the manufacturer, to prevent damage to internal parts.

K. Threaded: With threads according to ASME B1.20.1.

L. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Bronze Ball Valves, General: MSS SP-110 and have bronze body complying with ASTM B 584, except for Class 250 which shall comply with ASTM B 61, full-depth ASME B1.20.1 threaded or solder ends, and blowout-proof stems.

B. Two-Piece, Regular Port Bronze Ball Valves with Stainless-Steel Trim: Type 316 stainless-steel ball and stem, reinforced TFE seats, blow-out-proof stem, with adjustable stem packing, soldered or threaded ends; and 150 psig SWP and 600-psig CWP ratings.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Valves; by Conbraco Industries, Inc.; Series 70-140.
   b. Crane Valve Group; Crane Valves.
   c. Milwaukee Valve Company; Model BA100S.
   d. NIBCO INC.; Models S-580-70-66 or T-580-70-66.
   e. Watts Water Technologies, Inc.

2.3 GENERAL SERVICE BUTTERFLY VALVES

A. General: MSS SP-67, for bubble-tight shutoff, extended-neck for insulation, disc and lining suitable for potable water, unless otherwise indicated, and with the following features:

1. Full lug, and grooved valves shall be suitable for bi-directional dead end service at full rated pressure without the use or need of a downstream flange.

2. Valve sizes NPS 2 through NPS 6 shall have lever lock operator; valve sizes NPS 8 and larger shall have weatherproof gear operator.


1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Apollo Valves; by Conbraco Industries, Inc.; Series 143.
   b. Bray International, Inc.
   c. Crane Valve Group; Center Line.
   d. Milwaukee Valve Company.
   e. NIBCO INC.; LD-2000-3/5.
2.4 BRONZE CHECK VALVES

A. Bronze Check Valves, General: MSS SP-80.

B. Class 150, Bronze, Swing Check Valves with Bronze Disc: ASTM B-62 bronze body and seat with regrinding-type bronze disc, Y-pattern design, soldered or threaded end connections, and having 300 psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Apollo Valves; by Conbraco Industries, Inc.
   b. Crane Valve Group; Crane Valves.
   c. Crane Valve Group; Stockham Div.
   d. Hammond Valve.
   e. Milwaukee Valve Company; Model 515.
   f. NIBCO INC.; Models S-433-B or T-433-B.
   g. SSI Equipment, Inc.
   h. Watts Water Technologies.

2.5 SPRING-LOADED, CENTER-GUIDED LIFT-DISC (SILENT) CHECK VALVES

A. Lift-Disc Check Valves, General: FCI 74-1 and MIL-V-18436F, with spring-loaded, center-guided bronze disc and seat.

B. Class 125, Wafer, Lift-Disc Check Valves: Wafer style with cast-iron body with diameter made to fit within bolt circle, and having 200 psig CWP rating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Milwaukee Valve Company.
   b. Mueller Steam Specialty.
   c. NIBCO INC.; Model W-910-B.
   d. SSI Equipment, Inc.
   e. Tyco Flow Control; Keystone.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. 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.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. 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.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 20, 22, and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe. Butterfly valves shall be installed with stem horizontal to allow support for the disc and the cleaning action of the disc.

E. Install valves in position to allow full stem movement.

F. Install check valves for proper direction of flow and as follows:

  1. Lift Check Valves: With stem upright and plumb.

3.3 JOINT CONSTRUCTION

A. Refer to Division 15 Section “Basic Mechanical Materials and Methods” for basic piping joint construction.

3.4 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.

END OF SECTION 20 05 23
SECTION 20 05 29
HANGERS AND SUPPORTS

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 include the following:
   1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
   2. Division 21 Section "Fire-Suppression Piping" for pipe hangers for fire-protection piping.
   3. Division 20 Section “Mechanical General Requirements.”
   4. Division 20 Section “Basic Mechanical Materials and Methods.”
   5. Division 20 Section "Mechanical Vibration Controls" for vibration isolation devices.
   6. Division 22 Section "Pipe Expansion Fittings and Loops" for pipe guides and anchors.
   7. Division 23 Section(s) "Metal Ducts" for duct hangers and supports.
1.2 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

C. MFMA: Metal Framing Manufacturers Association.

1.3 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Thermal-hanger shield inserts.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze pipe hangers. Include Product Data for components.
   2. Metal framing systems. Include Product Data for components.
   3. Pipe stands. Include Product Data for components.
   4. Equipment supports.

C. Welding certificates.

1.5 QUALITY ASSURANCE

A. MSS Standards: Pipe hangers, supports, and accessories shall comply with the following:
   1. MSS SP-58, Pipe Hangers and Supports – Materials, Design and Manufacture.
   2. MSS SP-69, Pipe Hangers and Supports – Selection and Application.
   3. MSS SP-89, Pipe Hangers and Supports – Fabrication and Installation Practices.

B. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."
   4. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
   5. ASME Boiler and Pressure Vessel Code: Section IX.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 HANGER ROD MATERIAL

A. Threaded, hot rolled, steel rod conforming to ASTM A 36 or A575.
   1. Rod continuously threaded.
   2. Use of rod couplings is prohibited.

2.3 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-69, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:
   1. Anvil International, Inc.
   2. Cooper B-Line, Inc.
   3. Carpenter & Paterson, Inc.
   4. Hilti USA.
   5. ERICO International Corp.
   6. PHD Manufacturing, Inc.
   7. Tolco | Cooper B-Line, Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.4 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.5 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
B. Manufacturers:

2. Cooper B-Line, Inc.
4. Unistrut Corp.; Tyco International, Ltd.
5. Hilti USA.

C. Coatings: Manufacturer’s standard finish, unless bare metal surfaces are indicated.

D. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

E. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.6 METAL INSULATION SHIELDS

A. Manufacturers:

1. Anvil International, Inc.
2. Cooper B-Line, Inc.
3. Carpenter & Paterson, Inc.
4. ERICO International Corp.
5. PHD Manufacturing, Inc.
6. Tolco | Cooper B-Line, Inc.

B. Description: MSS SP-69, Type 40, protective shields. Shields shall span an arc of 180 degrees.

C. Shield Dimensions for Pipe: Not less than the following:

1. NPS 1/4 to NPS 2: 12 inches long and 0.048 inch thick.

2.7 PLASTIC INSULATION SHIELDS

A. Manufacturers:


B. Description: Polypropylene copolymer protective shields designed to snap directly onto strut channel. Shields shall span an arc of 180 degrees.

1. Operating Temperature Range: Minus 40 deg F to plus 178 deg F.

C. Certifications:

1. UL Classified for USA: UL-723 (ASTM E 84).
2. UL listed for Canada: ULC-S102.2.
3. Meets UL94 HB flammability standards.
D. Shield Dimensions for Pipe: Not less than the following:

1. NPS 1/4 to NPS 2: 12 inches long.

2.8 THERMAL-HANGER SHIELDS

A. Manufacturers:

1. Cooper B-Line, Inc.
2. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
5. ERICO International Corp.
6. Tolco | Cooper B-Line, Inc.
7. Value Engineered Products, Inc.

B. Description: Manufactured assembly consisting of insulation insert encased in 360 degree sheet metal shield.

1. Minimum Compressive Strength of Insert Material:
   a. 100-psig- for sizes smaller than NPS 6.
   b. 600-psig- for sizes NPS 6 and larger.

C. Insulation-Insert Material for Cold Piping: Full 360 degree, water-repellent treated, ASTM C 533, Type I calcium silicate with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Full 360 degree, water-repellent treated, ASTM C 533, Type I calcium silicate.

E. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

F. Include carbon steel ASTM A36 load distribution plates as required by load, pipe movement, hanger style, and hanger spacing.

G. Thermal-Hanger Shields for Flexible Foamed Elastomeric Insulated Piping:

1. Manufacturers:
   a. Cooper B-Line, Inc./Armacell; Armafix IPH.

2. Insulation-Insert Material for Copper Piping with Flexible Foamed Elastomeric Insulation: Use one of the following:
   a. Flexible foamed elastomeric, ASTM 534, Type I-Tubular Grade 1 with PUR/PIP support inserts.
b. Rigid Hytrel thermoplastic insulation coupling designed for use with copper tubing and elastomeric insulation from 3/8 inch to 1 inch thick.

2.9 FASTENER SYSTEMS

A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:
   a. Cooper B-Line, Inc.
   b. Empire Industries, Inc.
   c. Hilti, Inc.
   d. ITW Ramset/Red Head.
   e. MKT Fastening, LLC.
   f. Powers Fasteners.

B. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application. Exception: Do not use chemical fasteners to support hanger systems for fire protection piping.

1. Manufacturers:
   a. Hilti, Inc.
   b. ITW Ramset/Red Head.
   c. MKT Fastening, LLC.
   d. Powers Fasteners.

2. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.

2.10 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.11 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. 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, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified 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 outdoor applications or where exposed to outdoor conditions.

D. Use hangers and supports with plastic coating, or galvanized metallic coatings for applications in corrosive atmospheres.

E. Use metal framing, with plastic coating, or galvanized metallic coatings for metal framing in corrosive atmospheres.

F. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

G. Use padded hangers for piping that is subject to scratching.

H. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Single Pipes
   a. Support uninsulated pipe up to NPS 4 size with TYPE 1 or TYPE 10 attachments.
   b. Support uninsulated pipe NPS 6 size through NPS 12 size with TYPE 1 attachments.
   c. Support uninsulated pipe larger than NPS 12 size with double rod roller hangers, Type 41.
   d. Support insulated pipe up to NPS 2 size with Type 1 attachments and Type 40 insulation shield.
   e. Support insulated cold piping NPS 2-1/2 to NPS 12 size with TYPE 1 attachment with thermal-hanger shield.
   f. Support insulated hot piping NPS 2-1/2 size through NPS 12 size with roller hangers TYPES 41, 43, 44 or 46 with thermal-hanger shield designed for use with a pipe roller.

2. Parallel Pipes:
   a. Fabricate trapeze hangers from approved structural steel shapes in accordance with “Miscellaneous Materials” requirements or use commercially available
proprietary design, rolled steel. Refer to applicable requirements for “Single Pipes” and “Metal Fabrications.”

I. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. MSS Type 8 or spring type to meet system requirements.

J. Insulation Shields and Thermal-Hanger Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. For Trapeze or Clamped Systems: For insulated piping use thermal-hanger shields to prevent crushing insulation.
   2. For Trapeze Systems Constructed of Metal Strut: Plastic shields may be used in exposed locations.

K. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
   2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
   3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
   4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
   5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.

L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Anchor Devices, Concrete and Masonry: in accordance with Group I, Group II, Type 2, Class 2, Style 1 and Style 2, Group III and Group VIII or FS FF-S-325A. Furnish cast-in floor type equipment anchor devices with adjustable positions. Furnish built in anchor devices for masonry, unless otherwise approved by the Architect. Powder actuated anchoring devices shall not be used to support any mechanical systems components.
   2. Beam Clamps:
      a. Center Loading: TYPE 21, 28, 29 and 30, unless otherwise indicated. Type 27 shall be allowed to support single pipes NPS 6 size or smaller only.
      b. “C” Clamps: Type 19, 20 or 23, for supporting single pipes NPS 2-1/2 size or smaller only. Use of “C” clamps, or beam clamps of “C” pattern, or any modification thereof, is prohibited for supporting multiple pipes or pipes larger than NPS 2-1/2.

M. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Use spring supports and sway braces TYPES 48, 49, 50, 51, 52, 53, 54, 55 or 56. For specific points:
a. Provide spring supports at point of support where vertical movement will occur.
b. For light loads and vertical movement less than 1/4 inch, TYPES 48 or 49 spring cushion supports.
c. For vertical movements in excess of 1/4 inch but less than 1/2 inch, TYPES 51, 52 or 53 variable spring supports shall be used, loaded to not more than 75 percent of published load rating.
d. For vertical movements of 1/2 inch and more, TYPES 54, 55 and 56 constant support spring hangers.
e. Sway braces; TYPE 50.
f. Variable spring hangers in accordance with referenced MSS Standards with "medium" allowable load change.

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-102 for metal framing system selections and applications that are not specified in piping system Sections.

P. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

Q. Use chemical fasteners instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel 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 building structural frame.

B. Provide necessary piping and equipment supporting elements including: building structure attachments, supplementary steel, hanger rods, stanchions and fixtures, vertical pipe attachments, horizontal pipe attachments, anchors, guides, spring supports in accordance with the referenced codes, standards, and requirements specified. Support piping and equipment from building structure, not from roof deck, floor slab, other pipe, duct or equipment.

C. At connections between piping systems, hangers and equipment of dissimilar metals, insulate, using dielectric insulating material, nonferrous piping against direct contact with the building steel by insulating the contact point of the hanger and pipe or the hanger and building steel. Test each point of dielectric insulation with an ohm meter to ensure proper isolation of dissimilar materials. Test shall be observed by the Owner’s Representative and/or Architect.

D. Use copper plated or plastic coated supporting element in contact with copper tubing or glass piping.

E. File and paint cut ends and shop or field prime paint supporting element components.
F. Hang piping parallel with the lines of the building, unless otherwise indicated. Route piping in an orderly manner and maintain gradient. Space piping and components so a threaded pipe fitting may be removed between adjacent pipes and so there will be not less than 1/2 inch of clear space between finished surfaces and piping. Arrange hangers on adjacent parallel service lines in line with each other.

G. Flange loads on connected equipment shall not exceed 75 percent of maximum allowed by equipment manufacturer. Flange loads in liquid containing systems shall be checked in the presence of the Architect when piping is full of liquid. No flange load is allowed on pumps, vibration isolated equipment or flexible connectors.

H. Spring supports, within specified limitations: Constant support type, where necessary to avoid transfer of load from support to support or onto connected equipment; otherwise, variable support type located at points subject to vertical movement.

I. Where necessary, brace piping and supports against reaction, sway and vibration.

J. Do not hang piping from joist pans, floor decks, roof decks, equipment, ductwork, or other piping.

K. Install hangers and supports for piping at intervals specified, at locations not more than 3 feet from the ends of each runout, not more than 3 feet from connections to equipment, and not over 25 percent of specified interval from each change in direction of piping and for concentrated loads such as valves, etc.

L. Base the load rating for pipe support elements on loads imposed by insulated weight of pipe filled with water. The span deflection shall not exceed slope gradient of pipe.

M. If structural steel, roofs, or tunnels will allow support spacing greater than that shown above, Contractor shall submit proposed support system along with structural calculations documenting the allowance of such spacing, in accordance with ANSI, B31.1, and MSS Guidelines.

N. Support vertical risers independently of connected horizontal piping whenever practical, with supports at the base and at intervals to accommodate system range of load with thermal conditions. Support vertical risers at each floor penetration for piping in shafts or chases. Guide for lateral stability. Fit horizontal piping connected to moving risers with two spring supports connected adjacent to riser, spaced according to required hanger spacing.

O. For risers at temperatures of 100 deg F or less place riser clamps under fittings. Support carbon steel pipe at each operating level or floor and at not more than 15-foot intervals for pipe 2 inches and smaller, and at not more than 20 foot intervals for pipe 2-1/2 inches and larger.

P. After the piping systems have been installed, tested and placed in satisfactory operation, firmly tighten hanger rod nut and jam nut and upset threads to prevent movement of fasteners.
Q. Attach supporting elements connected to structural steel columns to preclude vertical slippage and cascading failure.

R. Attach pipe hangers and other supporting elements to roof purlins and trusses at panel points.

S. Where eccentric loading beam clamps are approved and where other work is supported by similar eccentric loading support element from the same structural member, locate eccentric loading support elements to minimize structural member torsion load.

T. Limit the location of supporting elements for piping and equipment, when supported from roof, to panel points of the bar joists.

U. Building structure shall not be reinforced except as approved by the Architect in writing.

V. Use approved cast-in-place inserts or built-in anchors for attachment to concrete structure. Size inserts and anchors for the total applied load with a safety factor in accordance with applicable codes but in no case less than 5. Coordinate installation of all imbedded items in accordance with manufacturer’s instructions. Position anchorage and imbedded items as indicated and/or where required and support against displacement during placing of concrete. Cutting or repositioning of concrete beam or girder or reinforcing steel to accommodate inserts will not be allowed. Provide removable closures in imbedded device openings to prevent entry of concrete.

W. Support piping and equipment from concrete building frame, not from roof or floor slabs unless otherwise indicated.

X. Use cast-in-place inserts in concrete beams and girders. Drilled anchors/wedge type inserts shall be used on vertical surfaces only. Coordinate with structural engineer.

Y. Attach piping supports to the side of concrete beams and concrete joist. Provide supplementary support steel as required. Cast-in-place or drilled anchors will not be permitted in the bottom of concrete beams and concrete joist.

Z. Attach piping supports to the side of concrete beams or concrete joist. Where intermediate hangers are required to meet the hanger spacing schedule, the Contractor may propose attachment of intermediate pipe supports to the bottom of the concrete slab pending submittal of a satisfactory pull out test. The Contractor shall submit pull out test criteria, pull out test results, proposed hanger detail and hanger point loads to the Architect for written approval.

AA. 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 above for individual pipe hangers.
2. Field fabricate from ASTM A36/A36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

BB. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

CC. 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.

DD. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.


FF. Install hangers and supports to allow controlled thermal and seismic 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.

GG. Install lateral bracing with pipe hangers and supports to prevent swaying.

HH. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

II. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

JJ. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

KK. Insulated Piping: Comply with the following:
   1. Pipe smaller than NPS 2: Install adjustable swivel ring or clevis type hangers with protection shield.
   2. Cold Pipe NPS 2-1/2 and larger: Install clevis type hangers with thermal hanger shields.
   3. Hot Pipe NPS 2-1/2 through NPS 5: Install single rod roller hanger with thermal hanger shield.
   4. Hot Pipe NPS 6 and larger: Install 2-rod roller hanger with thermal hanger shield.
   5. Trapeze Supported Pipe NPS 2 and smaller: Install with protection shield and secure to trapeze support with standard U-bolts and locknuts.
   6. Trapeze Supported Cold Pipe NPS 2-1/2 and larger: Install with thermal hanger shield and secure to trapeze support with standard U-bolts and locknuts.
7. Trapeze Supported Hot Pipe NPS 2-1/2 and larger: Install thermal hanger shield and cradle pipe in adjustable cast iron roller support.

L.L. Refer to individual piping sections for hanger spacing and hanger rod sizes.

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 smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.

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 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 contours of welded surfaces match adjacent contours.

3.5 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.6 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Equipment Supports: Painting is specified in Division 09 painting Sections.
C. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

D. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 20 05 29
SECTION 20 05 53
MECHANICAL IDENTIFICATION

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 include the following:

1. Division 20 Section “Mechanical General Requirements.”

1.2 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Valve numbering scheme.

D. Valve Schedules: For each piping system. Furnish extra copies (in addition to mounted copies) to include in Maintenance Manuals.
1.3 QUALITY ASSURANCE

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 location of access panels and doors.
   C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
   A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified:

      1. Seton.
      2. Brady.
      3. EMED.
      5. Brimar Industries, Inc.

2.2 EQUIPMENT IDENTIFICATION DEVICES
   A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.

      1. Data:

         a. Manufacturer, product name, model number, and serial number.
         b. Capacity, operating and power characteristics, and essential data.
         c. Labels of tested compliances.

      2. Location: Accessible and visible.
      3. Fasteners: As required to mount on equipment.

   B. Equipment Markers: Engraved, color-coded laminated plastic. Include contact-type, permanent adhesive.

      1. Terminology: Match schedules as closely as possible.
2. Data:
   a. Name and plan number.
   b. Equipment service.
   c. Design capacity.
   d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.

3. Size: 2-1/2 by 4 inches for control devices, dampers, and valves; 4-1/2 by 6 inches for equipment.

2.3 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.
   1. Colors: Comply with ASME (ANSI) A13.1, unless otherwise indicated.
   2. Type and Size of Letters: Comply with ANSI A13.1, unless otherwise indicated.
   3. Legends: Spelled out in full or commonly used and accepted abbreviations.
   4. Pipes with OD, Including Insulation, Less Than 6 Inches: Full-band pipe markers extending 360 degrees around pipe at each location.
   5. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
   6. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Pretensioned Pipe Markers: Precoiled semirigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

C. Shaped Pipe Markers: Preformed semirigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.

2.4 DUCT IDENTIFICATION DEVICES

A. Duct Markers: Vinyl, 2-inch minimum character height, with permanent pressure sensitive adhesive. Include direction and quantity of airflow, air handling unit or fan number, and duct service (such as supply, return, and exhaust).

2.5 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
   1. Size: 3 by 5-1/4 inches minimum.
   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 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 20, 21, 22, and 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer's option.

3.2 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:

1. Fan coil units.

B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.

1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.

3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:

   a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.

   b. Fan coil units.

C. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

1. Pipes with OD, Including Insulation, Less Than 6 Inches: Pretensioned pipe markers. Use size to ensure a tight fit.

2. Pipes with OD, Including Insulation, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.
B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

C. Underground Pipe Markers: Install 6 to 8 inches below finished grade, directly above buried pipe.

3.4 DUCT IDENTIFICATION

A. Identify ductwork with vinyl markers and flow direction arrows.

B. Locate markers at air handling units, each side of floor and wall penetrations, near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.6 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.7 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.
### 3.8 SCHEDULES

A. Paint colors are listed here for reference only. Painting is specified under Division 9.

#### PIPE LABELING AND COLOR CODING

<table>
<thead>
<tr>
<th>Drawing Abbrev.</th>
<th>Pipe System Label</th>
<th>Labels</th>
<th>Piping</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAN</td>
<td>Sanitary Sewer</td>
<td>White on Green</td>
<td>Dark Brown</td>
</tr>
<tr>
<td>V</td>
<td>Sanitary Vent</td>
<td>White on Green</td>
<td>Dark Brown</td>
</tr>
<tr>
<td>AW</td>
<td>Acid Waste</td>
<td>Black on Yellow</td>
<td>Black</td>
</tr>
<tr>
<td>AV</td>
<td>Acid Vent</td>
<td>Black on Yellow</td>
<td>Black</td>
</tr>
<tr>
<td>CW</td>
<td>Domestic Cold Water</td>
<td>White on Green</td>
<td>Light Green</td>
</tr>
<tr>
<td>NPCW</td>
<td>Non-Potable Cold Water</td>
<td>Black on Yellow</td>
<td>Dark Green</td>
</tr>
<tr>
<td>HW</td>
<td>Domestic Hot Water</td>
<td>Black on Yellow</td>
<td>Dark Green</td>
</tr>
<tr>
<td>G</td>
<td>Natural Gas</td>
<td>Black on Yellow</td>
<td>Yellow</td>
</tr>
<tr>
<td>A</td>
<td>Compressed Air (25psig)</td>
<td>White on Green</td>
<td>Dark Blue</td>
</tr>
<tr>
<td>Di</td>
<td>High Purity Water</td>
<td>White on Green</td>
<td>White</td>
</tr>
<tr>
<td>HWHS</td>
<td>Hot Water Htg. Supply</td>
<td>Black on Yellow</td>
<td>Dark Blue</td>
</tr>
<tr>
<td>HWHR</td>
<td>Hot Water Htg. Return</td>
<td>Black on Yellow</td>
<td>Dark Blue</td>
</tr>
<tr>
<td>CHWS</td>
<td>Chilled Water Supply</td>
<td>White on Green</td>
<td>Light Blue</td>
</tr>
<tr>
<td>CHWR</td>
<td>Chilled Water Return</td>
<td>White on Green</td>
<td>Light Blue</td>
</tr>
</tbody>
</table>

#### SHEET METAL WORK

<table>
<thead>
<tr>
<th>Service</th>
<th>Abbrev.</th>
<th>Labels</th>
<th>Ductwork</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air Conditioning Supply</td>
<td>Supply Air</td>
<td>White on Green</td>
<td>White</td>
</tr>
<tr>
<td>Exhaust Systems</td>
<td>Exhaust Air</td>
<td>Black on Yellow</td>
<td>Green</td>
</tr>
</tbody>
</table>

END OF SECTION 20 05 53
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 include the following:
      1. Division 20 Section “Mechanical General Requirements.”
      2. Division 20 Section “Basic Materials and Methods.”
      3. Division 23 Section “Hanger and Supports” for thermal hanger shield inserts.
      4. Division 22 Section “Plumbing Fixtures: for protective shielding guards.
      5. Division 23 Section ”Metal Ducts” for duct liners.

1.2 SUMMARY
   A. This Section includes mechanical insulation for pipe, duct, and equipment.

1.3 DEFINITIONS
   A. ASJ: All-service jacket.
   B. FSK: Foil, scrim, kraft paper.
   C. FSP: Foil, scrim, polyethylene.
   D. PVC: Polyvinyl Chloride.
   E. PVDC: Polyvinylidene chloride.
   F. SSL: Self-sealing lap.

1.4 INDOOR PIPING INSULATION SYSTEMS DESCRIPTION
   A. Acceptable preformed pipe and tubular insulation materials and thicknesses are scheduled on the Drawings, or identified for each piping system and pipe size range.

1.5 INDOOR DUCT AND PLENUM INSULATION SYSTEMS DESCRIPTION
   A. Acceptable indoor duct and plenum insulation materials and thicknesses are scheduled on the Drawings.

1.6 FIELD-APPLIED JACKETING SYSTEMS DESCRIPTION
   A. Acceptable field-applied jacketing materials and thicknesses are scheduled on the Drawings.
1.7 SUBMITTALS

A. Product Data: For each type of product indicated, identify thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings: Show details for the following:
   1. Application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Attachment and covering of heat tracing inside insulation.
   3. Insulation application at pipe expansion joints for each type of insulation.
   4. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   5. Removable insulation at piping specialties, equipment connections, and access panels.
   6. Application of field-applied jackets.
   7. Application at linkages of control devices.
   8. Field application for each equipment type
   9. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

C. Field quality-control inspection reports.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

C. Ductwork Maximum Temperature Limits: Based on ASTM C 411 test procedures.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Prior to installation, protect insulation from exposure to water and from physical damage. Prior to installation, store insulation in manufacturer’s original packaging.

1.10 COORDINATION

A. Coordinate size and location of supports, hangers, and pre-insulated pipe shields/supports specified in Division 23 Section "Hangers and Supports."
B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.11 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, GENERAL REQUIREMENTS

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. Adhesives used shall be fire resistant in their dry states and UL listed.

2.2 PIPE INSULATION MATERIALS

A. Flexible Elastomeric: 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 products specified.

   a. Armacell LLC; AP Armaflex.
   b. Nomaco K-Flex; Insul-Tube and Insul-Sheet.

B. Glass-Fiber, Preformed Pipe Insulation, Type I:
1. Products: Subject to compliance with requirements, provide one of the products specified.
   a. Johns Manville; Micro-Lok.
   b. Knauf Insulation; 1000 Pipe Insulation.
   c. Manson Insulation Inc.; Alley-K.
   d. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F Materials: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ or ASJ-SSL. Factory-applied jacket requirements are specified in Part 2 “Factory-Applied Jackets” Article.

2.3 DUCTWORK INSULATION MATERIALS

A. Blanket Insulation: 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. Factory-applied jacket requirements are specified in Part 2 “Factory-Applied Jackets” Article.

1. Products: Subject to compliance with requirements, provide one of the products specified.
   a. CertainTeed Corp.; Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Duct Wrap.
   d. Manson Insulation Inc.; Alley Wrap FSK.
   e. Owens Corning; All-Service Duct Wrap.

B. Board Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in Part 2 “Factory-Applied Jackets” Article.

1. Products: Subject to compliance with requirements, provide one of the products specified.
   a. CertainTeed Corp.; Commercial Board.
   b. Fibrex Insulations Inc.; FBX.
   c. Johns Manville; 800 Series Spin-Glas.
   d. Knauf Insulation; Insulation Board.
   e. Manson Insulation Inc.; AK Board.
   f. Owens Corning; Fiberglas 700 Series.

C. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.

1. Products: Subject to compliance with requirements, provide one of the products specified.
2.4 INSULATING CEMENTS

   1. Products: Subject to compliance with requirements, provide one of the products specified.
      a. Insulco, Division of MFS, Inc.; Triple I.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
   1. Products: Subject to compliance with requirements, provide one of the products specified.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
   1. Products: Subject to compliance with requirements, provide one of the products specified.
      a. Insulco, Division of MFS, Inc.; SmoothKote.
      c. Rock Wool Manufacturing Company; Delta One Shot.

2.5 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to it and to surfaces to be insulated, unless otherwise indicated.

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. Products: Subject to compliance with requirements, provide one of the products specified.
      a. Armacell LLC; 520 Adhesive.
      b. Foster Products Corporation, H. B. Fuller Company; 85-75.
      c. RBX Corporation; Rubatex Contact Adhesive.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide one of the products specified.

1. Products: Subject to compliance with requirements, provide one of the products specified.

   a. Childers Products, H.B. Fuller Company; CP-82.
   c. ITW TACC, Division of Illinois Tool Works; S-90/80.
   d. Marathon Industries, Inc.; 225.
   e. Mon-Eco Industries, Inc.; 22-25.
   f. Vimasco Corporation.

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the products specified.

   a. Dow Chemical Company (The); 739, Dow Silicone.
   e. Speedline Corporation; Speedline Vinyl Adhesive.

2.6 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the products specified.

   b. Foster Products Corporation, H. B. Fuller Company; 30-90.
   c. ITW TACC, Division of Illinois Tool Works; CB-50.
   d. Marathon Industries, Inc.; 590.
   e. Mon-Eco Industries, Inc.; 55-40.
   f. Vimasco Corporation; 749.
2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
   1. Products: Subject to compliance with requirements, provide one of the products specified.
      b. Foster Products Corporation, H. B. Fuller Company; 35-00.
      c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
      e. Mon-Eco Industries, Inc.; 55-50.
      f. Vimasco Corporation; WC-1/WC-5.
   2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 200 deg F.
   4. Solids Content: 63 percent by volume and 73 percent by weight.

2.7 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the products specified.
      b. Foster Products Corporation, H. B. Fuller Company; 95-44.
      c. Marathon Industries, Inc.; 405.
      d. Mon-Eco Industries, Inc.; 44-05.
      e. Vimasco Corporation; 750.
   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.
   5. Color: Aluminum.

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the products specified.
      a. Childers Products, H.B. Fuller Company; CP-76.
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.

2.8 FACTORY-APPLIED JACKETS

A. Insulation systems indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.9 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.

1. Products: Subject to compliance with requirements, provide one of the products specified.
   a. Vimasco Corporation; Elastafab 894.
   b. Or approved equal.


1. Products: Subject to compliance with requirements, provide one of the products specified.
   a. Childers Products, H.B. Fuller Company; Chil-Glas No. 5.
   b. Or approved equal.

C. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for duct, equipment, and pipe.

1. Products: Subject to compliance with requirements, provide one of the products specified.
   b. Vimasco Corporation; Elastafab 894.
2.10 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..

1. Products: Subject to compliance with requirements, provide one of the products specified.
   b. Lewco Products.
   c. Mid-Mountain.
   d. TCI.

2.11 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 specified; roll stock ready for shop or field cutting and forming.

1. Products: Subject to compliance with requirements, provide one of the products specified.
   a. Johns Manville; Zeston and Ceel-Co.
   c. Proto PVC Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.


4. Factory-fabricated tank heads and tank side panels.

D. PVC Fitting Covers: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C, and including flexible glass fiber insulation inserts.

1. Products: Subject to compliance with requirements, provide one of the products specified.
   a. Johns Manville; Zeston and Ceel-Co.
   c. Proto PVC Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by manufacturer.


4. Factory-fabricated fitting covers:
a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, and mechanical joints.

E. Self-Adhesive Outdoor Jacket: Laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with aluminum-foil facing.

1. Products: Subject to compliance with requirements, provide one of the products specified.

   a. MFM Building Products Corp.; FlexClad-400
   b. Polyguard; Alumaguard.
   c. Venture Tape Corp.; VentureClad.

F. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

1. Products: Subject to compliance with requirements, provide one of the products specified.

   a. Dow Chemical Company (The), Saran 540 Vapor Retarder Film.

G. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

1. Products: Subject to compliance with requirements, provide one of the products specified.

   a. Dow Chemical Company (The), Saran 560 Vapor Retarder Film.


1. Products: Subject to compliance with requirements, provide one of the products specified.

   a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2.12 REMOVABLE AND REUSABLE INSULATION COVERS

A. Flexible Style: Custom fabricated composite jackets for valves, flanges, and expansion joints consisting of 4 inches of high temperature fiberglass insulation compressed between Teflon impregnated fiberglass inner and outer facing stitched with fiberglass core Teflon thread, and secured with Velcro fasteners and double D-ring cinching. Service temperature range of minus 40 deg F to 500 deg F.
1. Fabricators:
   a. Apex Energy & Environmental Products Inc.
   b. 3i Supply Co.; K-Tex.
   c. Valley Group of Companies.

B. Rigid Style: Custom fabricated composite jackets for valves, flanges, and expansion joints consisting of rigid foam insulation with silicone impregnated fiberglass outer facing stitched with fiberglass thread, and secured with Velcro fasteners and double D-ring cinching. Service temperature range of minus 40 deg F to 500 deg F.

1. Fabricators:
   a. Valley Group of Companies.

2.13 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136 and UL listed.

1. Products: Subject to compliance with requirements, provide one of the products specified.
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
   b. Compac Corp.; 104 and 105.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches.
3. Thickness: 11.5 mils.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch 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 and UL listed.

1. Products: Subject to compliance with requirements, provide one of the products specified.
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
   b. Compac Corp.; 110 and 111.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
   d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches.
3. Thickness: 6.5 mils.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch 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: Subject to compliance with requirements, provide one of the products specified.
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
   b. Compac Corp.; 130.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
   d. Venture Tape; 1506 CW NS.
2. Width: 2 inches.
3. Thickness: 6 mils.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive and UL listed.

1. Products: Subject to compliance with requirements, provide one of the products specified.
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   b. Compac Corp.; 120.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
   d. Venture Tape; 3520 CW.
2. Width: 2 inches.
3. Thickness: 3.7 mils.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the products specified.
   a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.
2. Width: 3 inches.
3. Film Thickness: 4 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the products specified.
   a. Dow Chemical Company (The); Saran 560 Vapor Retarder Tape.

2. Width: 3 inches.
3. Film Thickness: 6 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

2.14 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the products specified.
   a. PABCO-Childers Metals; ITW Insulation Systems; Pab-Bands and Fabstraps.
   b. RPR Products, Inc.; Bands.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing or closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
   a. Products: Subject to compliance with requirements, provide one of the products specified.
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; CD.
      3) Midwest Fasteners, Inc.; CD.
      4) Nelson Stud Welding; TPA, TPC, and TPS.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   
a. Products: Subject to compliance with requirements, provide one of the products specified.
   
   1) AGM Industries, Inc.; CWP-1.
   2) GEMCO; Cupped Head Weld Pin.
   3) Midwest Fasteners, Inc.; Cupped Head.
   4) Nelson Stud Welding; CHP.

3. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   
a. Products: Subject to compliance with requirements, provide one of the products specified.
   
   1) AGM Industries, Inc.; RC-150.
   2) GEMCO; R-150.
   3) Midwest Fasteners, Inc.; WA-150.
   4) Nelson Stud Welding; Speed Clips.
   
b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

4. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   
a. Manufacturers:
   
   1) GEMCO.
   2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, stainless steel.
   
   1. Manufacturers:
   
   a. ACS Industries, Inc.
   b. C & F Wire.
   c. PABCO-Childers Metals; ITW Insulation Systems.
   d. RPR Products, Inc.
2.15 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.
3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 COMMON INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
D. Install insulation with longitudinal seams at the 4 o’clock or 8 o’clock position on 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 as 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 thermal hanger 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 thermal hanger inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer’s recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at the 4 o’clock or 8 o’clock position on the pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness. Where compression of insulation is possible, fabricate/install insulation per manufacturer’s recommendations.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
5. Handholes.
6. Cleanouts.

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:

1. Terminate ductwork insulation at angle closure of fire damper sleeves.
2. Install pipe insulation continuously through penetrations of fire-rated walls and partitions.

   a. Firestopping is specified in Division 07 Section “Through-Penetration Firestop Systems.”

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. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place
with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

E. Install removable and reusable insulation covers in accordance with fabricator’s instructions, and at the following locations:

1. At valves, flanges, and expansion joints. Expansion joints shall have jacket installed in a manner to allow for replacing of joints without removing insulation cover.

3.6 FLEXIBLE ELASTOMERIC PIPE INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer’s recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer’s recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer’s recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.7 GLASS-FIBER PIPE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install PVC fitting covers when available.
   2. When PVC fitting covers are not available, install preformed pipe insulation to outer diameter of pipe flange:
      a. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
      b. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with fiberglass or mineral wool blanket insulation as specified for system.
   3. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install PVC fitting covers when available.
   2. When PVC fitting covers 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 PVC fitting covers when available.
2. When PVC fitting covers 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.

3.8 DUCT AND PLENUM INSULATION INSTALLATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with insulation pins.

1. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not over compress 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.

2. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

3. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
4. 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.

5. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

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 and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not over compress 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 from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
   b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

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-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

C. Flexible Elastomeric Thermal Insulation Installation for Ducts and Plenums: Install insulation over entire surface of ducts and plenums.

1. Apply 100 percent coverage of adhesive to surface with manufacturer’s recommended adhesive.
2. Seal longitudinal seams and end joints.
3. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with strips of same material used to insulate duct and following manufacturer’s installation instructions.

3.9 FIELD-APPLIED JACKET INSTALLATION

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

C. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer’s recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

D. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer’s recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

E. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof
sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

F.  Where sound barrier jackets are indicated, install in accordance with manufacturer’s instructions.

G.  Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer’s written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch- circumference limit allows for 2-inch- overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal for “fish mouthing,” and use PVDC tape along lap seal to secure joint.
5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.10  FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system specified in Division 09 painting Sections.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer’s recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

END OF SECTION 20 07 00
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. Provisions of Division 20 Section “Mechanical General Requirements” apply to this Section.

C. Related Sections include the following:
   1. Division 10 Section "Fire-Protection Specialties" for cabinets and fire extinguishers.
   2. Division 20 Section “Basic Mechanical Materials and Methods.”
   3. Division 20 Section "Hangers and Supports."

1.2 SUMMARY
   A. This Section includes water-based fire-suppression systems inside the building.

1.3 DEFINITIONS
   A. CR: Chlorosulfonated polyethylene synthetic rubber.
   B. Working Plans: Documents, including drawings, calculations, and material specifications prepared according to NFPA 13 and NFPA 14 for obtaining approval from authorities having jurisdiction.

1.4 SYSTEM DESCRIPTIONS
   A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device.

1.5 PERFORMANCE REQUIREMENTS
   B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   C. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction.
      1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
      2. Sprinkler Occupancy Hazard Classifications, for bidding purposes, as follows:
         a. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
         b. Lab Areas: Ordinary Hazard, Group 1.
c. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
d. Office and Public Areas: Light Hazard.
e. Flammable Liquid Storage Room and Cabinets: Extra-Hazard Group 2.

3. Minimum Density for Automatic-Sprinkler Piping Design:

a. Light-Hazard Occupancy: 0.10 gpm/sq. ft. over 1500-sq. ft. area.
b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
c. Extra-Hazard, Group 2 Occupancy: 0.40 GPM over 1500 sq. ft. area.

4. Maximum Protection Area per Sprinkler:

a. Office Spaces: 225 sq. ft.
b. Storage Areas: 130 sq. ft.
c. Mechanical Equipment Rooms: 130 sq. ft.
d. Electrical Equipment Rooms: 130 sq. ft.
e. Other Areas: According to NFPA 13 recommendations, unless otherwise indicated.

D. Water velocity in the piping system shall not exceed the following:

1. Aboveground mains: 32 ft./sec.
2. Sprinkler branch lines: 24 ft./sec.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

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

1. Wiring Diagrams: For power, signal, and control wiring.

C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Domestic water piping.
2. Compressed air piping.
3. HVAC hydronic piping and duct work.
4. Laboratory gas piping.
5. Items penetrating finished ceiling include the following:
a. Lighting fixtures.
b. Air outlets and inlets.

E. Qualification Data: For qualified Installer and professional engineer.

F. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, and the local offices of the Owner’s insurance underwriter including hydraulic calculations, if applicable.

1. Sprinklers shall be referred to on drawings, submittals, and other documentation, by the sprinkler identification number (SIN) or model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.


H. Field quality-control reports.

I. Operation and Maintenance Data: For sprinkler specialties to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer’s responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

B. The provisions and requirements of the NFPA and the Owner’s insurance underwriter constitute mandatory minimum requirements for the work of this Section.

C. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems."

1.8 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.
B. Coordinate with ceiling installer to ensure proper grid type and installation for use with flexible sprinkler drops.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STANDARD-WEIGHT BLACK STEEL PIPE AND FITTINGS

A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53, ASTM A 135, or ASTM A 795, with factory- or field-formed threaded ends, and with factory applied antimicrobial coating on inner wall of pipe.

5. Steel Threaded Couplings: ASTM A 865.


2. Steel Flanges and Flanged Fittings: ASME B16.5.

C. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53, ASTM A 135, or ASTM A 795, with factory- or field-formed, square-cut- or roll- grooved ends, and with factory applied antimicrobial coating on inner wall of pipe.

1. Grooved-Joint Piping Systems:
   a. Manufacturers:
      1) Anvil International, Inc.; Model 7401.
      2) Tyco Fire & Building Products; Grinnell Mechanical Products; Model 577 or 772.
      3) Victaulic Co. of America; Style 005 or 009.
b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.

c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, rubber gasket listed for use with housing, and steel bolts and nuts.

2.3 SPRINKLER SPECIALTY FITTINGS

A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping.

B. Sprinkler Drain and Alarm Test Fittings: Cast-or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.

1. Manufacturers:
   a. Tyco Fire & Building Products LP.
   b. Fire-End and Croker Corp.
   c. Viking Corp.
   d. Victaulic Co. of America.

C. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.

1. Manufacturers:
   b. Potter-Roemer; Fire-Protection Div.

D. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.

1. Manufacturers:
   a. AGF Manufacturing Co.
   b. Tyco Fire & Building Products LP.
   c. G/J Innovations, Inc.
   d. Triple R Specialty of Ajax, Inc.

E. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.

1. Manufacturers:
   a. CECA, LLC.
   b. Merit.

F. Flexible Sprinkler Drop Fittings:
1. Manufacturers:
   a. FlexHead Industries, Inc.
   b. Victaulic Co. of America; AquaFlex Sprinkler Fittings.

2. Description: UL listed and FMG approved flexible hose for connection to sprinkler, and with bracket for connection to commercial ceiling grid.
5. Size: Same as connected piping, for sprinkler.

2.4 LISTED FIRE-PROTECTION VALVES

A. Valves shall be UL listed or FMG approved, with 175-psig minimum pressure rating.

B. Ball Valves: Comply with UL 1091, except with ball instead of disc.
   1. NPS 1-1/2 and Smaller: Bronze body with threaded ends.
   2. NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.
   3. NPS 3: Ductile-iron body with grooved ends.
   4. Manufacturers:
      a. NIBCO.
      b. Victaulic Co. of America.

C. Butterfly Valves: UL 1091.
   1. NPS 2-1/2 and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.
      a. Manufacturers:
         1) McWane, Inc.; Kennedy Valve Div.
         2) Mueller Company.
         3) NIBCO.
         4) Tyco Fire & Building Products.
         5) Victaulic Co. of America.

D. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.
   1. Manufacturers:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Crane Co.; Crane Valve Group; Jenkins Valves.
      c. Tyco Fire & Building Products.
      d. Hammond Valve.
2.5 UNLISTED GENERAL-DUTY VALVES

A. Ball Valves NPS 2 and Smaller: MSS SP-110, 2-piece copper-alloy body with chrome-plated brass ball, 600-psig minimum CWP rating, blowout-proof stem, and threaded ends.

B. Check Valves NPS 2 and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and threaded ends.

C. Gate Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, solid wedge, and threaded ends.

D. Globe Valves NPS 2 and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, nonmetallic disc, and threaded ends.

2.6 SPRINKLERS

A. Sprinklers shall be UL listed or FMG approved, with 175-psig minimum pressure rating.
B. Manufacturers:

1. Reliable Automatic Sprinkler Co., Inc.
2. Tyco Fire & Building Products.
3. Victaulic Co. of America.
4. Viking Corp.

C. Automatic Sprinklers:

1. With heat-responsive glass bulb element complying with the following:
   a. UL 199, for nonresidential applications.
   b. UL 1767, for early-suppression, fast-response applications.

D. Sprinkler Types and Categories: Nominal 1/2-inch orifice for 165 deg F "Ordinary" unless otherwise indicated or required by application.

E. Sprinkler types, features, and options as follows:

1. Concealed ceiling sprinklers, including cover plate.
2. Extended-coverage sprinklers.
3. Flush ceiling sprinklers, including escutcheon.
4. Pendent sprinklers.
5. Quick-response sprinklers.
6. Recessed sprinklers, including escutcheon.
7. Sidewall sprinklers.
8. Upright sprinklers.

F. Sprinkler Finishes: Chrome plated, bronze, and painted.

G. Special Coatings: Wax, lead, and corrosion-resistant paint.

H. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers. Escutcheons listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.

2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

I. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler. Sprinkler guards listed, supplied, and approved for use with the sprinkler by the sprinkler manufacturer.

2.7 PRESSURE GAGES

A. Manufacturers:
1. AMETEK, Inc.; U.S. Gauge.
2. Ashcroft Inc.
3. Marsh Bellofram.
4. Viking Corp.
5. Weiss Instruments, Inc.

B. Description: UL 393, 3-1/2- to 4-1/2-inch-diameter, dial pressure gage with range of 0 to 250 psig minimum.

1. Water System Piping: Include caption "WATER" on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in Part 1 "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 EXAMINATION

A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.

B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.

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

3.3 PIPING APPLICATIONS, GENERAL

A. Flanges, flanged fittings, unions, nipples, grooved-joint couplings, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.
3.4 SPRINKLER SYSTEM PIPING APPLICATIONS

A. Wet-Pipe Sprinklers: Use the following:

<table>
<thead>
<tr>
<th>Pipe Type</th>
<th>1 ½&quot; &amp; Smaller</th>
<th>2&quot;</th>
<th>2 ½&quot; – 3 ½&quot;</th>
<th>4&quot;</th>
<th>5&quot; – 6&quot;</th>
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<td>Standard weight steel, threaded fittings</td>
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<tr>
<td>Standard weight steel, locking fittings</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
<td>NO</td>
</tr>
<tr>
<td>Standard weight steel, grooved fittings</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Schedule 10 steel, grooved fittings</td>
<td>NO</td>
<td>NO</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
</tbody>
</table>

3.5 VALVE APPLICATIONS

A. The following requirements apply:

1. Listed Fire-Protection Valves: UL listed or FMG approved for applications where required by NFPA 13.
   a. Shutoff Duty: Use ball, butterfly, or gate valves.

2. Unlisted General-Duty Valves: For applications where UL-listed and FMG-approved valves are not required by NFPA 13.
   a. Shutoff Duty: Use ball, butterfly, or gate valves.
   b. Throttling Duty: Use ball or globe valves.

3.6 JOINT CONSTRUCTION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 with wall thickness less than Schedule 40 unless approved by authorities having jurisdiction and threads are checked by a ring gage and comply with ASME B1.20.1.

C. Use of saddle style tees is not acceptable.

D. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.
   1. All grooved couplings, fittings, gaskets, valves, and specialties shall be the product of a single manufacturer.
2. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.

3.7 PIPING INSTALLATION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping installation.

B. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

C. Install unions adjacent to each valve in pipes NPS 2 and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.

D. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 and larger connections.

E. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.

F. Install sprinkler piping with drains for complete system drainage.

G. Hangers and Supports: Comply with NFPA 13 for hanger materials.
   1. Install sprinkler system piping according to NFPA 13, except use of “C” clamps, or beam clamps of “C” pattern, or any modification thereof, is prohibited for supporting pipes larger than NPS 2-1/2.
   2. Refer to Division 20 Section “Hangers and Supports” for additional requirements.

H. Fill wet-pipe sprinkler system piping with water.

3.8 VALVE INSTALLATION

A. Install listed fire-protection valves, unlisted general-duty 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.

3.9 SPRINKLER APPLICATIONS

A. Use the following sprinkler types:
   1. Rooms without Ceilings: Upright sprinklers.
   2. Rooms with Suspended Ceilings: Recessed sprinklers.
3. Sprinkler Finishes:
   a. Upright, Pendent 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.
   b. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.

4. Sprinkler Guards: For exposed sprinkler heads subject to damage.

3.10 SPRINKLER INSTALLATION
A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels and tiles.
B. Install sprinklers into flexible sprinkler drop fittings and install into bracket on ceiling grid. Install according to manufacturer’s instructions and NFPA, State, and local guidelines. Ceiling grid must meet requirements of ASTM C 635 and C 636, coordinate with ceiling installer.

3.11 CONNECTIONS
A. Install piping adjacent to equipment to allow service and maintenance.
B. Connect water-supply piping to fire-suppression piping.
C. Electrical Connections: Power wiring and fire alarm wiring are specified in Division 26.
D. Connect alarm devices to fire alarm.
E. Ground equipment according to Division 26 Section “Grounding and Bonding.”
F. Connect wiring according to Division 26 Section “Conductors and Cables.”
G. 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.

3.12 LABELING AND IDENTIFICATION
A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and in Division 20 Section “Mechanical Identification.”

3.13 FIELD QUALITY CONTROL
A. Perform the following field tests and inspections and prepare test reports:
1. **Leak Test**: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. **Test and adjust controls and safeties**: Replace damaged and malfunctioning controls and equipment.
3. **Flush, test, and inspect sprinkler systems** according to NFPA 13, “Systems Acceptance” Chapter.
4. **Flush, test, and inspect standpipe systems** according to NFPA 14, “System Acceptance” Chapter.
5. Verify that equipment hose threads are same as local fire department equipment.

B. Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.

C. Verify that specified tests of piping are complete.

D. Verify that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type.

E. Verify that sprinklers are correct types, have correct finishes and temperature ratings, and have guards as required for each application.

F. Energize circuits to electrical equipment and devices.

G. Adjust operating controls and pressure settings.

H. Coordinate with fire alarm tests. Operate as required.

I. Report test results promptly and in writing to Architect and authorities having jurisdiction.

### 3.14 CLEANING AND PROTECTION

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

C. Protect sprinklers from damage until Substantial Completion.

### 3.15 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves. Refer to Division 20 Section "Mechanical General Requirements."

END OF SECTION 21 11 00
SECTION 22 11 16
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 include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods” for materials and methods common to mechanical piping systems.
3. Division 20 Section “Hangers and Supports.”
4. Division 20 Section "Meters and Gages" for thermometers, pressure gages, and fittings.
5. Division 20 Section “Valves” for general duty valves.
6. Division 22 Section "Domestic Water Piping Specialties" for water distribution piping specialties.

1.2 SUMMARY

A. This Section includes domestic water piping inside the building.
1.3 PERFORMANCE REQUIREMENTS

A. Where not indicated on the Drawings, provide components and installation capable of producing domestic water piping systems with 125 psig, unless otherwise indicated.

1.4 SYSTEMS DESCRIPTION

A. Potable and non-potable domestic water piping system materials are scheduled on the Drawing.

B. Refer to Application Schedules on the Drawings for valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   2. Drain Duty: Hose-end drain valves.

C. Transition and special fittings with pressure ratings at least equal to piping rating may be used unless otherwise indicated.

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.


C. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
2.2 PIPING MATERIALS

A. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.3 COPPER TUBE AND FITTINGS

A. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper.
   2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
   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.

B. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.
   2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
   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.

2.4 VALVES

A. General-duty valves; and drain valves are specified in Division 20 Section "Valves."

B. Balancing valves are specified in Division 22 Section "Domestic water Piping Specialties."

PART 3 - EXECUTION

3.1 PIPING SYSTEM INSTALLATION

A. Basic piping installation requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

3.2 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

3.3 HANGER AND SUPPORT INSTALLATION

A. Pipe hanger and support devices are specified in Division 20 Section "Hangers and Supports." Install the following:
1. **Vertical Piping:** MSS Type 8 or Type 42, clamps.
2. **Individual, Straight, Horizontal Piping Runs:** According to the following:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer than 100 Feet: MSS Type 49, spring cushion rolls, if indicated.
3. **Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer:** MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. **Base of Vertical Piping:** MSS Type 52, spring hangers.

B. Install supports according to Division 20 Section "Hangers and Supports."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
   3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   4. NPS 2-1/2: 108 inches with 1/2-inch rod.
   5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
   6. NPS 6: 10 feet with 5/8-inch rod.
   7. NPS 8: 10 feet with 3/4-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Soft copper tube: Continuous support using v-shaped plastic pipe channel, maximum hanger spacing 8 feet with 3/8-inch rod.

H. Alternate support for copper tubing NPS 3/4 and smaller: Continuous support using v-shaped plastic pipe channel, maximum hanger spacing 8 feet with 3/8-inch rod.

I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

### 3.4 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 the following:
   1. **Plumbing Fixtures:** Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Fixtures."
2. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.5 FIELD QUALITY CONTROL

A. Inspect domestic water piping as follows:

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 24 hours 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 test or inspection, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test domestic water piping as follows:

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 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 150 psig. 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 required corrective action.

3.6 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 plugs used 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.

3.7 CLEANING AND DISINFECTION

A. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

B. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
   a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
   b. Fill and isolate system according to either of the following:
      1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
      2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
   c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
   d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities.

END OF SECTION 22 11 16
SECTION 22 11 19
DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”
   3. Division 20 Section "Meters and Gages" for thermometers, pressure gages, and flow meters in domestic water piping.
   4. Division 22 Section "Domestic Water Piping" for water meters.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig, unless otherwise indicated.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Field quality-control test reports.

C. Flow Reports and Settings: For calibrated balancing valves.

D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.
1.4 QUALITY ASSURANCE

A. NSF Compliance:
   2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; Conbraco Industries, Inc.
      b. FEBCO; a Division of Watts Water Technologies, Inc.
      c. Watts Water Technologies, Inc.; Watts Regulator Co.
      d. Zurn Plumbing Products Group; Wilkins Div.
   2. Standard: ASSE 1012.
   3. Operation: Continuous-pressure applications.
   5. Body: Bronze.
   7. Finish: Chrome plated.

B. Reduced-Pressure-Principle Backflow Preventers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Apollo Valves; Conbraco Industries, Inc.
      b. FEBCO; a Division of Watts Water Technologies, Inc.
      c. Watts Water Technologies, Inc.; Ames Fire & Waterworks.
      d. Watts Water Technologies, Inc.; Watts Regulator Co.
      e. Zurn Plumbing Products Group; Wilkins Div.
   3. Operation: Continuous-pressure applications.
   4. Pressure Loss: 12 psig maximum, through middle 1/3 of flow range.
   5. Size: Refer to plans.
   6. Body: Bronze for NPS 2 and smaller; cast-iron or ductile-iron, with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
8. Configuration: Designed for horizontal, straight through flow.
9. Accessories:
   a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller; gate-type with flanged ends on inlet and outlet of NPS 2-1/2 and larger.
   c. Y-Pattern strainer and soft-seated check valve.

2.2 WATER HAMMER ARRESTERS

A. Water Hammer Arresters (Copper Tube Type):
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. MIFAB, Inc.
      b. PPP Inc.
      c. Sioux Chief Manufacturing Company, Inc.
      d. Tyler Pipe; Wade Div.
      e. Watts Drainage Products Inc.
   3. Type: Copper tube with piston.
   4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

B. Water Hammer Arresters (Metal Bellows Type):
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. AMTROL, Inc.
      b. Josam Company.
      c. MIFAB, Inc.
      e. Tyler Pipe; Wade Div.
      f. Watts Drainage Products Inc.
      g. Zurn Plumbing Products Group; Specification Drainage Operation.
   3. Type: Precharged stainless steel bellows.
   4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.
2.3 AIR VENTS

A. Bolted-Construction Automatic Air Vents:
   1. Body: Bronze.
   2. Pressure Rating: 125-psig minimum pressure rating at 140 deg F.
   3. Float: Replaceable, corrosion-resistant metal.

B. Welded-Construction Automatic Air Vents:
   2. Pressure Rating: 150-psig minimum pressure rating.
   3. Float: Replaceable, corrosion-resistant metal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
   1. Locate backflow preventers in same room as connected equipment or system.
   2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
   3. Do not install bypass piping around backflow preventers.

C. Install temperature-actuated water mixing valves with strainers, and check stops or shutoff valves on inlets and with shutoff valve on outlet.
   1. Install thermometers and water regulators if specified.
   2. Install cabinet-type units recessed in or surface mounted on wall as specified.

D. Install water hammer arresters in water piping according to PDI-WH 201.
E. Install air vents at high points of water piping.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 20, 21, 22 and 23 Sections. Drawings indicate general arrangement of piping and specialties.

3.3 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
   1. Intermediate atmospheric-vent backflow preventers.
   2. Reduced-pressure-principle backflow preventers.

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:
   1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device’s reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves as follows:
   1. Set calibrated balancing valves at calculated presettings.
   2. Measure flow at all stations and adjust where necessary.
   3. Record settings and mark balancing devices.

C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 22 11 19
SECTION 22 13 16
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 include the following:
   1. Division 20 Section “Mechanical General Requirements”.
   2. Division 20 Section “Basic Mechanical Materials and Methods”.
   3. Division 22 Section “Drainage Piping Specialties”.
   4. Division 22 Section "Chemical-Waste Piping" for chemical-waste and vent piping systems.

1.2 DEFINITIONS
B. EPDM: Ethylene-propylene-diene terpolymer rubber.
C. LLDPE: Linear, low-density polyethylene plastic.
D. NBR: Acrylonitrile-butadiene rubber.
E. PE: Polyethylene plastic.
F. PVC: Polyvinyl chloride plastic.
G. TPE: Thermoplastic elastomer.

1.3 SYSTEMS DESCRIPTIONS
A. Sanitary waste and vent piping system materials are scheduled on the Drawing.

1.4 SUBMITTALS
A. Product Data: For pipe, tube, fittings, and couplings.
B. Field quality-control inspection and test reports.

1.5 QUALITY ASSURANCE
A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
B. Cast-iron soil pipe shall be marked with the collective trademark of Cast Iron Soil Pipe Institute (CISPI).

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. Do not proceed with interruption of sanitary waste service without Owner’s written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS
A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class.
B. Gaskets: ASTM C 564, rubber.

2.3 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.
B. CISPI, Hubless-Piping Couplings:
   1. Manufacturers:
      a. ANACO-Husky.
      b. Ferguson Enterprises, Inc.; ProFlo (Private labeled Ideal Clamp Products, Inc.).
      c. Ideal Clamp Products, Inc.; a Tomkins Company.
      d. Mission Rubber Company; a division of MCP Industries, Inc.
      e. Tyler Pipe.
   3. Description: NSF certified for compliance with CISPI 310. Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
C. Heavy-Duty, Hubless-Piping Couplings:
   1. Manufacturers:
      a. ANACO-Husky; SD 4000.
      b. Clamp-All Corp; 125.
      c. Ferguson Enterprises, Inc.; ProFlo (Private labeled Ideal Clamp Products, Inc.).
      d. Ideal Clamp Products, Inc.; a Tomkins Company.
   3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
   1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
   1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   2. Gaskets: AWWA C111, rubber.

C. Flanges: ASME 16.1, Class 125, cast iron.

2.5 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Hard Copper Tube: ASTM B 88, Types L, water tube, drawn temper.
   2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
   3. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.6 SPECIAL PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

   1. Manufacturers:
      b. Fernco, Inc.
      c. Logan Clay Products Company (The).
      d. Mission Rubber Co.
      e. NDS, Inc.
      f. Plastic Oddities, Inc.

   2. Sleeve Materials:
      b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
      c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:
   b. Mission Rubber Co.

C. Rigid, Unshielded, Nonpressure Pipe Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:
   a. ANACO.

D. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.

1. Manufacturers:
   b. Dresser, Inc.; DMD Div.
   c. Ford Meter Box Company, Inc. (The); Pipe Products Div.
   d. JCM Industries, Inc.
   e. Smith-Blair, Inc.
   f. Viking Johnson.

2. Center-Sleeve Material: Manufacturer's standard.
3. Gasket Material: Natural or synthetic rubber.
4. Metal Component Finish: Corrosion-resistant coating or material.

E. Wall-Penetration Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

1. Manufacturers:
   a. SIGMA Corp.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 02 Section "Earthwork" for excavating, trenching, and backfilling.
3.2 PIPING SYSTEM INSTALLATION

A. Sanitary sewer piping outside the building is specified in Division 02 Section "Sanitary Sewerage."

B. Basic piping installation requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

C. 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."

D. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

E. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
   1. Building Sanitary Drain: 1/8-inch per foot downward in direction of flow, unless otherwise noted.
   2. Horizontal Sanitary Drainage Piping: 1/8-inch per foot downward in direction of flow, unless otherwise noted.
   3. Vent Piping: 1/8-inch per foot down toward vertical fixture vent or toward vent stack.

3.3 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."


C. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead and oakum calked joints.

D. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

3.4 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 20 Section "Hangers and Supports." Install the following:
1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Install individual, straight, horizontal piping runs according to the following:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 20 Section "Hangers and Supports."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   4. NPS 6: 60 inches with 3/4-inch rod.
   5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.

F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4: 84 inches with 3/8-inch rod.
   2. NPS 1-1/2: 108 inches with 3/8-inch rod.
   3. NPS 2: 10 feet with 3/8-inch rod.
   4. NPS 2-1/2: 11 feet with 1/2-inch rod.
   5. NPS 3: 12 feet with 1/2-inch rod.
   6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
   7. NPS 6: 12 feet with 3/4-inch rod.
   8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4: 72 inches with 3/8-inch rod.
   2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   3. NPS 2-1/2: 108 inches with 1/2-inch rod.
   4. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
   5. NPS 6: 10 feet with 5/8-inch rod.
   6. NPS 8: 10 feet with 3/4-inch rod.
3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

   1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
   2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
   3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
   4. 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 and larger.

3.6 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 20 Section "Mechanical Identification."

3.7 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. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

3.8 CLEANING

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.

END OF SECTION 22 13 16
SECTION 22 13 19
DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL .............................................................................................................................................. 1
1.1 RELATED DOCUMENTS ...................................................................................................................... 1
1.2 DEFINITIONS ........................................................................................................................................ 1
1.3 SUBMITTALS ......................................................................................................................................... 2
1.4 QUALITY ASSURANCE........................................................................................................................ 2

PART 2 - PRODUCTS ........................................................................................................................................... 2
2.1 CAST-IRON CLEANOUTS ................................................................................................................... 2
2.2 FLOOR DRAINS ................................................................................................................................... 4
2.3 TRAP SEAL PROTECTION DEVICES ................................................................................................... 5
2.4 MISCELLANEOUS DRAINAGE PIPING SPECIALTIES ........................................................................ 5

PART 3 - EXECUTION .......................................................................................................................................... 6
3.1 INSTALLATION ..................................................................................................................................... 6
3.2 CONNECTIONS .................................................................................................................................. 7
3.3 FIELD QUALITY CONTROL ................................................................................................................. 7
3.4 PROTECTION ....................................................................................................................................... 7

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 include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 DEFINITIONS


B. FOG: Fats, oils, and greases.

C. FRP: Fiberglass-reinforced plastic.

D. HDPE: High-density polyethylene plastic.

E. PE: Polyethylene plastic.

F. PP: Polypropylene plastic.

G. PUR: Polyurethane plastic.

H. PVC: Polyvinyl chloride plastic.
1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories.

B. Shop Drawings:

C. Field quality-control test reports.

D. Operation and Maintenance Data: For drainage piping specialties to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a NRTL acceptable to authorities having jurisdiction, and marked for intended use.


PART 2 - PRODUCTS

2.1 CAST-IRON CLEANOUTS

A. Size: Cleanouts shall be same nominal size as the pipe they serve up to 4 inches. For pipes larger than 4 inches nominal size, minimum size of cleanout shall be 4 inches.

B. Exposed Cast-Iron Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. MIFAB, Inc.; C1460.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.
4. Closure: Countersunk or raised-head, brass or bronze plug with tapered threads.
C. Cast-Iron Floor Cleanouts (Not-On-Grade Interior Floor Areas):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. MIFAB, Inc.; C-1100-C-R-34.
   c. Sioux Chief Manufacturing Company, Inc.
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products Inc.
   g. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M.
3. Type: Adjustable housing.
4. Body or Ferrule: Cast iron.
5. Clamping Device: Required.
7. Closure: Brass, bronze, or plastic plug with tapered threads.
8. Adjustable Housing Material: Cast iron with threads, set-screws or other device.
9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy with scoriated cover in service areas, and recessed cover to accept floor finish material in finished floor areas.
10. Frame and Cover Shape: Round.
11. Top Loading Classification: Medium Duty.
12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

D. Cast-Iron Wall Cleanouts (Finished Wall Areas):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. MIFAB, Inc.; C1460-RD.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M. Include wall access.
3. Body: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.
4. Closure: Countersunk or raised-head, drilled-and-threaded bronze or brass plug with tapered threads.
5. Wall Access: Round, deep, chrome-plated bronze flat, chrome-plated brass or stainless-steel cover plate with screw.
2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains (Toilet Rooms, Labs, and Janitor's Closet) FD-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. MIFAB, Inc.
   e. Tyler Pipe; Wade Div.
   f. Watts Drainage Products Inc.
   g. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.6.3.
5. Seepage Flange: Required.
7. Outlet: Bottom.
11. Top Shape: Round, with vandal proof screws.
12. Dimensions of Top or Strainer: 7 inch diameter.
15. Inlet Fitting: Gray iron, with spigot outlet.
16. Trap-Seal Primer Valve Fitting:
   a. Description: Cast iron, with spigot inlet and spigot outlet, and trap-seal primer valve connection.
   b. Size: Same as floor drain outlet with NPS 1/2 side inlet.

B. Cast-Iron Floor Sink Drains FS-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. MIFAB, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.3.
5. Seepage Flange: Required.
7. Outlet: Bottom.
9. Top or Strainer Material: Gray iron.
10. Top of Body and Strainer Finish: Gray iron.
11. Top Shape: Square.
12. Dimensions of Top or Strainer: 10 inch by 10 inch, having 28 square inches of free area, and with flat bottom strainer.
14. Outlet Connection: Gray iron, with spigot outlet.
15. Trap-Seal Primer Valve Fitting:
   a. Description: Cast iron, with spigot inlet and spigot outlet, and trap-seal primer valve connection.
   b. Size: Same as floor drain outlet with NPS 1/2 side inlet.

2.3 TRAP SEAL PROTECTION DEVICES

A. Barrier Type Trap Seal Protection Devices:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. SureSeal Manufacturing; Inline Floor Drain Trap Sealer.
   5. Size: 2 inch, 3 inch, 3-1/2 inch, or 4 inch.

2.4 MISCELLANEOUS DRAINAGE PIPING SPECIALTIES

A. Air-Gap Fittings:
   1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
   2. Body: Bronze or cast iron.
   3. Inlet: Opening in top of body.
   4. Outlet: Larger than inlet.
   5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
   4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Position floor drains for easy access and maintenance.
   2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
      Set with grates depressed according to the following drainage area radii:
         a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than $1/4$-inch total depression.
         b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
         c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
   3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
   4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

F. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

G. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.
H. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 13 19
SECTION 22 42 00
PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 22 Section “Domestic Water Piping Specialties” for backflow preventers; individual-fixture, water tempering valves; and specialty fixtures not included in this Section.
4. Division 22 Section “Drainage Piping Specialties” for floor drains, and specialty fixtures not included in this Section.

1.2 DEFINITIONS


B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.
D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

F. FRP: Fiberglass-reinforced plastic.

G. PMMA: Polymethyl methacrylate (acrylic) plastic.

H. PVC: Polyvinyl chloride plastic.


1.3 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For plumbing fixtures and trim to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.


E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with applicable ANSI, ASME, ASSE, ASTM, ICC, NSF, and UL standards and other requirements specified for plumbing fixtures, trim, fittings, components, and features.

PART 2 - PRODUCTS

2.1 FIXTURE SUPPLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. BrassCraft; a Masco Company.
   3. Any of the approved plumbing fixture manufacturers.

B. Description: Chrome-plated brass, loose-key or screwdriver angle stops with brass stems; rigid, chrome-plated copper risers; and chrome-plated wall flanges.

2.2 ARCHITECT-FURNISHED FIXTURES

A. SK-1: Fume Hood.
   1. Provide the following:
      a. Direct-Connected Drain Piping: NPS 1-1/4 polypropylene tailpiece and tubular waste to wall with wall flange.
      b. Point of Use Dilution Trap: Required.
      c. Fixture Supplies: CW, G, A.

2.3 COMBINATION UNITS

A. Combination Units, EES-1:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Bradley Corporation; S19314 Series.
      b. Guardian Equipment Co.
      c. Haws Corporation.
      d. Speakman Company.
   2. Description: Plumbed, accessible, freestanding, with emergency shower and eyewash equipment.
a. Piping: Galvanized steel.
   1) Unit Supply: NPS 1-1/4 minimum from top or side.
   2) Unit Drain: Outlet at side near bottom.
   3) Shower Supply: NPS 1 with flow regulator and stay-open ball valve.
   4) Eyewash Supply: NPS 1/2 with flow regulator and stay-open ball valve.

b. Shower Capacity: Deliver potable water at rate not less than 20 gpm for at least 15 minutes.
   1) Valve Actuator: Pull rod.
   2) Shower Head: 8-inch minimum diameter, plastic.

c. Eyewash Equipment: With capacity to deliver potable water at rate not less than 0.4 gpm for at least 15 minutes.
   1) Valve Actuator: Paddle and Treadle.
   2) Receptor: Stainless-steel bowl.

2.4 WATER-TEMPERING EQUIPMENT

A. Water-Tempering Equipment, MV-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Armstrong International, Inc. (RADA)
   b. Bradley Corporation.
   c. Guardian Equipment Co.
   d. Haws Corporation.
   e. Lawler Manufacturing Co., Inc.; Model 911 E.
   f. Leonard Valve Company.
   g. Powers, a Watts Industries Co.; Model ES 200.
   h. Speakman Company.

2. Description: Factory-fabricated, hot- and cold-water-tempering equipment with thermostatic mixing valve.

   a. Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water at a single emergency eye/face wash and drench shower unit, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

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

3.2 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install counter-mounting fixtures in and attached to casework.

C. Install fixtures level and plumb according to roughing-in drawings. Install accessible fixtures at heights required by local codes.

D. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Fixtures with flushometer valves, and faucets or valves with integral stops.

E. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

F. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

G. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.

2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

H. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 20 Section "Basic Mechanical Materials and Methods."

I. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 7 Section "Joint Sealants."
3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Individual water line branches, waste lines, vents, and traps for connection to individual fixtures, fixture fittings and specialties shall be in accordance with the schedule on the Drawings.

D. Ground equipment according to Division 26 Section “Grounding and Bonding.”

E. Connect wiring according to Division 26 Section “Conductors and Cables.”

3.4 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow and stream.

C. Adjust flow at laboratory faucets having serrated nozzles to prevent splashing.

D. Replace washers and seals, or cartridges of leaking and dripping faucets and stops.

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers’ recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 00
SECTION 22 61 13
LABORATORY AIR, GAS, AND VACUUM PIPING

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

B. Related Sections include the following:
   1. Division 11 Section “Laboratory Fume Hoods” for laboratory fume hood outlets requiring laboratory air or vacuum service.
   2. Division 12 Section "Metal Laboratory Casework" for metal casework and outlets requiring laboratory air or vacuum service.
   3. Division 20 Section “Mechanical General Requirements.”
   4. Division 20 Section “Basic Mechanical Materials and Methods.”
   5. Division 20 Section "Meters and Gages" for thermometers and pressure gages.
6. Division 22 Section "Laboratory Air and Vacuum Equipment" for laboratory air and vacuum equipment and related accessories.
7. Division 20 Section "Valves."

1.2 SUMMARY

A. This Section includes piping for laboratory gases and vacuum, and related specialties.

1. Laboratory Gases:
   a. Compressed-air.
   b. Natural gas.

1.3 DEFINITIONS

A. PTFE: Polytetrafluoroethylene plastic.
B. TFE: Tetrafluoroethylene plastic.
C. CGA: Compressed Gas Association.
D. BAS: Building Automation System.

1.4 PERFORMANCE REQUIREMENTS

A. General: Provide laboratory gas and vacuum piping systems that comply with NFPA 99, Level 4 requirements for materials and installation.
B. Components and installation shall be capable of withstanding the following minimum pressure, unless otherwise indicated:
   1. Laboratory Gas Piping: 125 psig.
   2. Laboratory Vacuum Piping: 15 psig.

1.5 SYSTEMS DESCRIPTIONS

A. Laboratory Gases And Vacuum Piping Systems: Use tubing, fittings, and joining methods according to the following applications:
   1. Interior and Underslab Laboratory Gases Pressure Piping: Use Type K, hard copper tubing, wrought copper pressure fittings, and brazed joints.
   2. Interior and Underslab Laboratory Vacuum: Use Type L, hard copper tubing, wrought copper pressure fittings, and soldered joints.
   3. Interior Liquid Nitrogen Piping: Use factory pre-insulated piping system.

B. Drawings indicate valve types to be used for laboratory air and vacuum piping. If specific valve types are not indicated, the following requirements apply:
   1. Shutoff Valves NPS 3 and Smaller: Copper-alloy ball valve.
2. Shutoff Valves NPS 4 and Larger: Stainless-steel ball valve.
3. Check Valves NPS 3 and Smaller: Bronze.
4. Check Valves NPS 4 and Larger: Cast iron.
5. Zone Valves: With copper-tube extensions and gage.

1.6 SUBMITTALS

A. Product Data: For the following:
   1. Laboratory gas and vacuum tubing and fittings.
   2. Laboratory gas and vacuum valves and valve boxes.
   3. Alarm system components.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Coordination Drawings: For laboratory gas and vacuum systems. Include relationship to other services that serve same work area.

D. Brazing Certificates: As required by ASME Boiler and Pressure Vessel Code, Section IX, or AWS B2.2.

E. Piping Material Certification: Signed by Installer certifying that laboratory gas and vacuum piping materials comply with NFPA 99 requirements.

F. Qualification Data: For testing agency.

G. Field quality-control test reports.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

B. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a NRTL acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NFPA 51, Oxygen-fuel Gas System for Welding, Cutting, and Allied Processes.

E. Comply with NFPA 54, "National Fuel Gas Code."

F. Comply with NFPA 70, "National Electrical Code."

H. Comply with UL 544, "Medical and Dental Equipment," for laboratory gas and vacuum specialties.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBES, AND FITTINGS

A. Copper Tube: ASTM B 819, Type K or L, seamless, drawn-temper, medical gas tube that has been factory cleaned, purged, and sealed for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and blue for Type L tube.

1. Fittings: Factory cleaned, purged, and bagged for oxygen service according to ASTM B 819 or field cleaned, purged, and bagged as specified in "Preparation" Article in Part 3.

   a. Copper Pressure Fittings: ASME B16.22, wrought-copper solder-joint pressure type or MSS SP-73, wrought copper with dimensions for brazed joints.
   c. Copper Unions: ASME B16.22 or MSS SP-123.

B. Flexible Pipe Connectors: Corrugated-bronze inner tubing with bronze wire-braid covering and ends brazed to inner tubing.

1. Cleaning: Factory cleaned, purged, and sealed or bagged for oxygen service according to ASTM B 819 or field cleaned, purged, and sealed or bagged as specified in "Preparation" Article in Part 3.
2. Working-Pressure Rating: 200 psig minimum.
3. End Connections NPS 2 and Smaller: Threaded copper pipe or plain-end copper tube.
4. End Connections NPS 2-1/2 and Larger: Flanged copper alloy.
5. Manufacturers:

   a. ANAMET Inc.
   b. Flex-Hose Co., Inc.
   c. Flexicraft Industries.
   d. Hyspan Precision Products, Inc.
   e. Metraflex, Inc.
2.3 FACTORY PRE-INSULATED PIPING SYSTEM

A. Copper Tubing: ASTM B88, Type K, hard drawn.
   1. Fittings: ANSI B16.18 cast bronze or ANSI B16.22 wrought copper.

B. Factory Preparation: Factory clean all piping, valves, fittings and other components of system. Systems shall be thoroughly clean of oil, grease, and other readily oxidizable materials as if for oxygen service. After cleaning, particular care shall be exercised in the storage and handling of such material. Such material shall be temporarily capped or plugged to prevent recontamination before final assembly. Just prior to final assembly, such material shall be examined internally for contamination and shall be recleaned if necessary.

C. Insulation: Three inch thickness, rigid 90 to 95 percent closed cell polyurethane with 1.9 to 2.1 pounds per cubic foot density and a coefficient of thermal conductivity of 0.14 BTU/(Hr.)(Sq.Ft.)(F/in) at 73 degrees F. Jacket shall be PVC with a minimum thickness of .060 inch.

D. Minimum System Pressure Rating: 125 psig

E. Isolation Valves: Globe valves.

F. Manufacturers:
   1. Insul-Tek.
   2. Rovanco.
   3. Thermacor.

2.4 JOINING MATERIALS

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for joining materials not in this Section.

B. Brazing Filler Metals: AWS A5.8, BCuP series alloys. Flux is prohibited unless used with bronze fittings.

C. Threaded-Joint Tape: PTFE.

D. Gasket Material: ASME B16.21, nonmetallic, flat, asbestos free, and suitable for service.

2.5 VALVES

A. Valves, General: Refer to Division 20 Section "Valves."

B. Copper-Alloy Ball Valves: Factory cleaned for oxygen service and bagged. MSS SP-110, 3-piece-body, full-port ball valve rated for 300-psig minimum working pressure; with chrome-
plated brass ball, PTFE or TFE seats, blowout-proof stem, threaded or solder-joint ends, and locking-type handle designed for quarter turn between opened and closed positions.

1. Manufacturers:
   b. Amico Corporation.
   c. Beacon Medaes.
   d. Conbraco Industries, Inc., Apollo Ball Valves.
   e. Milwaukee Valve Company.
   f. NIBCO INC.
   g. Squire-Cogswell/Aeros Instruments.

C. Bronze Check Valves: Straight-through-pattern, spring-loaded ball check valve; designed for 300-psig minimum working pressure.

D. Forged Steel Check Valves: Class 800, forged steel body, stainless steel trim, swing check valve, with socket weld ends.

E. Natural Gas Valves, NPS 3 and Smaller: Bronze or brass body with AGA or CSA stamp, UL listed or FM approved for service, ball type with chrome-plated brass ball and lever handle, or butterfly valve with stainless-steel disc and fluorocarbon elastomer seal and lever handle; 125-psig minimum pressure rating.

   1. Manufacturers:
      a. Conbraco Industries, Inc.
      b. Milwaukee Valve Company.
      c. NIBCO INC.

2. Tamperproof Feature: Include design for locking.

F. Safety Valves: Bronze body with settings to match system requirements.

   1. Pressure Relief Valves: ASME construction, poppet type.
   2. Vacuum Relief Valves: Specialty manufacturer's option.

G. Pressure Regulators: Bronze body and trim; spring-loaded, diaphragm-operated, relieving type; manual pressure-setting adjustment; rated for 250-psig minimum inlet pressure; and capable of controlling delivered air pressure within 0.5 psig for each 10-psig inlet pressure.

H. Automatic Drain Valves: Corrosion-resistant metal body and internal parts, 200-psig minimum working-pressure rating, and capable of automatic discharge of collected condensate.

2.6 MASTER GAS SHUT OFF VALVE AND VALVE BOX

A. Manufacturers:
1. BeaconMedaes.
2. Metcraft Industries Inc.; A606 Master Gas Valve Box.
3. Squire-Cogswell/Aeros Instruments Inc.; Healthcair.

B. Master Gas Shut-Off Valve Box: Formed steel, stainless steel, or formed or extruded aluminum for recessed or surface mounting as indicated on the drawings, in sizes to permit manual operation of valves, with holes for piping and anchors.

1. Interior Finish: Factory-applied white enamel.
2. Cover Plate: Aluminum or extruded-anodized aluminum or stainless steel with NAAMM AMP 503, No. 4 finish.
3. Hinged, key locking door with continuous stainless piano type hinge. Door labeled "MASTER GAS VALVE."
4. Valve-Box Windows: Clear or tinted transparent plastic.

C. Master gas shut off valve: Natural gas valve as specified in this Section.

D. Provide union ahead of valve within box.

E. Exposed gas piping located within master gas valve box shall be painted yellow. Refer to Division 20 Section "Mechanical Identification" and Division 09.

2.7 LABORATORY PRESSURE REGULATORS

A. Pressure regulators shall be compact design, die cast aluminum body, balanced poppet design, locking adjustment knob, with convoluted diaphragm. Regulators for nitrogen system shall have 0-60 psi gauge. Regulators for compressed air shall have 0-125 psi gauge.

B. Manufacturer:

1. Coil Hose Pneumatics 26R3.

2.8 TEST GAS

A. Description: Oil-free dry nitrogen complying with CGA P-9, for purging and testing of piping.

2.9 IDENTIFICATION

A. Refer to Division 20 Section "Mechanical Identification" for identification of piping, valves, gages, alarms, and specialties.

PART 3 - EXECUTION

3.1 PREPARATION

A. Interruption of Existing Laboratory Air and Vacuum Services: Do not interrupt laboratory air and vacuum services to facilities occupied by Owner or others unless permitted under the
following conditions and then only after arranging to provide temporary laboratory air and vacuum services according to requirements indicated:

1. Notify owner not less than two days in advance of proposed interruption of laboratory air services.
2. Do not proceed with interruption of laboratory air services without owner’s written permission.

B. Cleaning of Piping: If factory-cleaned and -capped laboratory air and vacuum piping is not available or if precleaned piping must be recleaned because of exposure, perform the following procedures:

1. Clean laboratory air and vacuum tubes and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
2. Wash laboratory air and vacuum piping and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
   a. Scrub to ensure complete cleaning.
   b. Rinse with clean, hot water to remove cleaning solution.

3.2 PIPING SYSTEM INSTALLATION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping installation.

B. Install thermometers and pressure gages according to Division 20 Section "Meters and Gages."

C. Install flexible pipe connector at each connection to laboratory air and vacuum equipment.

D. Purge laboratory gas and vacuum piping, using oil-free dry nitrogen, after installing piping but before connecting to gages.

E. Install underslab laboratory air, gas, and vacuum piping in protective conduit fabricated with PVC pipe and fittings.

3.3 VALVE INSTALLATION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping and valve installation.

B. Install shutoff valve at each connection to and from laboratory air and vacuum specialties and equipment.

C. Install check valves to maintain correct direction of fluid flow to and from laboratory air and vacuum specialties and equipment.
D. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

E. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.
   1. Pressure System Valves: Install pressure gage downstream from valve.
   2. Suction System Valves: Install vacuum gage upstream from valve.

F. Install pressure safety and vacuum relief valves where recommended by specialty manufacturers.

3.4 JOINT CONSTRUCTION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.


3.5 HANGER AND SUPPORT INSTALLATION

A. Refer to Division 20 Section "Hangers and Supports" for pipe hanger and support devices. Install the following:
   1. Vertical Piping: MSS Type 8 or 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs: According to the following:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
      b. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.
      c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 20 Section "Hangers and Supports."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

E. Install supports and anchors according to Division 20 Section "Hangers and Supports," with spacing according to NFPA 99.

F. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
LABORATORY AIR, GAS AND VACUUM PIPING

1. NPS 1/4: 60 inches with 3/8-inch rod.
2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
4. NPS 1: 96 inches with 3/8-inch rod.
6. NPS 1-1/2: 10 feet with 3/8-inch rod.
7. NPS 2: 11 feet with 3/8-inch rod.
8. NPS 2-1/2: 13 feet with 1/2-inch rod.
9. NPS 3: 14 feet with 1/2-inch rod.
10. NPS 3-1/2: 15 feet with 1/2-inch rod.
11. NPS 4: 16 feet with 1/2-inch rod.
12. NPS 5: 18 feet with 1/2-inch rod.
13. NPS 6 NPS: 20 feet with 5/8-inch rod.
14. NPS 8: 23 feet with 3/4-inch rod.

G. Install supports for vertical copper tubing every 10 feet.

H. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to specialties and equipment to allow service and maintenance.

C. Specialty and Equipment Flanged Connections: Use cast-copper-alloy companion flange with gasket and brazed joint for connection to copper tube.

D. Ground specialties and equipment according to Division 26 Section "Grounding and Bonding."

E. Connect wiring according to Division 26 Section "Conductors and Cables."

F. 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.

3.7 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for laboratory air and vacuum piping systems. Refer to Division 20 Section "Mechanical Identification" for labeling and identification materials.
B. Captions and Color-Coding: Comply with ASME (ANSI) A13.1 unless otherwise indicated.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Agency: Engage a qualified independent testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

C. Perform the following field tests and inspections and prepare test reports:

1. Inspect, test, and certify completed laboratory gas and vacuum systems according to requirements specified. Inspect, test, and certify each piping system, including specialties, alarm system, safety devices, and source equipment.

2. Provide oil-free dry nitrogen, materials, and equipment required for testing.

3. Laboratory Gas Piping Testing: Owner to witness all tests. 72 hour written notice required. Use oil-free dry nitrogen, unless otherwise indicated, and perform procedures and tests as indicated. Include the following:

   a. Piping Integrity Tests:

      1) Blow Down: Clear piping before connecting service connections or outlets.

      2) Initial Pressure Tests: Subject each piping section to test pressure of 1.5 times system working pressure, but not less than 150 psig, before attaching system components, after installing station outlets with test caps (if supplied) in place, and before concealing piping system. Maintain test until joints are examined for leaks by means of soapy water. Repair leaks with new materials and retest systems.

      3) Purge Tests: Perform heavy intermittent purging of piping and full-flow purging of service connections.

   b. Verification and Final Testing: Activate systems with compressed air at normal operating pressure.

      1) Standing-Pressure Tests: Install assembled system components after testing individual systems as specified above. Subject systems to 24-hour standing-pressure test. Verify that pressure differences comply with required calibration. Repair leaks with new materials and retest systems.

      2) Pressure Relief Valve Tests: Verify proper valve operation.

      3) Cross-Connection Tests: Activate only compressed-air system. Verify that air flows from each laboratory air outlet and does not flow from vacuum inlets. Repeat cross-connection test for laboratory vacuum system.


      5) Labeling: Verify correct labeling.
4. Laboratory Vacuum Piping Testing: Use oil-free dry nitrogen, unless otherwise indicated, and perform procedures and tests as indicated. Include the following:
   a. Blow Down: Clear piping before connecting service connections or inlets.
   b. Pressure Tests: Subject each piping section to test pressure of 15 psig for 24 hours. Verify that pressure drop does not exceed 5 psig. Repair leaks with new materials and retest systems.
   c. Cross-Connection Tests: Perform as part of laboratory air piping testing.
   d. Labeling: Verify correct labeling.

5. Test and adjust controls and safeties.

D. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:

1. Inspections performed.
2. Procedures, materials, and gases used.
3. Test methods used.
4. Results of tests.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain laboratory air and vacuum alarm system. Refer to Division 1 Section “Closeout Procedures.”

END OF SECTION 22 61 13
SECTION 22 61 19
LABORATORY VACUUM 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. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”
3. Division 22 Section “Laboratory Air and Vacuum Piping" for compressed-air and vacuum piping, valves, alarms, and related specialties.

1.2 SUMMARY

A. This Section includes laboratory air and vacuum equipment and related accessories.
1.3 DEFINITIONS

A. Actual Air: Air delivered from air compressors. Flow rate is delivered compressed air measured in acfm.

B. Expanded Air: Air delivered from vacuum pumps. Flow rate is delivered expanded air measured in ecfm.

C. Standard Air: Free air at 68 deg F and 1 atmosphere (29.92 in. Hg) before compression or expansion and measured in scfm.

1.4 PERFORMANCE REQUIREMENTS

A. Laboratory air and vacuum equipment shall comply with NFPA 99, Level 4 requirements for laboratories in healthcare facilities.

1.5 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following laboratory air and vacuum equipment:

1. Vacuum pumps, including receivers and outlet filters.

B. Shop Drawings:

1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.

2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

3. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.


C. Product Certificates: Certificates of shop inspection and data report for receiver tanks as required by ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. Qualification Data: For Installer.

E. Startup service reports.

F. Operation and Maintenance Data: For the following laboratory air and vacuum equipment and accessories to include in emergency, operation, and maintenance manuals:

1. Vacuum pumps.
1.6 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative of laboratory vacuum equipment manufacturer for both installation and maintenance of units required for this Project.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of laboratory air and vacuum equipment and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a NRTL acceptable to authorities having jurisdiction, and marked for intended use.

D. ASME Compliance: Fabricate and label receiver tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

E. Comply with NFPA 70, "National Electrical Code."


G. Comply with UL 544, "Medical and Dental Equipment."

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for concrete bases. Refer to Division 3 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:

   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PACKAGED LABORATORY VACUUM PUMPS AND RECEIVERS

A. Description: Factory-assembled, -wired, -piped, and -tested; electric-motor-driven; air-cooled; continuous-duty vacuum pump and receivers for laboratory systems.

B. Control Panels: Automatic control station with load control and protection functions. Comply with NEMA ICS 2 and UL 508.
1. Mounting and Wiring: Factory installed and connected as an integral part of equipment package.
2. Enclosure: NEMA ICS 6, Type 12 control panel, unless otherwise indicated.
   a. Control Voltage: 120-V ac or less, using integral control power transformer.
   b. Motor Overload Protection: Overload relay in each phase.
   c. Starting Devices: Hand-off-automatic selector switch in cover of control panel, plus pilot device for automatic control.
4. Instrumentation: Include receiver vacuum gage, inlet-line vacuum gage, hour meter, discharge-air and coolant temperature gages, and control transformer.
5. Alarm Signal Device: For connection to master alarm panels to indicate when backup vacuum pump is operating.

C. Motors: Comply with requirements in Division 20 Section "Motors."

D. Receivers: Steel tank constructed according to ASME Boiler and Pressure Vessel Code, Section VIII, Division 1; and bearing appropriate code symbols. Include vacuum relief valve, vacuum gage, and automatic drain.
   1. Orientation: Vertical arrangement.
   2. Capacity: Refer to schedule on Drawings.
   3. Pressure Rating: 100 psig minimum and suitable for vacuum produced by vacuum pump(s).

E. Vacuum Pumps: Rotary-Vane as specified.

2.3 ROTARY-VANE LABORATORY VACUUM PUMPS

A. Oil-Sealed, Rotary-Vane Laboratory Vacuum Pumps: Simplex unit.
   1. Manufacturers:
      b. Beacon Medaes.
      c. Busch, Inc.
      d. Nash Elmo Industries.
      e. Squire-Cogswell/Aeros Instruments.
   2. Vacuum Pump(s): Nonpulsating, rotary sliding-vane type with oil-sealed sliding vanes.
      b. Number of Vacuum Pumps: One.
PART 3 - EXECUTION

3.1 PREPARATION

A. Clean equipment, accessories, and components that have not been cleaned for oxygen service and sealed or that are furnished unsuitable for laboratory applications, according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."

3.2 CONCRETE BASES

A. Install concrete bases for laboratory air and vacuum equipment. Concrete base is specified in Division 20 Section "Basic Mechanical Materials and Methods," and concrete materials and installation requirements are specified in Division 3.

3.3 EQUIPMENT INSTALLATION

A. Install laboratory vacuum equipment according to NFPA 99.

B. Install laboratory vacuum equipment on concrete bases. Set and connect units according to manufacturers’ written instructions. Install units level, plumb, and anchored to substrate in locations indicated. Maintain manufacturers’ recommended clearances. Orient equipment so controls and devices are accessible for servicing.

1. Anchor packaged equipment to concrete base according to manufacturers’ written instructions and criteria applicable to Project.

   a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.

   b. Install epoxy-coated anchor bolts for supported equipment; extend through concrete base and anchor into structural concrete floor.

   c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

   d. Install anchor bolts to elevations required for proper attachment to supported equipment.
e. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

C. Vibration Isolation: Install spring isolators with a minimum deflection of ½ inch. Vibration isolation devices and installation requirements are specified in Division 20 Section "Mechanical Vibration Controls."

D. Maintain manufacturer's recommended clearances for service and maintenance.

E. Install the following devices on laboratory vacuum equipment:
   1. Thermometer, Vacuum Gage, and Vacuum Relief Valve: Install on each vacuum receiver.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 20, 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Connect piping to vacuum pumps, and receivers, except safety relief valve connections, with flexible pipe connectors of materials suitable for service. Flexible pipe connectors and their installation are specified in Division 22 Section "Laboratory Air and Vacuum Piping."

D. Ground equipment according to Division 26 Section "Grounding and Bonding."

E. Connect wiring according to Division 26 Section "Conductors and Cables."

F. 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.

3.5 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for laboratory vacuum equipment. Refer to Division 20 Section "Mechanical Identification" for labeling and identification materials.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to test, inspect, and adjust components and equipment installation and to perform startup service.
B. Perform the following final checks:

1. Verify that specified tests of piping systems are complete.
2. Verify that potable-water supply connections to equipment have correct backflow preventer.
3. Check for piping connection leaks.
4. Check for lubricating oil in lubricated-type equipment.
5. Check belt drives for proper tension.
6. Verify that vacuum equipment filters and piping are clear.
7. Check for equipment vibration-control supports and flexible pipe connectors and verify that equipment is properly attached to substrate.
8. Check safety valves for correct settings. Ensure that settings are greater than air-compressor discharge pressure but not greater than rating of system components.
9. Check vacuum relief valves for correct settings.
10. Test operation of equipment safety controls and devices.
11. Drain receiver tanks.

C. Verify that laboratory vacuum equipment is installed and connected according to the Contract Documents.

D. Verify that electrical wiring installation complies with manufacturer's submittal and written installation requirements in Division 26 Sections.

E. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

F. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

G. Complete installation and startup checks according to manufacturer’s written instructions.

H. Prepare written report documenting testing procedures and results.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain laboratory air and vacuum equipment.

END OF SECTION 22 6119
SECTION 22 66 53
CHEMICAL-WASTE 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 include the following:
   1. Division 20 Section “Mechanical General Requirements”.
   2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 DEFINITIONS

A. PP: Polypropylene plastic.

B. HSCI: High silicone cast iron.

C. CPVC: Chlorinated polyvinyl chloride plastic.

D. CR: Chlorosulfonated polyethylene synthetic rubber.
E. EPDM: Ethylene-propylene-diene terpolymer rubber.
F. FPM: Vinylidene fluoride-hexafluoro propylene copolymer rubber.
G. HDPE: High-density polyethylene plastic.
H. PE: Polyethylene plastic.
I. PTFE: Polytetrafluoroethylene plastic.
J. PVC: Polyvinyl chloride plastic.
K. PVDF: Polyvinylidene fluoride plastic.
L. RTRF: Fiberglass (reinforced-thermosetting-resin fittings).

1.3 SYSTEMS DESCRIPTIONS
A. Chemical-waste piping system materials are scheduled on the Drawing.

1.4 SUBMITTALS
A. Product Data: For chemical-waste piping materials, components, and specialties and for neutralization systems.
B. Shop Drawings: Diagram power, signal, and control wiring.
C. Maintenance Data: For neutralization systems and tanks to include in maintenance manuals.

1.5 QUALITY ASSURANCE
A. Source Limitations: Obtain pipe, fittings, and joining materials for each piping system through one source from a single manufacturer.
   1. Exception: Piping from different manufacturers may be used in same system if indicated and suitable transition fittings matching both piping materials are used.
B. Piping materials shall bear label, stamp, or other markings of specified testing laboratory.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a NRTL acceptable to authorities having jurisdiction, and marked for intended use.
D. Comply with ASME B31.3, "Process Piping."
E. Comply with NFPA 70.
1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store piping and specialties with sealing plugs in ends or with end protection.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Neutralization-Tank Limestone: Equal to 200 percent of amount required for each tank sump initial charge. Furnish limestone in 50-lb bags.

2. Neutralization-System Limestone and Chemicals: For each neutralization system.
   a. Limestone: Equal to 500 percent of amount required for tank sump initial charge. Furnish limestone in 50-lb bags.
   b. Chemicals: Equal to 1000 percent of neutralizing chemicals required for filling tanks.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPES, TUBES, AND FITTINGS

A. PP Drainage Pipe and Fittings: ASTM F 1412, pipe extruded and drainage-pattern fittings molded, with Schedule 40 dimensions, from PP resin with fire-retardant additive complying with ASTM D 4101. Include fusion- and mechanical-joint ends.

1. Manufacturers:
   a. Fischer, George, Inc.
   b. Ipex Inc.
   c. Orion Fittings, Inc.
   d. Zurn Plumbing Products Group.

2. Exception: Pipe and fittings made from PP resin without fire-retardant additive may be used for underground installation.
2.3 JOINING MATERIALS

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for commonly used joining materials.

B. Couplings: Assemblies with combination of clamps, gaskets, sleeves, and threaded or flanged parts; compatible with piping and system liquid; and made by piping manufacturer for joining system piping.

C. Adapters and Transition Fittings: Assemblies with combination of clamps, couplings, adapters, gaskets, and threaded or flanged parts; compatible with piping and system liquid; and made for joining different piping materials.

D. Flanges: Assemblies of companion flanges gasket complying with ASME B16.21 and compatible with system liquid, and bolts and nuts.

2.4 SPECIALTIES

A. Plastic Dilution Traps: Corrosion-resistant PP, with mechanical-joint pipe connections and removable base.

1. Manufacturers:
   a. IPEX Co.
   c. Orion Fittings, Inc.
   d. Sloane, George Fischer, Inc.
   e. Town & Country Plastics, Inc.

2. Dilution Tanks: 1-gal. capacity, with clear base unless colored base is indicated. Include two NPS 1-1/2 top inlets and one NPS 1-1/2 side outlet.

B. PP Sink Outlets: NPS 1-1/2, with clamping device, stopper, and 7-inch- high overflow fitting.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 02 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 SPECIALTY INSTALLATION

A. Install neutralization tanks on smooth and level foundation or floor surface. Include full initial charge of limestone.
3.3 PIPING INSTALLATION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping installation.

B. Install piping next to equipment, accessories, and specialties to allow service and maintenance.

3.4 JOINT CONSTRUCTION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping joint construction. If specific joint construction is not indicated, follow piping manufacturer’s written instructions.

B. Plastic-Piping Electrofusion Joints: Make polyolefin drainage-piping joints according to ASTM F 1290.

C. Plastic-Piping, Heat-Fusion Joints: Make polyolefin pressure-piping joints according to ASTM D 2657.

D. Dissimilar-Material Piping Joints: Make joints using adapters compatible with both system materials.

E. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used unless otherwise indicated.

3.5 HANGER AND SUPPORT INSTALLATION

A. Refer to Division 20 Section "Hangers and Supports" for pipe hanger and support devices. Install the following:

1. Vertical Piping: MSS Type 8 or MSS Type 42, riser clamps.
2. Individual, Straight, Horizontal Piping Runs:
   a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
   c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 20 Section "Hangers and Supports."

C. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.
F. Install vinyl-coated hangers for PP piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 2: 33 inches with 3/8-inch rod.
2. NPS 2-1/2 and NPS 3: 42 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
4. NPS 6: 48 inches with 3/4-inch rod.
5. NPS 8: 48 inches with 7/8-inch rod.

G. Install supports for vertical PP piping every 72 inches.

H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in Division 20 Section "Mechanical Identification."

3.7 FIELD QUALITY CONTROL

A. Chemical-Waste Piping Inspection:

1. Do not enclose, cover, or put drainage and vent piping into operation until it is inspected and approved by authorities having jurisdiction.
2. 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:
   a. Roughing-in Inspection: Arrange for inspection of piping system before concealing after system roughing-in and before setting fixtures and equipment.
   b. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
3. Reinspections: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Chemical-Waste Piping Testing: Test systems according to procedures of authorities having jurisdiction or, in absence of published procedure, according to the following:

1. Test for leaks and defects in new piping systems and parts of existing systems 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 system tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Rough Plumbing Test Procedure: Test piping at completion of piping roughing-in. Tightly close all openings in piping system, and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before test starts through completion of test, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures and equipment have been set and their traps filled with water, test connections and prove gastight and watertight. Plug stack openings on roof and building drain where it leaves building, and introduce air into system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of fixture to measure pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest system or portion thereof until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

3.8 CLEANING

A. Use procedures prescribed by authorities having jurisdiction or, if not prescribed, use procedures described below:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Clean piping by flushing with potable water.

3.9 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Verify that neutralization system is installed and connected according to the Contract Documents.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain neutralization systems. Refer to Division 20 Section “Mechanical General Requirements.”

END OF SECTION 26 66 53
SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING

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 include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 SUMMARY
A. This Section includes testing, adjusting, and balancing to produce design objectives for the following:
   1. Air Systems:

iDesign Solutions, LLC
LABORATORY EQUIPMENT SPECIFICATIONS
TESTING, ADJUSTING, AND BALANCING
a. Constant-volume air systems.

2. Hydronic Piping Systems:
   a. Variable-flow systems.

3. Laboratory fume hood airflow balancing.
4. Exhaust hood airflow balancing.
5. Existing systems TAB.
6. Verifying that automatic control devices are functioning properly.
7. Reporting results of activities and procedures specified in this Section.

B. Include rebalancing of air systems, or system portions affected by recommended sheave changes.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. AHJ: Authority having jurisdiction.

C. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

D. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

E. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

F. NC: Noise criteria.

G. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

H. RC: Room criteria.

I. Report Forms: Test data sheets for recording test data in logical order.

J. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

K. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
L. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

M. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

N. TAB: Testing, adjusting, and balancing.

O. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

P. Test: A procedure to determine quantitative performance of systems or equipment.

Q. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

A. Qualification Data: Within 15 days from Contractor's Notice to Proceed, submit 2 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.


D. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

E. Sample Report Forms: Submit two sets of sample TAB report forms.

F. Warranties specified in this Section.

1.5 QUALITY Assurance

A. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.

B. Approved Balancing Agencies.

1. The TAB firm selected shall be from the following list:

   a. Absolut Balance Company, Inc.; South Lyon, MI.
   b. Aerodynamics Inspecting Company; Dearborn, MI.
   c. Aireconomics, Inc.; Grand Rapids, MI.
   d. Airflow Testing Inc.; Lincoln Park, MI.
C. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:
   a. Submittal distribution requirements.
   c. TAB plan.
   d. Work schedule and Project-site access requirements.
   e. Coordination and cooperation of trades and subcontractors.
   f. Coordination of documentation and communication flow.

D. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.


F. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

G. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.

1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.
1.6 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.

1.7 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and
   equipment, HVAC controls installers, and other mechanics to operate HVAC systems and
   equipment to support and assist TAB activities.

B. Notice: Provide seven days advance notice for each test. Include scheduled test dates
   and times.

C. Perform TAB after leakage and pressure tests on air and water distribution systems have
   been satisfactorily completed.

1.8 WARRANTY

A. National Project Performance Guarantee: If AABC standards are used, provide a
   guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating,
   and Air Conditioning Systems" forms stating that AABC will assist in completing requirements
   of the Contract Documents if TAB firm fails to comply with the Contract Documents.
   Guarantee includes the following provisions:

   1. The certified TAB firm has tested and balanced systems according to the Contract
      Documents.
   2. Systems are balanced to optimum performance capabilities within design and
      installation limits.

B. Special Guarantee: If NEBB standards are used, provide a guarantee on NEBB forms stating
   that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails
   to comply with the Contract Documents. Guarantee shall include the following provisions:

   1. The certified TAB firm has tested and balanced systems according to the Contract
      Documents.
   2. Systems are balanced to optimum performance capabilities within design and
      installation limits.
PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

B. Examine system and equipment test reports.

C. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

D. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

E. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

F. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

G. Examine strainers for clean screens and proper perforations.

H. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

I. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

J. Examine system pumps to ensure absence of entrained air in the suction piping.

K. Examine equipment for installation and for properly operating safety interlocks and controls.

L. Examine automatic temperature system components to verify the following:
   1. Dampers, valves, and other controlled devices are operated by the intended controller.
   2. Dampers and valves are in the position indicated by the controller.
   3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes is according to the Contract Documents.
8. Controller set points are set at indicated values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to indicated values.

M. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

B. Perform the following field tests and inspections to new and renovated portions of duct systems according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:

1. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.

C. Complete system readiness checks and prepare system readiness 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.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
B. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

C. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts, or use reduced scale contract documents with notations.

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. Cut insulation, and drill ducts for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes with neat patches, neoprene plugs, threaded plugs, or threaded twist-on metal caps, and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

F. Check air flow within intake plenums and mixing boxes of air handling units for uneven flow and temperature stratification and prepare a report with profile elevations (temperature and velocity) on each coil or filter face for Architect.

G. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

H. Verify that motor starters are equipped with properly sized thermal protection.

I. Check dampers for proper position to achieve desired airflow path.

J. Check for airflow blockages.

K. Check condensate drains for proper connections and functioning.

L. Check for proper sealing of air-handling unit components.

M. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
1. Measure fan static pressures to determine actual static pressure as follows:
   a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
   b. Measure static pressure directly at the fan outlet.
   c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from 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.

2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
   a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.

4. Do not recommend 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 modes 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 at a point downstream from the balancing damper and adjust volume dampers until the proper airflow is achieved.
   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. 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 terminal 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 terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using 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.

### 3.6 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 approved pump flow rate.

**B.** Prepare schematic diagrams of systems’ “as-built” piping layouts, or use reduced scale contract documents with notations.

**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 expansion tank liquid level.
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 system controls so automatic valves are wide open to heat exchangers.
6. 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.
7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.

### 3.7 PROCEDURES FOR 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.
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.
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 5 percent of design.

**B.** Set calibrated balancing valves, if installed, at calculated presettings.
C. 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.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

E. 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.

F. Equipment installed with pressure independent characterized control valves (PICCV) or auto-flow devices shall not require hydronic system balancing unless multiple coils are served from a single PICCV or auto-flow device (Example: AHU coil banks with multiple coils). Measure flow through each PICCV and auto-flow device and compare measured value to scheduled value to verify proper valve/device was installed and valve is functional. Verify flow for 100 percent of PICCV and auto-flow devices. Report discrepancies.

G. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

H. Measure the differential-pressure control valve settings existing at the conclusions of balancing, and record in report.

3.8 PROCEDURES FOR HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each 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.

3.9 PROCEDURES FOR LABORATORY FUME HOODS

A. Before performing laboratory fume hood testing, measure, adjust and record the supply airflow and airflow patterns of each supply air outlet that is located in the same room as the hood. Adjust the air outlet flow pattern to minimize turbulence and to achieve the
desired airflow patterns at the face and inside the hood. Verify that adequate makeup air is available to achieve the indicated flow of the hood.

B. Measure, adjust, and record the airflow of each laboratory fume hood by duct Pitot-tube traverse with the laboratory fume hood sash in the design open position.

1. For laboratory fume hoods installed in variable exhaust systems, measure, adjust, and record the hood exhaust airflow at maximum and at minimum airflow conditions.
2. For laboratory fume hoods designed with integral makeup air, measure, adjust, and record the exhaust and makeup airflow.
3. Verify that no air is by-passed within hood. Report if baffles require modification at designated sash height.

C. For laboratory fume hoods that are connected to centralized exhaust systems using automatic dampers, adjust the damper controller to obtain the indicated exhaust airflow.

D. After balancing is complete, do the following:

1. Measure and record the static pressure at the hood duct connection with the hood operating at indicated airflow.
2. Measure and record the face velocity across the open sash face area. Measure the face velocity at each point in a grid pattern. Perform measurements at a maximum of 12 inches between points and between any point and the perimeter of the opening.
   a. For laboratory fume hoods designed to maintain a constant face velocity at varying sash positions, also measure and record the face velocity at 50 and 25 percent of the design open sash position.
   b. Calculate and report the average face velocity by averaging all velocity measurements.
   c. Calculate and report the exhaust airflow by multiplying the calculated average face velocity by the sash open area. Compare this quantity with the exhaust airflow measured by duct Pitot-tube traverse. Report differences.
   d. If the average face velocity is less than the indicated face velocity, retest the average face velocity and adjust hood baffles, fan drives, and other parts of the system to provide the indicated average face velocity.

3. Check each laboratory fume hood for the capture and containment of smoke by using a hand-held emitting device. Observe the capture and containment of smoke flow pattern across the open face and inside the hood. Make adjustments necessary to achieve the desired results.

E. With the room and laboratory fume hoods operating at indicated conditions, perform an "as-installed" performance test of the laboratory fume hood according to ASHRAE 110. Test each laboratory fume hood(s) and document the test results.
3.10 PROCEDURES FOR EXHAUST HOODS

A. Measure, adjust, and record the airflow of each exhaust hood. Measure airflow by duct Pitot-tube traverse. If a duct Pitot-tube traverse is not possible, explain why, in the report, and explain the test method used.

B. After balancing is complete, do the following:
   1. Measure and record the static pressure at the hood exhaust-duct connection.
   2. Check the hood for capture and containment of smoke using a smoke emitting device. Observe the smoke pattern. Make adjustments to achieve optimum results.

3.11 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:
   1. Air handling equipment and outlets: Plus or minus 5 percent.
      a. Where terminal units serve 6 or more outlets within a common room, individual outlets may vary up to plus or minus 10 percent of design flow rates if overall room supply is within plus or minus 5 percent.
   2. Heating-Water Flow Rate: 0 to minus 10 percent.
   3. Cooling-Water Flow Rate: 0 to plus 5 percent.

3.12 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: As Work progresses, prepare 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.

3.13 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
   1. Include a list of instruments used for procedures, along with proof of calibration.
C. Final Report Contents: In addition to certified field report data, include the following:

1. Manufacturers’ test data.
2. Field test reports prepared by system and equipment installers.
3. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of TAB firm.
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 firm who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. Summary of contents including the following:
   a. Indicated versus final performance.
   b. Notable characteristics of systems.
   c. Description of system operation sequence if it varies from the Contract Documents.
12. Nomenclature sheets for each item of equipment.
13. Notes to explain why certain final data in the body of reports varies from indicated values.
14. Test conditions for fans and pump performance forms including the following:
   a. Settings for outside-, 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.

E. 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 outside, supply, return, and exhaust airflows.
2. Water flow rates.
3. Terminal units.

F. 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, and bore.
   h. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Motor Data:
   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches, and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
   g. Number of belts, make, and size.

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Suction static pressure in inches wg.

G. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:
   a. System and air-handling unit number.
   b. Location and zone.
   c. Traverse air temperature in deg F.
   d. Duct static pressure in inches wg.
   e. Duct size in inches.
   f. Duct area in sq. ft.
   g. Indicated airflow rate in cfm.
   h. Indicated velocity in fpm.
   i. Actual airflow rate in cfm.
   j. Actual average velocity in fpm.
H. Air-Terminal-Device Reports:

1. Unit Data:
   a. System and air-handling unit identification.
   b. Location and zone.
   c. Test apparatus used.
   d. Area served.
   e. Air-terminal-device make.
   f. Air-terminal-device number from system diagram.
   g. Air-terminal-device type and model number.
   h. Air-terminal-device size.
   i. Air-terminal-device effective area in sq. ft.

2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm.
   b. Air velocity in fpm.
   c. Preliminary airflow rate as needed in cfm.
   d. Preliminary velocity as needed in fpm.
   e. Final airflow rate in cfm.
   f. Final velocity in fpm.
   g. Space temperature in deg F.

I. 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. Airflow rate in cfm.
   b. Entering-water temperature in deg F.
   c. Leaving-water temperature in deg F.
   d. Water pressure drop in feet of head or psig.
   e. Entering-air temperature in deg F.
   f. Leaving-air temperature in deg F.

3. 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. Randomly 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 to the Contract Documents in the Final Report.

B. Final Inspection:

1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of Architect.
3. Architect shall randomly select measurements documented in the final report to be rechecked. The 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 the 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.
6. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.
7. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

3.15 ADDITIONAL TESTS

A. Within 90 days of completing TAB, perform additional testing and balancing 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 testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION 23 05 93
SECTION 23 09 33
TEMPERATURE CONTROLS

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 work of this section.

B. Related Sections include the following:

1. Division 20 Section “Mechanical General Requirements.”
2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
1.3  DEFINITIONS

A.  BAS: Building Automation System
B.  CAD: Computer Aided Design.
C.  DDC: Direct-digital controls.
D.  TC: Temperature Control.

1.4  SYSTEM DESCRIPTION

A.  Temperature control building automation system consisting of direct digital control system terminal equipment controllers, sensors, transducers, relays, switches, data communication network, etc. and all associated control wiring and raceway systems.
B.  BAS/DDC system programming, database and graphic display generation at the existing remote operator workstation.
C.  Control valves, operators, control wiring, etc.
D.  Electric and electronic control accessories, and other control system devices.

1.5  SEQUENCE OF OPERATION

A.  Control sequences for HVAC systems, subsystems, and equipment are indicated on project drawings.

1.6  SUBMITTALS

A.  Submit under Division 20, 21, 22 and 23 provisions of respective project and as supplemented in this section.
B.  All control submittal requirements shall be submitted at one time with exception to control valves (when required). Early submittals of control valves shall be incorporated with the complete temperature controls submittal.
C.  Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
   1. Each control device labeled with setting or adjustable range of control
D.  Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
E.  Shop Drawings:
1. Shop drawings shall be done on CAD. Minimum size 11” x 17”.
2. Schematic flow diagrams showing fans, coils, valves, and control devices.
4. Details of control panel faces and interior, including controls, instruments, termination blocks and labeling.
5. Written sequence of operation for each controlled system.
6. Schedule of valves including leakage and flow characteristics (Refer to Design Data).
7. Complete bill of materials to identify and quantify all control components.
8. Overall system schematic showing communication trunk cabling to new and existing DDC controllers including component locations and wire termination details.
9. DDC controller layouts showing connected data points and LAN connections. DDC controller terminations including power supply and remote control component termination details shall be provided.

F. Design Data: Provide indicated component selection and sizing criteria for the following component categories:

   1. Control valves:
      a. Component tag.
      b. Equipment served/function.
      c. Media type.
      d. Design flow rate (GPM).
      e. Design pressure drop (ft. head) of (psi)
      f. Calculated valve Cv
      g. Selected valve Cv
      h. Resultant pressure drop (ft. head) of (psi) with selected valve.
      i. Valve size.
      j. Line size to valve connection (excluding reducers).
      k. Type (ball, butterfly, globe, etc.).
      l. Configuration (2-way, 3-way mixing, 3-way diverting).
      m. Normal position (normally open, normally closed, floating).
      n. Actuator spring range (where applicable).
      o. Actuator power requirement.
      p. Valve shut-off rating (ft. head) of (psi)
      q. Valve body pressure/temperature rating.
      r. Valve manufacturer/model number.
      s. Actuator manufacturer/model number.

G. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

H. Submit field reports indicating operating conditions after detailed check out of systems at Date of Substantial Completion.

I. Project Record Documents: Include the following:
1. Revise Shop Drawings to reflect actual installation and operating sequences.
2. Record actual locations of control components, including control units and sensors.
3. Submit the electronic files for all as-built shop drawings on diskette in pdf format.

J. Maintenance Manuals: Include the following:
1. Product data with installation details, maintenance instructions and lists of spare parts for each type of control device.
2. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
3. Calibration records and list of set points.

1.7 REFERENCES

C. ASTM D1693 - Environmental Stress - Cracking of Ethylene Plastics.
D. NEMA DC 3 - Low-Voltage Room Thermostats.
E. UL 1820 - Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics Only.

1.8 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is an approved installer of the automatic control system manufacturer for both installation and maintenance of units required for this Project.
B. Manufacturer Qualifications: A firm experienced in manufacturing automatic temperature-control systems similar to those indicated for this Project and with a record of successful in-service performance.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
D. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."

1.9 COORDINATION

A. Coordinate work under Division 20, 21, 22 and 23 provisions and as supplemented in this section.
B. Coordinate location of space temperature sensors and other exposed control sensors with plans and room details before installation.
C. Coordinate installation of system components with installation of mechanical systems and equipment to achieve compatibility.

D. Ensure installation of components is complementary to installation of similar components in other systems.

E. Coordinate control wiring requirements, including actual terminal block numbers, with mechanical equipment manufacturers or suppliers.

F. Ensure control system installation is complete, checked, tested and functioning properly prior to system balancing and Owner/Engineer system checkout.

G. Cooperate fully with the Test and Balance Contractor and provide labor to operate the temperature control system as required to meet the scope of work defined in Division 23 Section "Testing, Adjusting and Balancing."

1.10 WARRANTY

A. Provide warranty per Division 20 Section "General Mechanical Requirements".

PART 2 - PRODUCTS

2.1 DESCRIPTION OF THE BUILDING AUTOMATION SYSTEM (BAS)

A. The building automation system (BAS) shall be fully integrated, distributed data processing system incorporating direct digital control (DDC) for the control and monitoring of heating, ventilating and air conditioning (HVAC) equipment and other related systems. Microprocessor based DDC controllers shall be directly connected to HVAC equipment sensors and actuators. A data communication network shall allow data exchange between the DDC controllers and the existing Siemens Apogee Building Automation System.

B. Approved Manufacturer – System Provider (Location):

2.2 DIRECT DIGITAL CONTROL (DDC) PANELS

A. Control Panels: Modular in design and consisting of stand-alone microprocessor board with ROM and fully custom programmable RAM, EPROM, and/or EEPROM memory, integral interface equipment and power surge protection. DDC panels shall be connected directly to sensors, controlled devices and the communication network.

B. Powerfail Restart and Battery Backup: Minimum of 72 battery backup hours for complete system RAM memory and clock, with automatic battery charger or 48 hour low voltage alarm warning. Upon full system power recovery, all clocks shall be automatically synchronized, and all controlled equipment shall be automatically re-started based on correct clock time and sequence of operation.
C. Provide fully functional communication interface ports for communication between processor, other processors, Operator Workstation, portable operator unit and portable programmer terminal.

D. Panel enclosure shall be finished steel or rigid plastic with hinged door and keyed lock. Electronics shall be removable for protection during mounting of panel.

2.3 DDC TERMINAL EQUIPMENT CONTROLLERS

A. Application specific microprocessor based controllers capable of stand-alone operation for terminal equipment indicated on the drawings. Controllers shall be networked together and connected to the building's existing BAS/DDC network.

B. Each controller shall have electronic outputs compatible with the electronically operated terminal equipment fan control and coil control valves where applicable.

C. TC installation contractor shall provide 24 VAC power requirements including transformers.

D. Room temperature sensors for the DDC air terminal equipment controllers where applicable:

   1. Sensing Element: Thermistor type or resistance temperature detector (RTD). Accuracy shall be +/- 0.5 degrees F over the range of 55 degrees F to 95 degrees F.
   2. Cover: Locking type.
   3. Provide with exposed +/- setpoint adjustment dial and exposed temperature reading.
   4. Provide with exposed override switch to allow an occupant to reset the space to occupied control during the unoccupied cycle for a predetermined time period.
   5. Provide with portable operator unit plug-in port.

2.4 DDC INPUT/OUTPUT SENSORS

A. Air Static/Differential Pressure Transmitters:

   1. Variable capacitance type with ranges not exceeding 150 percent of maximum expected input. Transmitter shall have zero and span adjustments.
   2. Safe overpressure rating shall be minimum 5 times the range.
   3. Temperature compensated with thermal error of not greater than 0.04 percent of full scale in temperature range of 40 to 100 deg F.
   4. Accuracy: One percent of full scale.
   5. Manufacturers:

      a. Dwyer.
      b. Setra.
      c. Modus.
      d. Air Monitor.
B. Current Sensors:

1. Split-core donut transformer type for monitoring AC current, with analog output signal as indicated. Current sensors used on motor side of variable frequency drives shall have low frequency detection capability.
2. Analog sensors shall have accuracy of ±1% full scale.
3. Manufacturers:
   a. Neilsen-Kuljian.
   b. Veris Industries.
   c. Scientific-Columbus

C. Current Switches:

1. Split-core donut transformer type for monitoring AC current, with digital output signal. Current switches used on motor side of variable frequency drives shall have low frequency detection capability.
2. Current switches with digital output shall have adjustable trip settings. Field adjust current switches to trip at approximately 90% of normal motor operating amperage.
3. Manufacturers:
   a. Neilsen-Kuljian.
   b. Veris Industries.
   c. Scientific-Columbus.

D. Differential Pressure Switches:

1. Shall provide electrical switching action upon a sensed pressure differential increase between two points. Sensitivity shall be suitable for the application. Setpoint shall be adjustable over the full range of the device. Switching action shall open or close two independent single pole double throw switches. Electrical switch rating shall be 10 amps at 120 VAC.
2. Pressure rating of switch and connecting tubing:
   a. Air flow - Rated for 12 inches W.C.

2.5 DDC DATA COMMUNICATIONS NETWORK

A. Data communication network shall be provided to allow data transmission between all new DDC controllers and the existing building DDC network.

B. Data communications media shall be twisted pair wires.

C. All required repeaters, hubs, active links, gateways, etc., and associated power supplies shall be provided as required to provide shared point and control information between DDC controllers.

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TEMPERATURE CONTROLS
D. Failure of any individual DDC panel shall not cause the loss of communications between peer DDC panels.

E. Error recovery and communication initialization routines shall be resident in each network connected device.

2.6 CONTROL AND INSTRUMENTATION TUBING

A. Copper Tubing: ASTM B280 or ASTM B75, seamless, hard drawn or annealed.

B. Copper Tubing: ASTM B280 or ASTM B75, seamless, hard drawn or annealed.
   1. Fittings: UL approved rod or forged brass rated to 200 psig at 100 degrees F.
   2. Joints: Ball Sleeve compression type.

C. Polyethylene Tubing: Black, UL 1820 flame and smoke retardant where exposed in an air plenum, virgin polyethylene, conforming to modified ASTM D1693 test. All non-metallic tubing shall be minimum 1/4" O.D.; micro-sleeve is not acceptable.
   1. Fittings: UL approved rod or forged brass rated to 200 psig at 100 degrees F.
   2. Joints: Compression or barbed type.

2.7 CONTROL VALVES AND VALVE OPERATORS

A. Globe Pattern:
   1. Up to 2 inches: Bronze body, bronze trim, rising stem, renewable composition disc, single seated, screwed ends with backseating capability, repackable under pressure.
   2. Over 2 inches: Iron body, bronze trim, rising stem, plug-type disc, flanged ends, renewable seat and disc, repackable under pressure.
   3. Valve stem packing shall be tetrafluorethylene, spring loaded and self-adjusting. Packless construction is acceptable.
   4. Manufacturers:
      a. Siemens.

B. Ball Valves:
   1. Up to 2 inches: Bronze body with screwed ends, stainless steel or chrome plated brass ball, characterizing disc, stainless steel or brass stem, and resilient reinforced Teflon seats.
   2. Manufacturers:
      a. Siemens.

C. Electric Operators:
1. Operators shall be electronic type to accept signals from direct digital controller for proportional control.
2. Valves shall spring return to normal position as indicated. Terminal unit tempering coil control valve operators are not required to be spring return.
3. Select with sufficient shut-off power for system pressure and highest operating torque, and torque requirements of valves which may stick because of infrequent use.
4. Select to provide smooth proportioning control under operating conditions normal to the system.

D. Hydronic Systems:
   1. Valve minimum pressure rating shall meet or exceed the system minimum pressure rating as noted for each system in Division 22 Section “Valves,” and in Division 22 Section “Hydronic Piping.”
   2. Valve minimum temperature ratings shall be 250 deg F.
   3. Replaceable plugs and seats of stainless steel or brass, selected for maximum lift under application conditions.
   4. Pressure Drop: As scheduled on the drawings, or if not scheduled, select for a pressure drop equal to two times the pressure drop of the associated heat transfer device. Pressure drop of the selected valve shall not exceed a maximum of 15 feet of head or a minimum of 2.3 feet of head.
   5. Two way valves shall have equal percentage characteristics. Size two way valve operators to close valves against pump shut off head.

2.8 ELECTRICAL REQUIREMENTS FOR CONTROLS WORK

A. Electrical accessories such as relays, switches, contactors and control transformers shall meet the requirements of the Division 26 Specifications of respective project.

B. Electrical wiring and conduit shall meet the requirements of the Division 26 Specifications.

C. All control wiring in mechanical rooms and any other exposed wiring by electrical contractor areas shall be run in conduit. Low voltage temperature control wiring in concealed accessible locations (i.e. above lay-in ceilings), as well as low voltage temperature control wiring within partitions, may be run using plenum rated cable, neatly tie-wrapped and fastened to the building structure (not to ceiling or ceiling support wires).

D. Conduits carrying control wiring shall be sized for a maximum fill of 40% of capacity.

E. Where raceway is required, two separate raceway systems shall be provided; one for A.C. wiring and the other for D.C. wiring.

F. Data transmission cabling and equipment grounding procedures shall meet the latest FCC guidelines for electromagnetic field generation.
G. All control wiring sizes and types shall meet or exceed the equipment manufacturer's recommendations.

PART 3 - EXECUTION

3.1 INSTALLATION - CONTROL SYSTEMS

A. Install in accordance with manufacturer's instructions.

B. Check and verify location of temperature sensors and other exposed control sensors with plans and room details before installation. Locate room temperature sensors and thermostats 48 inches above floor unless noted otherwise.

C. Sensors used for closed loop control must be connected to the same DDC panel as the associated output signal.

D. Provide conduit and electrical wiring where required.

E. All wiring in altered and unaltered areas shall be run concealed. Use of "wiremold" or exposed conduits will be permitted only where approved by the Architect.

F. Splicing of DDC sensor cabling at junction boxes shall not be acceptable.

G. All equipment which has moving parts and is remotely started by the control system shall be provided with warning labels no less than 2 inches in height, and in bright warning color, stating that the equipment is remotely started by automatic controls. Such labels shall be posted clearly in the area of any moving parts, such as belts, fans, pumps, etc.

H. Locate all control components and accessories such that they are easily accessible for adjustment, service and replacement.

I. Locate, size and support sensing elements in airstreams so that they properly sense the representative condition. Controlling, transmitting and indicating elements shall be located to sense the average condition. Safety elements shall be located to sense the extreme condition.

J. Locate, support and install all control components and accessories so that they will not be subject to vibration, excessive temperatures, dirt, moisture or other harmful conditions beyond their rated limitations.

K. Where insulation is penetrated due to the installation of sensing elements or tubing, reseal the openings air and vapor tight. Provide brackets for devices to be located on insulated surfaces so as to clear the finished surface of the insulation and to avoid puncturing the vapor seal.
L. Provide all necessary relays, switches, linkages, control devices, accessories and connections as required for a complete and operational control system as specified herein and shown.

M. All electric valve and damper operators shall be capable of moving from full closed to full open, or vice versa, within 60 seconds.

3.2 IDENTIFICATION AND MARKING

A. All controllers, sensors, relays, switches, etc. shall be marked with the same identification number as used on the as-built shop drawings. Use Brother P-touch label maker or similar with black text on clear or white super adhesive tape. If label applied in wet environment, spray label with clear enamel for waterproofing.

B. Wire shall be color coded according to functional use. Identify color coding format on record drawings.

C. Identify each wire as to ID number at each control panel, field device, and splice.

3.3 GRAPHIC DISPLAY GENERATION

A. TC system provider shall generate the following graphic displays as a minimum at the existing operator workstations, arranged in logical penetration paths:

1. Floor plans for each floor within each building, with display of present values of space conditions sensed by connected space sensors.
2. Schematic diagram for each HVAC system. Each system schematic display shall include at least the following:
   a. Schematic arrangement of ductwork, fans, coils, valves, piping,
   b. System name,
   c. Area served,
   d. Present value or status of all inputs, along with present setpoint,
   e. Present percent open for each valve, etc. based on commanded position,
   f. Reset schedule parameters for all points, where applicable,
   g. Present occupancy mode,
   h. Associated space conditions and setpoints, where applicable,
   i. Color coding to indicate normal and abnormal values, alarms, etc.

3. Sequence of operation in written (text) format for each HVAC system.
4. Overall BAS system schematic.
5. System management graphic for each network device and/or DDC panel.

3.4 CALIBRATION AND START-UP

A. After installation and connection of control components, test, adjust and re-adjust as required all control components in terms of function, design, systems balance and performance. Make systems ready for environmental equipment acceptance tests.
B. After environmental equipment has been accepted and after the systems have operated in normal service for two weeks, check the adjustment on control components and recalibrate where required. Components not in calibration shall be recalibrated to function as required, or shall be replaced. Control devices, linkages, and other control components shall be calibrated and adjusted for stable and accurate operation in accordance with the design intent and to obtain optimum performance from the equipment controlled. Cause every device to automatically operate as intended to ensure its proper functionality.

3.5 ACCEPTANCE PROCEDURE

A. Upon successful completion of start-up and recalibration as indicated in this section, the Architect shall be requested in writing to inspect the satisfactory operation of the control systems.

B. Demonstrate operation of all control systems, including each individual component, to the Owner and Architect.

C. After correcting all items appearing on the punch list, make a second written request to the Owner and Architect for inspection and approval.

D. After all items on the punch list are corrected and formal approval of the control systems is provided by the Architect, the Contractor shall indicate to the Owner in writing the commencement of the warranty period.

END OF SECTION 23 09 33
SECTION 23 31 13
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 include the following:

1. Division 20 Section "Mechanical General Requirements."
2. Division 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.
1.2 SUMMARY

A. This Section includes metal ducts for supply, return, outside, relief air, and exhaust air-distribution systems in pressure classes from minus 6- to plus 6-inch wg.

B. Products Installed but Not Furnished Under This Section:

1. Terminal boxes which are to be furnished by the Laboratory Airflow Controls Contractor shall be installed by the Mechanical Contractor. Refer to Division 23 Section “Laboratory Airflow Controls.”

1.3 DEFINITIONS

A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.

B. Low Pressure: Up to 2 inch WG and velocities less than 1,500 fpm. Construct for 2 inch WG positive or negative static pressure.

C. Medium Pressure: Greater than 2 inch WG to 6 inch WG and velocities greater than 1,500 fpm and less than 2,500 fpm. Construct for 6 inch WG positive or negative static pressure.

D. High Pressure: Greater than 6 inch WG to 12 inch WG and velocities greater than 2,500 fpm. Construct for 12 inch WG positive or negative static pressure.

E. FRP: Fiberglass-reinforced plastic.

F. PVC: Polyvinyl Chloride.

1.4 SYSTEM DESCRIPTION

A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.5 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 Application Schedule” Article.

1.6 SUBMITTALS

A. Shop Drawings: CAD-generated and drawn to 1/4 inch equals 1 foot scale. Show fabrication and installation details for metal ducts. Shop drawings shall be reviewed and approved by the Architect prior to any fabrication.
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Duct layout indicating sizes and pressure classes.
3. Elevations of top and bottom of ducts.
4. Dimensions of main duct runs from building grid lines.
5. Fittings.
6. Reinforcement and spacing.
7. Seam and joint construction.
8. Penetrations through fire-rated and other partitions.
9. Equipment installation based on equipment being used on Project.
10. Duct accessories, including access doors and panels.
11. Hangers and supports, including methods for duct and building attachment, vibration isolation, and seismic restraints.

B. 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.

C. Welding certificates.

D. Field quality-control test reports.

1.7 QUALITY ASSURANCE

A. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.8 COORDINATION

A. Sheet metal trades shall cooperate fully with the Laboratory Airflow Controls Trades and shall attend all field installation training sessions.

B. Sheet metal trades shall cooperate fully with the Test and Balance Contractor and provide all miscellaneous caps and any other materials required for structural integrity and leakage testing of the complete duct system in whole or in part. Refer to Division 23 Section "Testing, Adjusting and Balancing."

1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

C. Sheet metal trades shall participate in the above ceiling coordination program. Refer to Division 01 requirements.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL MATERIALS

A. Comply with SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.


D. Carbon-Steel Sheets: ASTM A 366/A 366M, cold-rolled sheets; commercial quality; with oiled, matte finish for exposed ducts.

E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.

F. Tie Rods: For rectangular ducts having a side dimension of 48 inches or greater. Galvanized steel, 3/8-inch minimum diameter.

2.3 SEALANTS 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. Elastomeric Sealant Tape: 3 inches wide; modified butyl adhesive backed.

1. Manufacturers:

   a. Hardcast; Foil-Grip 1402 and Foil-Grip 1402-181BFX.

C. Water-Based Joint and Seam Sealant:
1. Manufacturers:
   a. Hardcast; Flex-Grip 550 and Versa-Grip 181.
   b. Polymer Adhesives; No. 11.
   c. United McGill.


5. Water resistant.

6. Mold and mildew resistant.

7. VOC: Maximum 75 g/L (less water).

8. Maximum Static-Pressure Class: 10-inch wg, positive and negative.


10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Flanged Joint Sealant: Comply with ASTM C 920.


2. Type: S.

3. Grade: NS.


5. Use: O.

E. Gaskets: Chloroprene elastomer, 40 durometer, 1/8 inch thick, full face, one piece vulcanized or dovetailed at joints.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg 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.

2.4 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

B. Hanger Materials: Galvanized sheet steel or threaded steel rod.


2. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
3. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

4. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials. Attachments for stainless steel and PVC-coated duct shall be stainless steel.

D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.

3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

E. Load Rated Cable Suspension System for Noncorrosive Environments: Tested to five times the Safe Working Loads and verified by the SMACNA Testing and Research Institute.

1. Cable: Aircraft quality 7 x 7 and 7 x 19 wire rope.

2. Fastener: One-piece, die-cast zinc housing with Type 302 S26 stainless steel hardened and tempered springs, and oil impregnated, sintered, hardened and tempered steel locking wedges.
3. End Fixings: Loop, stud or toggle; or plain end suitable for wire rope beam clamp.
4. Manufacturers:
   b. Duro Dyne Corp.; Dyna-Tite System.

F. Stainless Steel Load Rated Cable Suspension System for Corrosive Environments: Tested to five times the Safe Working Loads and verified by the SMACNA Testing and Research Institute.

1. Cable: Aircraft quality stainless steel 7 x 7 and 7 x 19 wire rope.
   a. Stainless steel complying with ASTM A 492.

2. Fastener: One-piece, stainless steel housing with Type 302 S26 stainless steel hardened and tempered springs, and ceramic locking wedges.
3. End Fixings:
   a. Loop End: Type 316L/A4 stainless steel.
b. Stud or Toggle End: Type 304L/A2 stainless steel.
c. Plain end suitable for stainless steel wire rope beam clamp.

4. Manufacturers:
   b. Duro Dyne Corp.; Dyna-Tite System.

G. Welded Supports: Structural steel shapes with zinc rich paint. Equivalent, proprietary design, rolled steel structural support systems may be used in lieu of mill rolled structural steel.

2.5 RECTANGULAR DUCT FABRICATION

A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA’s “HVAC Duct Construction Standards--Metal and Flexible” and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.

1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA’s “HVAC Duct Construction Standards--Metal and Flexible.”
3. Internal Tie Rod: Ducts having a side dimension of 48 inches or greater only.

B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer’s and SMACNA guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.

1. Manufacturers:
   a. Ductmate Industries, Inc.
   b. Nexus Inc.
   c. Ward Industries, Inc.

C. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.

2.6 ROUND AND FLAT-OVAL DUCT AND FITTING FABRICATION

A. Diameter as applied to flat-oval ducts in this Article is the diameter of a round duct with a circumference equal to the perimeter of a given size of flat-oval duct.

B. Round and Flat-Oval, Spiral Lock-Seam Ducts:

1. Manufacturers:
   a. Eastern Sheet Metal (ESM).
C. Round, Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" or SMACNA "Industrial Duct Construction Standards" as required based on pressure class.

1. Round fittings shall be factory fabricated welded design. Use of field fabricated fittings (welded design) shall only be permitted when factory fabricated fittings are unavailable.

D. Flat-Oval, Spiral Lock-Seam Ducts: Fabricate supply ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" or SMACNA "Industrial Duct Construction Standards" as required based on pressure class.

1. Flat-oval fittings shall be factory fabricated welded design. Use of field fabricated fittings (welded design) shall only be permitted when factory fabricated fittings are unavailable.

E. Duct Joints:

1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
2. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
3. Ducts Larger Than 72 Inches in Diameter: Companion angle flanged joints per SMACNA "HVAC Duct Construction Standards--Metal and Flexible," Figure 3-2.
5. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.

a. Manufacturers:

1) AccuDuct Mfg. Inc.
2) Ductmate Industries, Inc.
3) Eastern Sheet Metal (ESM).
4) Lindab Inc.
5) Universal Spiral Air.
6. Flat-Oval Ducts: Prefabricated connection system consisting of two flanges and one synthetic rubber gasket.

   a. Manufacturers:

      1) AccuDuct Mfg. Inc.
      2) Ductmate Industries, Inc.
      3) Eastern Sheet Metal (ESM).
      5) SEMCO Incorporated.
      6) Universal Spiral Air.

F. Low Pressure Ductwork (plus or minus 2 inches W.G. Static Pressure Class)

   1. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible provide single thickness turning vanes.
   2. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.

G. Medium and High Pressure Ductwork (For Static Pressure Class Greater than plus or minus 2 inches W.G.)

   1. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible provide single thickness turning vanes.
   2. Transform duct sizes gradually, not exceeding 15 degrees divergence and 30 degrees convergence.
   3. Fabricate continuously welded medium and high pressure round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Joints shall be minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.
   4. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.

H. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.

I. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

J. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:

   1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg:
   a. Ducts 3 to 36 Inches in Diameter: 0.034 inch.
   b. Ducts 37 to 50 Inches in Diameter: 0.040 inch.
   c. Ducts 52 to 60 Inches in Diameter: 0.052 inch.
   d. Ducts 62 to 84 Inches in Diameter: 0.064 inch.

3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg:
   a. Ducts 3 to 26 Inches in Diameter: 0.034 inch.
   b. Ducts 27 to 50 Inches in Diameter: 0.040 inch.
   c. Ducts 52 to 60 Inches in Diameter: 0.052 inch.
   d. Ducts 62 to 84 Inches in Diameter: 0.064 inch.

4. Flat-Oval Mitered Elbows: Welded construction with same metal thickness as longitudinal-seam flat-oval duct.

5. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.

6. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.

7. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.

8. Round Elbows Larger Than 14 Inches in Diameter and All Flat-Oval Elbows: Fabricate gored elbows unless space restrictions require mitered elbows.

9. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick with 2-piece welded construction.

10. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.

11. Flat-Oval Elbow Metal Thickness: Same as longitudinal-seam flat-oval duct specified above.

12. Pleated Elbows for Sizes through 14 Inches in Diameter and Pressures through 10-Inch wg: 0.022 inch.

K. PVC-Coated Elbows and Fittings: Fabricate elbows and fittings as follows:

1. Round Elbows 4 to 8 Inches in Diameter: Two piece, die stamped, with longitudinal seams spot welded, bonded, and painted with PVC aerosol spray.
2. Round Elbows 9 to 26 Inches in Diameter: Standing-seam construction.
3. Round Elbows 28 to 60 Inches in Diameter: Standard gored construction, riveted and bonded.
4. Other Fittings: Riveted and bonded joints.
5. Couplings: Slip-joint construction with a minimum 2-inch insertion length.
PART 3 - EXECUTION

3.1 DUCTWORK APPLICATION SCHEDULE
A. Ductwork materials and performance requirements are scheduled on the Drawing.

3.2 DUCT INSTALLATION
A. Construct and install ducts according to SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
B. Install round and flat-oval ducts in lengths not less than 12 feet unless interrupted by fittings.
C. Install ducts with fewest possible joints.
D. Install fabricated fittings for changes in directions, size, and shape and for connections.
E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.
F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
I. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.
J. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.
K. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.
L. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.
N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, and sleeves. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories."

iDesign Solutions, LLC
LABORATORY EQUIPMENT SPECIFICATIONS
METAL DUCTS
O. Install ducts with hangers and braces designed to withstand, without damage to equipment, seismic force required by applicable building codes.

P. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.


1. Intermediate level.

3.3 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.

3.4 PVC-COATED DUCT, SPECIAL INSTALLATION REQUIREMENTS

A. Repair damage to PVC coating with manufacturer’s recommended materials.

3.5 UNDERSLAB DUCTS, SPECIAL INSTALLATION REQUIREMENTS

A. Verify undamaged condition of ducts before enclosure with fill or encasement.

B. Protect ducts from damage by equipment used in placing fill materials and concrete on or around ducts.

C. Protect duct openings from damage and prevent entrance of foreign materials.

3.6 RANGE HOOD EXHAUST DUCTS, SPECIAL INSTALLATION REQUIREMENTS

A. Install ducts to allow for thermal expansion through 2000 deg F temperature range.

B. Install ducts without dips or traps that may collect residues unless traps have continuous or automatic residue removal.
C. Install access openings at each change in direction and at intervals defined by NFPA 96; locate on sides of duct a minimum of 1-1/2 inches from bottom; and fit with grease-tight covers of same material as duct.

D. Install welded test ports or prefabricated test port section in the exhaust duct for the duct Pitot-tube traverse. Install each test port with a threaded cap that is liquid tight.

E. Do not penetrate fire-rated assemblies except as permitted by applicable building codes.

F. Field Quality Control:
   1. Prior to use or concealment of any portion of grease duct system, perform leakage test in presence of Code Official.
   2. Light test or approved equivalent test method shall be performed to determine that welded and brazed joints are liquid tight.
   3. Lamp shall be not less than 100 watts and shall be open to emit light equally in all directions perpendicular to duct walls.

3.7 DUCT SEALING

A. Seal duct seams and joints according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated. Ducts must be properly cleaned and sealed in strict accordance with sealant manufacturer's instructions.
   1. Seal Class: Refer to Application Schedule on the Drawings.
   2. Seal ducts before external insulation is applied.
   3. After pressure testing, remake leaking joints until leakage is equal to or less than maximum allowable. Refer to Application Schedule on the Drawings for allowable leakage rates.

3.8 HANGING AND SUPPORTING

A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.

B. Support vertical ducts at maximum intervals of 16 feet and at each floor.

C. Install concrete inserts before placing concrete.

D. Support ductwork from building structure, not from roof deck, floor slab, pipe, other ducts, or equipment.

E. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

F. Install roof mounted duct supports in accordance with manufacturer's instructions. Provide additional membrane layer or walkpads under support bases as required.

G. Use load rated cable suspension system for round duct in exposed locations.
3.9 CONNECTIONS

A. Make connections to equipment with flexible connectors according to Division 15 Section "Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.10 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.

3.11 FIELD QUALITY CONTROL

A. Duct System Cleanliness Tests:
   1. Visually inspect duct system to ensure that no visible contaminants are present.

B. Duct system will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.12 START UP

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 23 31 13
SECTION 23 33 00
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 include the following:
      1. Division 20 Section “Mechanical General Requirements.”
      2. Division 23 Section “Testing, Adjusting, and Balancing” for duct test holes.
      3. Division 23 Section “Temperature Controls” for motorized control dampers.
      4. Division 21 Section “Fire Alarm” for duct-mounting fire and smoke detectors.

1.2 DEFINITIONS
   A. NVLAP: National Voluntary Laboratory Accreditation Program.
   B. Low Pressure: Up to 2 inch WG and velocities less than 1,500 fpm. Construct for 2 inch WG positive or negative static pressure.
C. Medium Pressure: Greater than 2 inch WG to 6 inch WG and velocities greater than 1,500 fpm and less than 2,500 fpm. Construct for 6 inch WG positive or negative static pressure.

D. High Pressure: Greater than 6 inch WG to 12 inch WG and velocities greater than 2,500 fpm. Construct for 12 inch WG positive or negative static pressure.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

   a. Special fittings.
   c. Control damper installations.
   d. Wiring Diagrams: Power, signal, and control wiring.

C. Source quality-control reports.

D. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE


B. Comply with AMCA 500-D testing for damper rating.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
2.2 SHEET METAL MATERIALS

A. Comply with SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Stainless Steel: ASTM A 480/A 480M, Types 304 and 316 as indicated.

D. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.


F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

H. Tie Rods: Stainless steel, 1/4-inch diameter for lengths 36 inches or less; 3/8-inch diameter for lengths longer than 36 inches for use in ducts in humid or corrosive atmospheres.

I. Bird Screens: No. 2 mesh, 0.063 inch diameter galvanized wire screen with open area of not less than 72 percent. Conceal sharp edges by adding metal edging consisting of rod, flat or angle iron, or 16 gage galvanized sheet steel turned over at least 3/4 inch on both sides.

2.3 LOW PRESSURE MANUAL VOLUME DAMPERS

A. Manufacturers:

1. American Warming and Ventilating.
2. Arrow United Industries.
5. Louvers and Dampers.
6. Nailor Industries Inc.
7. Ruskin Company.
8. Vent Products Company, Inc.

B. General Description: 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.
1. Except for dampers in round ductwork sized 12 inches and smaller, provide end bearings.

C. Rectangular Volume Dampers: Multiple-opposed-blade design, AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications.

D. Round Volume Dampers 16-inch Diameter and Smaller: Single-blade design, AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications.

E. Round Volume Dampers Larger than 16-inch Diameter: Multiple-opposed-blade design AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications.

F. Damper Materials:

1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch-thick, galvanized sheet steel.
4. Bearings: Oil-impregnated bronze, molded synthetic, or stainless-steel sleeve type.
5. Tie Bars and Brackets: Galvanized steel.

G. Jackshaft: 1-inch-diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.

H. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.4 MANUAL VOLUME DAMPERS (IRIS STYLE)

A. Manufacturers:

2. Fantech; Systemair Group; IR Series.
3. Ruskin Company; VFBD35.

B. Description: Round manual volume damper complete with pressure ports, constructed of galvanized Type 316 stainless steel, fitted with a neoprene gasket, and using interlocking steel plates and calibrated control lever to form an adjustable aperture.
2.5 TURNING VANES

A. Fabricate to comply with SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.

B. Manufactured Turning Vanes: Double-vane or airfoil-shaped, curved blades of galvanized sheet steel set into vane runners suitable for duct mounting.

1. Manufacturers:
   b. Ductmate Industries, Inc.
   c. Duro Dyne Corp.
   d. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

C. Acoustic Turning Vanes: Double-vane curved blades of galvanized sheet steel with perforated faces and fibrous-glass fill set into vane runners suitable for duct mounting.

1. Manufacturers:
   a. Ductmate Industries, Inc.
   b. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

2.6 DUCT-MOUNTING ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class. Doors may be field fabricated in accordance with SMACNA Standards, or commercially produced.

B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.

1. Manufacturers:
   a. Air Balance, Inc.
   b. Greenheck.
   c. Nailor Industries Inc.
   d. Ruskin Company.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

3. Provide number of hinges and locks as follows:
   a. Less Than 12 Inches Square: Secure with two sash locks.
   b. Up to 18 Inches Square: Two hinges and two compression locks.
   c. Up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
   d. Sizes 24 by 48 Inches and Larger: One additional hinge.
C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch thickness. Include cam latches.

   1. Manufacturers:
      a. Ductmate Industries, Inc.
      b. Flexmaster U.S.A., Inc.

   2. Frame: Galvanized sheet steel, with spin-in notched frame.

D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

E. Insulation: 1-inch-thick, fibrous-glass or polystyrene-foam board.

2.7 DUCT ACCESS PANEL ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Ductmate Industries, Inc.
   2. Flame Gard, Inc.
   3. 3M.

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0528-inch carbon steel.

D. Fasteners: Carbon steel. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.8 FLEXIBLE CONNECTORS

A. Manufacturers:

   1. ADSCO Manufacturing LLC.
   2. Duro Dyne Corp.
   3. Senior Flexonics Pathway.
   4. Ventfabrics, Inc.

B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Select metal compatible with ducts.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F.

2.9 FLEXIBLE DUCTS, LOW AND MEDIUM PRESSURE

A. Manufacturers:

1. Flexmaster Type 8M, UL 181, Class 1.
3. Hart & Cooley.

B. Flexible Ducts: Interlocking spiral of galvanized steel or aluminum construction or fabric supported by helically wound spring steel wire or flat steel bands; rated to 6 inches WG positive and 4 inches WG negative for low and medium pressure ducts.

C. Insulated Flexible Ducts: Flexible duct wrapped with flexible glass fiber insulation, enclosed by a fire retardant polyethylene vapor barrier jacket; maximum 0.23 K value at 75 deg F.

D. Acoustical performance tested in accordance with the Air Diffusion Council's Flexible Air Duct Test Code FD 72-R1, Section 3.0, Sound Properties shall be as follows:

The insertion loss (dB) of a 10 foot length of straight duct when tested in accordance with ASTM E477, at a velocity of 2500 feet per minute, shall be minimum:

<table>
<thead>
<tr>
<th>Octave Band</th>
<th>2</th>
<th>3</th>
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<td>Hz.</td>
<td>125</td>
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<td>2000</td>
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<td>6&quot; diameter</td>
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<td>8&quot; diameter</td>
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<tr>
<td>12&quot; diameter</td>
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<td>29</td>
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<td>33</td>
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The radiated noise reduction (dB) of a 10 foot length of straight duct when tested in accordance with ASTM E477, at a velocity of 2500 feet per minute, shall be minimum:

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<td>6&quot; diameter</td>
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<td>13</td>
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<td>8&quot; diameter</td>
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<td>12&quot; diameter</td>
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The self generated sound power levels (LW) dB are 10-12 Watt of a 10 foot length of straight duct for an empty sheet metal duct when tested in accordance with ASTM E477, at a velocity of 1000 feet per minute, shall not exceed:

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<td>12&quot; diameter</td>
<td>53</td>
<td>44</td>
<td>36</td>
<td>27</td>
<td>21</td>
<td>22</td>
</tr>
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</table>

E. Flexible Duct Fittings: Galvanized steel, twist-in design with damper. Size as indicated.
F. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches to suit duct size.

2.10 FLEXIBLE DUCT ELBOW SUPPORTS

A. Manufacturer:
   1. Automation Industries Thermaflex; FlexFlow Elbow.
   2. Smart Air & Energy Solutions; SMART Flow Elbow.

B. Elbow supports shall be constructed of durable composite material and be fully adjustable to support flexible duct diameters 6 inches through 16 inches.

C. Elbow supports shall be UL listed for use in return air plenum spaces.

2.11 CUSTOM FABRICATED HOODS

A. Material: Type 316 stainless steel welded construction.

B. Provide drain connections and duct collars as indicated on Drawings.

C. Size and configuration of each hood shall be as indicated on Drawings.

D. Coordinate with other Trades for knockouts for lights, etc.

2.12 DUCT ACCESSORY HARDWARE

A. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

2.13 FINISHES

A. Chemical Resistant Coating: P-403 manufactured by Heresite Chemical Company.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts and PVC coated ducts; and aluminum accessories in aluminum ducts.

C. Install volume dampers in ducts with liner in a manner that avoids damage to and erosion of duct liner.
D. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.

E. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct coils.
   2. Upstream from duct filters.
   3. At drain pans and seals.
   4. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
   5. Control devices requiring inspection.
   6. Elsewhere as indicated.

F. Install access doors with swing against duct static pressure.

G. Install duct-mounting, rectangular access doors with long dimension at right angles to direction of airflow and of largest standard size which can be accommodated in duct. Maximum size: 21 by 14 inches.

H. Label access doors according to Division 20 Section "Mechanical Identification."

I. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

J. Connect diffusers or light troffer boots to low pressure ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.

K. Connect flexible ducts to metal ducts with draw bands.

L. Install flexible duct elbow supports at each diffuser, grille, or register, and elsewhere as indicated.

M. Install turning vanes in rectangular duct elbows in excess of 45 degrees, and where indicated:
   1. Use manufactured double-vane turning vanes unless otherwise specified.
   2. Seat outboard-most vane in heal of duct elbow.
   3. Provide vanes for all runner punchings, practice of eliminating every other vane is prohibited.
   4. Use single-vane turning vanes in low pressure square elbows.

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. Inspect turning vanes for proper and secure installation.

3.3 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 23 33 00
SECTION 23 37 13
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 1 Specification Sections, apply to this Section.

1.2 SUBMITTALS
A. Product Data: For each product indicated, include the following:
   1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
   2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.

PART 2 - PRODUCTS

2.1 AIR DIFFUSION DEVICES
A. Manufacturers: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   1. Anemostat; a Mestek Company.
   2. Krueger; Tomkins PLC.
   3. Nailor Industries of Texas Inc.
5. Titus; Tomkins PLC.
6. Tuttle & Bailey; Tomkins PLC.

B. Terminal air diffusion devices have been chosen in terms of specific air distribution requirements, spacing, and sound characteristics.

C. Provide plaster frames for units installed in plaster ceilings.

D. Provide gaskets for supply terminal air devices mounted in finished surfaces.

E. Air diffusion devices shall be standard off white baked enamel finish unless noted otherwise. Provide air diffusion device interior surfaces, including blank-offs, with black matte finish.

F. Air pattern adjustments shall be made from the face of the device.

G. Refer to drawings and schedules for quantities, types, and finishes.

H. Coordinate frame types with Architectural Reflected Ceiling Plan.

2.2 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."


PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. 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. Wall-Mounted Supply Registers: Install 6 inches below finished ceiling unless otherwise indicated.

D. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13
SECTION 23 82 19
FAN-COIL 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 include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Basic Mechanical Materials and Methods.”

1.2 DEFINITIONS
A. BAS: Building automation system.
B. IAQ: Indoor air quality.

1.3 SUBMITTALS
A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.


C. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension components.
2. Structural members to which fan-coil units will be attached.
3. Method of attaching hangers to building structure.
4. Size and location of initial access modules for acoustical tile.
5. Items penetrating finished ceiling, including the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Sprinklers.
   e. Access panels.

6. Perimeter moldings for exposed or partially exposed cabinets.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For fan-coil units to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.5 COORDINATION

A. Coordinate layout and installation of fan-coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
B. Coordinate size and location of wall sleeves for outdoor-air intake.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan-Coil-Unit Filters: Furnish spare filter for each filter installed.
2. Fan Belts: Furnish one set of spare fan belts for each unit installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 BLOWER COIL UNITS

A. Manufacturers:

1. Carrier; a United Technologies Company.
2. Daikin Applied; a member of Daikin Industries, Ltd.
3. Enviro-Tec, Johnson Controls, Inc.
4. Magic Aire; div. of United Electric Company L.P.

B. Description: Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

C. Coil Section Insulation: Minimum 1/2-inch thick dual-density coated glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.

1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.

D. Drain Pans: Stainless steel. Fabricate pans and drain connections to comply with ASHRAE 62.1. Include factory-installed float switch to detect high condensate water level and disable fan operation.
E. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panels.

F. Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color.
   1. Return-Air Plenum: Sheet metal plenum finished to match the chassis.
   2. Dampers: Galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.

G. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   1. Washable Foam: 70 percent arrestance and 3 MERV.

H. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

I. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.

J. Belt-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the cabinet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.

K. Motors: Comply with requirements in Division 20 Section "Motors."

L. Control devices and operational sequence are specified in Division 23 Sections "Temperature Controls" and indicated on "Sequence of Operation" on the Drawings.

M. Electrical Connection: Factory wire motors and controls for a single electrical connection.

N. Capacities and Characteristics: Refer to schedule on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fan-coil units level and plumb.

B. Install fan-coil units to comply with NFPA 90A.

C. Suspend fan-coil units from structure with elastomeric hangers. Vibration isolators are specified in Division 20 Section "Mechanical Vibration Controls."

D. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above finished floor.

E. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 20 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

1. Install piping adjacent to machine to allow service and maintenance.
2. Connect condensate drain to indirect waste.
   a. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.

B. Connect refrigerant tubing to components. Install tubing to allow access to unit. Evacuate and charge with refrigerant in accordance with manufacturer’s instructions.

C. Water Piping: Unless otherwise indicated:

1. Install union or flange and isolation valve on supply-water connection.
2. Install union or flange and calibrated balancing valve or PICCV as indicated on the Drawings on return-water connection.
3. Hydronic specialties are specified in Division 23 Section "Hydronic Piping."

D. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Division 23 Section "Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

E. Ground equipment according to Division 26 Section "Grounding and Bonding."

F. Connect wiring according to Division 26 Section "Conductors and Cables."
3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan-coil units.

END OF SECTION 23 82 19
SECTION 26 00 10
ELECTRICAL GENERAL REQUIREMENTS

PART 1 - GENERAL .................................................................................................................. 1
1.1 RELATED DOCUMENTS ................................................................................................... 1
1.2 SUMMARY ....................................................................................................................... 2
1.3 REFERENCES .................................................................................................................. 2
1.4 QUALITY ASSURANCE ................................................................................................. 2
1.5 CODES, PERMITS AND FEES ..................................................................................... 3
1.6 DRAWINGS ..................................................................................................................... 3
1.7 MATERIAL AND EQUIPMENT MANUFACTURERS .................................................... 4
1.8 INSPECTION OF SITE ................................................................................................... 4
1.9 ITEMS REQUIRING PRIOR APPROVAL ...................................................................... 4
1.10 SHOP DRAWINGS/SUBMITTALS ............................................................................. 5
1.11 OPERATION AND MAINTENANCE INSTRUCTIONAL MANUALS ......................... 5
1.12 RECORD DRAWINGS ................................................................................................ 6
1.13 INSTRUCTION OF OWNER PERSONNEL ............................................................... 6
1.14 WARRANTY .................................................................................................................. 7
1.15 USE OF EQUIPMENT .................................................................................................. 7
1.16 COORDINATION ........................................................................................................ 7

PART 2 - PRODUCTS (NOT APPLICABLE) ............................................................................. 8

PART 3 - EXECUTION ............................................................................................................. 8
3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION ......................... 8
3.2 DEMOLITION WORK ..................................................................................................... 8
3.3 INSTALLATION OF EQUIPMENT ............................................................................. 9
3.4 WORK IN EXISTING BUILDINGS ............................................................................ 9
3.5 DISPOSAL .................................................................................................................... 10
3.6 CHASES AND RECESES ........................................................................................... 10
3.7 CUTTING, PATCHING AND DAMAGE TO OTHER WORK ..................................... 10
3.8 EQUIPMENT CONNECTIONS .................................................................................... 11
3.9 CLEANING ................................................................................................................... 11
3.10 PROTECTION AND HANDLING OF EQUIPMENT AND MATERIALS .............. 11
3.11 EXTRA WORK ............................................................................................................ 11
3.12 DRAWINGS AND MEASUREMENTS ...................................................................... 11

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 work of this section.
1.2 SUMMARY

A. This Section includes electrical general administrative and procedural requirements. The following requirements are included in this Section to supplement the requirements specified in Division 1 Specification Sections.

1.3 REFERENCES

A. All materials shall be new. The electrical and physical properties of all materials, and the design, performance characteristics, and methods of construction of all items of equipment, shall be in accordance with the latest issue of the various, applicable Standard Specifications of the following recognized authorities:

1. A.N.S.I. - American National Standards Institute
2. A.S.T.M. - American Society for Testing Materials
3. I.C.E.A. - Insulated Cable Engineers Association
4. I.E.E.E. - Institute of Electrical and Electronics Engineers
5. N.E.C. - National Electrical Code
6. N.E.C.A. -National Electrical Contractors Association
7. N.E.M.A. - National Electrical Manufacturer’s Association
8. U.L. - Underwriters Laboratories, Inc.

1.4 QUALITY ASSURANCE

A. Scope of Work: Furnish all labor, material, equipment, technical supervision, and incidental services required to complete, test and leave ready for operation the electrical systems as specified in the Division 26 Sections and as indicated on Drawings.

1. Contract Documents are complimentary, and what is required by one shall be as binding as if required by all. In the event of inconsistencies or disagreements within the Construction Documents bids shall be based on the most expensive combination of quality and quantity of the work indicated.
2. The Contractor understands that the work herein described shall be complete in every detail.

B. Ordinances and Codes: Perform all Work in accordance with applicable Federal, State and local ordinances and regulations, the Rules and Regulations of NFPA, NECA, and UL, unless otherwise indicated.

1. Notify the Architect/Engineer before submitting a proposal should any changes in Drawings or Specifications be required to conform to the above codes, rules or regulations. After entering into Contract, make all changes required to conform to above ordinances, rules and regulations without additional expense to the Owner.
C. Source Limitations: All equipment of the same or similar systems shall be by the same manufacturer.

D. Tests and Inspections: Perform all tests required by state, city, county and/or other agencies having jurisdiction. Provide all materials, equipment, etc., and labor required for tests.

E. Performance Requirements: Perform all work in a first class and workmanlike manner, in accordance with the latest accepted standards and practices for the trades involved.

F. Sequence and Schedule: Work so as to avoid interference with the work of other trades. Be responsible for removing and relocating any work which in the opinion of the Owner’s Representatives causes interference.

1.5 CODES, PERMITS AND FEES

A. Unless otherwise indicated, all required permits, licenses, inspections, approvals and fees for electrical work shall be secured and paid for by the Contractor. All work shall conform to all applicable codes, rules and regulations.

B. All work shall be executed in accordance with the rules and regulations set forth in local and state codes. Prepare any detailed Drawings or diagrams which may be required by the governing authorities. Where the Drawings and/or Specifications indicate materials or construction in excess of code requirements, the Drawings and/or Specifications shall govern.

1.6 DRAWINGS

A. The Drawings show the location and general arrangement of equipment, electrical systems and related items. They shall be followed as closely as elements of the construction will permit.

B. 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.

C. Deviations from the Drawings, with the exception of minor changes in routing and other such incidental changes that do not affect the functioning or serviceability of the systems, shall not be made without the written approval of the Architect/Engineer.

D. The architectural and structural Drawings take precedence in all matters pertaining to the building structure, mechanical Drawings in all matters pertaining to mechanical trades and electrical Drawings in all matters pertaining to electrical trades. Where there are conflicts or differences between the Drawings for the various trades, report such conflicts or differences to the Architect/Engineer for resolution.
1.7 MATERIAL AND EQUIPMENT MANUFACTURERS

A. All items of equipment shall be furnished complete with all accessories normally supplied with the catalog items listed and all other accessories necessary for a complete and satisfactory operating system. All equipment and materials shall be new and shall be standard products of manufacturers regularly engaged in the production of electrical equipment and shall be of the manufacturer’s latest design.

B. If an approved manufacturer is other than the manufacturer used as the basis for design, the equipment or product provided shall be equal in size, quality, durability, appearance, capacity, and efficiency through all ranges of operation, shall conform with arrangements and space limitations of the equipment shown on the plans and/or specified, shall be compatible with the other components of the system and shall comply with the requirements for Items Requiring Prior Approval specified in this section of the Specifications. All costs to make these items of equipment comply with these requirements including, but not limited to, electrical work, and building alterations shall be included in the original Bid. Similar equipment shall be by one manufacturer.

C. Where existing equipment is modified to include new switches, circuit breakers, metering or other components, the new components shall be by the original equipment manufacturer and shall be listed for installation in the existing equipment. Where original equipment manufacturer components are not available, third party aftermarket components shall be listed for the application and submitted to the engineer for approval. Reconditioned or salvaged components shall not be used unless specifically indicated on the drawings.

1.8 INSPECTION OF SITE

A. Visit the site, examine and verify the conditions under which the Work must be conducted before submitting Proposal. The submitting of a Proposal implies that the Contractor has visited the site and understands the conditions under which the Work must be conducted. No additional charges will be allowed because of failure to make this examination or to include all materials and labor to complete the Work.

1.9 ITEMS REQUIRING PRIOR APPROVAL

A. Bids shall be based upon manufactured equipment specified. All items that the Contractor proposes to use in the Work that are not specifically named in the Contract Documents must be submitted for review prior to bids. Such items must be submitted in compliance with Division 1 specifications. Requests for prior approval must be accompanied by complete catalog information, including but not limited to, model, size, accessories, complete electrical information and performance data in the form given in the equipment schedule on the drawings at stated design conditions. Where
items are referred to by symbolic designations on the drawings, all requests for prior approval shall bear the same designations.

1. Equipment to be considered for prior approval shall be equal in quality, durability, appearance, capacity and efficiency through all ranges of operation, shall fulfill the requirements of equipment arrangement and space limitations of the equipment shown on the plans and/or specified and shall be compatible with the other components of the system.

2. All costs incurred to make equipment comply with other requirements, including providing maintenance, clearance, electrical, replacement of other components, and building alterations shall be included in the original bid.

B. Voluntary alternates may be submitted for consideration, with listed addition or deduction to the bid.

1.10 SHOP DRAWINGS/SUBMITTALS

A. Submit project-specific submittals for review in compliance with Division 1.

B. All shop Drawings shall be submitted in groupings of similar and/or related items (lighting fixtures, switchgear, etc.). Incomplete submittal groupings will be returned unchecked.

C. If deviations (not substitutions) from Contract Documents are deemed necessary by the Contractor, details of such deviations, including changes in related portions of the project and the reasons therefore, shall be submitted with the submittal for approval.

D. Submit for approval shop drawings for all electrical systems or equipment but not limited to the items listed below. Where items are referred to by symbolic designation on the Drawings and Specifications, all submittals shall bear the same designation (light fixtures). Refer to other sections of the electrical Specifications for additional requirements.

1. Lighting Control Devices
2. Fuses
3. Interior Lighting
4. Enclosed Controllers
5. Enclosed Switches
6. Communications Backbone Cabling
7. Communications Horizontal Cabling
8. Fire Alarm

1.11 OPERATION AND MAINTENANCE INSTRUCTIONAL MANUALS

A. Submit project specific Operation and Maintenance Instructional Manuals for review in compliance with Division 1 Specification Sections.
B. Provide complete operation and maintenance instructional manuals covering all electrical equipment herein specified, together with parts lists. Maintenance and operating instructional manuals shall be job specific to this project. Generic manuals are not acceptable. Four (4) copies of all literature shall be furnished for Owner and shall be bound in ring binder form. Maintenance and operating instructional manuals shall be provided when construction is approximately 75% complete.

C. The operating and maintenance instructions shall include a brief, general description for all electrical systems including, but not limited to:

1. Routine maintenance procedures.
2. Trouble-shooting procedures.
3. Contractor’s telephone numbers for warranty repair service.
5. Recommended spare parts lists.
6. Names and telephone numbers of major material suppliers and subcontractors.
7. System schematic drawings on 8-1/2” x 11” sheets.

1.12 RECORD DRAWINGS

A. Submit record drawings in compliance with Division 1.

B. Contractor shall submit to the Architect/Engineer, record drawings on electronic media which have been neatly marked to represent as-built conditions for all new electrical work.

C. The Contractor shall keep accurate note of all deviations from the construction documents and discrepancies in the underground concealed conditions and other items of construction on field drawings as they occur. The marked up field documents shall be available for review by the Architect, Engineer and Owner at their request.

1.13 INSTRUCTION OF OWNER PERSONNEL

A. Before final inspection, instruct Owner’s designated personnel in operation, adjustment, and maintenance of electrical equipment and systems at agreed upon times. A minimum of 8 hours of formal instruction to Owner’s personnel shall be provided for each building. Additional hours are specified in individual specification sections.

B. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.

C. In addition to individual equipment training provide overview of each electrical system. Utilize the as-built documents for this overview.

D. Prepare and insert additional data in operation and maintenance manual when need for such data becomes apparent during instruction, or as requested by Owner.
1.14 WARRANTY

A. Warranty: Comply with the requirements in Division 1 Specification Sections. Contractor shall warranty that the electrical installation is free from defects and agrees to replace or repair, to the Owner’s satisfaction, any part of this electrical installation which becomes defective within a period of one year (unless specified otherwise in other Division 26 sections) from the date of substantial completion following final acceptance, provided that such failure is due to defects in the equipment, material, workmanship or failure to follow the contract documents.

B. Contractor shall be responsible for any temporary services including equipment and installation required to maintain operation as a result of any equipment failure or defect during warranty period.

C. File with the Owner any and all warranties from the equipment manufacturers including the operating conditions and performance capacities they are based on.

1.15 USE OF EQUIPMENT

A. The use of any equipment, or any part thereof for purposes other than testing even with the Owner's consent, shall not be construed to be an acceptance of the work on the part of the Owner, nor be construed to obligate the Owner in any way to accept improper work or defective materials.

B. Do not use Owner's lamps for temporary lighting except as allowed and directed by the Owner. Equip lighting fixtures with new lamps when the project is turned over to the Owner.

1.16 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical 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 raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 8 Section "Access Doors and Frames."

C. Coordinate electrical testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.
PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 DEMOLITION WORK

A. All demolition of existing electrical equipment and materials will be done by this Contractor unless otherwise indicated. Include all items such as, but not limited to, electrical equipment, devices, lighting fixtures, conduit, and wiring called out on the Drawings and as necessary whether such items are actually indicated on the Drawings or not in order to accomplish the installation of the specified new work.

B. In general, demolition work is indicated on the Drawings. However, the Contractor shall visit the job site to determine the full extent and character of this work.

C. Unless specifically noted to the contrary, removed materials shall not be reused in the work. Salvaged materials that are to be reused shall be stored safe against damage and turned over to the appropriate trade for reuse. Salvaged materials of value that are not to be reused shall remain the property of the Owner unless such ownership is waived. Items on which the Owner waives ownership shall become the property of the Contractor, who shall remove and legally dispose of same, away from the premises.

D. Where equipment or fixtures are removed, outlets shall be properly blanked off, and conduits capped. After alterations are done, the entire installation shall present a "finished" look, as approved by the Architect/Engineer. The original function of the present electrical work to be modified shall not be changed unless required by the specific revisions to the system as specified or as indicated.
E. Reroute signal wires, lighting and power wiring as required to maintain service. Where walls and ceilings are to be removed as shown on the Drawings, the conduit is to be cut off by the Electrical Trades so that the abandoned conduit in these walls and ceilings may be removed with the walls and ceilings by the Architectural Trades. All dead-end conduit runs shall be plugged at the remaining line outlet boxes or at the panels.

F. Where new walls and/or floors are installed which interfere with existing outlets, devices, etc., the Electrical Trades shall adjust, extend and reconnect such items as required to maintain continuity of same.

G. All electrical work in altered and unaltered areas shall be run concealed wherever possible. Use of surface raceway or exposed conduits will be permitted only where approved by the Architect/Engineer.

H. Existing lighting shall be reused where indicated on plans. Reused fixtures shall be detergent cleaned, relamped and reconditioned suitable for satisfactory operation and appearance.

3.3 INSTALLATION OF EQUIPMENT

A. Install all equipment in strict accordance with all directions and recommendations furnished by the manufacturer. Where such directions are in conflict with the Drawings and Specifications, report such conflicts to the Architect/Engineer for resolution.

B. Device Location:
   1. Allow for relocation prior to installation of wiring devices and other control devices, for example, receptacles, switches, fire alarm devices, and access control devices, within a 10-foot radius of indicated location without additional cost.

3.4 WORK IN EXISTING BUILDINGS

A. The Owner will provide access to existing buildings as required. Access requirements to occupied buildings shall be identified on the project schedule. The Contractor, once Work is started in the existing building, shall complete same without interruption so as to return work areas as soon as possible to Owner.

B. Adequately protect and preserve all existing and newly installed Work. Promptly repair any damage to same at Contractor's expense.

C. Consult with the Owner's Representative as to the methods of carrying on the Work so as not to interfere with the Owner's operation any more than absolutely necessary. Accordingly, all service lines shall be kept in operation as long as possible and the services shall only be interrupted at such time as will be designated by the Owner's Representative.
3.5 DISPOSAL

A. Fluorescent Lamps

1. Fluorescent lamps are known to contain mercury and are classified as hazardous material. All fluorescent lamps shall be assumed to contain mercury unless tested and confirmed otherwise with a toxicity characteristic leaching procedure (TCLP).
2. Hazardous materials (fluorescent lamps), shall be sent to a lamp recycling facility. The materials shall be properly packaged with labels that meet the Department of Transportation Regulations and stored in a secure location prior to transportation.
3. The Contractor shall identify the costs of the lamp disposal process including, but not limited to, the lamp packaging, storage, transportation, disposal, and any profile fees.
4. At the completion of the project, provide documentation to verify that the lamps have been properly disposed of in accordance with all local, state and federal guidelines.

B. Ballasts

1. Lighting ballasts manufactured prior to 1979 have been known to contain polychlorinated biphenyls (PCBs). Unless specifically noted on the ballast as containing “No PCBs,” the ballast shall be assumed to contain components with PCB materials.
2. Hazardous materials (ballasts with PCBs), shall be disposed of at a hazardous waste incineration facility, or at a recycling facility in accordance with the Code of Federal Regulations as administered by the EPA in regards to this issue. The ballasts shall be packaged/stored in fifty-five gallon steel drums with labels that meet the Department of Transportation Regulations.
3. The Contractor shall identify the costs of the ballast disposal process including, but not limited to, the packaging, storage, transportation, disposal, and any profile fees.
4. Provide at completion of the project documentation (manifests) to verify that the ballasts have properly been disposed of in accordance with all local, state and federal guidelines.

3.6 CHASES AND RECESSES

A. Provided by the architectural trades, but the Contractor shall be responsible for their accurate location and size.

3.7 CUTTING, PATCHING AND DAMAGE TO OTHER WORK

A. Refer to General Conditions for requirements.

B. All cutting, patching and repair work shall be performed by the Contractor through approved, qualified subcontractors. Contractor shall include full cost of same in bid.
3.8 EQUIPMENT CONNECTIONS

A. Make connections to equipment, motors, lighting fixtures, and other items included in the work in accordance with the approved shop Drawings and rough-in measurements furnished by the manufacturers of the particular equipment furnished. All additional connections not shown on the Drawings, but called out by the equipment manufacturer's shop Drawings shall be provided.

3.9 CLEANING

A. All debris shall be removed daily as required to maintain the work area in a neat, orderly condition.

B. Final cleanup shall include, but not be limited to, washing of fixture lenses or louvers, switchboards, substations, motor control centers, panels, etc. Fixture reflectors and lenses or louvers shall be left with no water marks or cleaning streaks.

3.10 PROTECTION AND HANDLING OF EQUIPMENT AND MATERIALS

A. Equipment and materials shall be protected from theft, injury or damage.

B. Protect conduit openings with temporary plugs or caps.

C. Provide adequate storage for all equipment and materials delivered to the job site. Location of the space will be designated by the Owner's representative or Architect/Engineer. Equipment set in place in unprotected areas must be provided with temporary protection.

3.11 EXTRA WORK

A. For any extra electrical work which may be proposed, this Contractor shall furnish to the General Contractor, an itemized breakdown of the estimated cost of the materials and labor required to complete this work. The Contractor shall proceed only after receiving a written order from the General Contractor establishing the agreed price and describing the work to be done. Prior to any extra work which may be proposed, the Electrical Contractor shall submit unit prices (same prices for increase/decrease of work) for the following items: 3/4", 1", 1-1/2" conduit; #12, #10, #8, #6, #2 wire; receptacle, data box, specified surface raceway, fire alarm combination visual/audible notification appliance, fire alarm visual notification appliance, or other devices which may be required for any proposed extra work.

3.12 DRAWINGS AND MEASUREMENTS

A. The Drawings are not intended to be scaled for rough-in measurements nor to serve as Shop Drawings. Field measurements necessary for ordering materials and fitting the...
installation to the building construction and arrangement are the Contractor’s responsibility. The Contractor shall check latest Architectural Drawings and locate light switches from same where door swings are different from Electrical Drawings.

END OF SECTION 26 00 10
SECTION 26 05 19
CONDUCTORS AND CABLES

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes:
   1. Building wires and cables rated 600V and less.
   2. Connectors, splices, and terminations rated 600 V and less.

B. Related Sections include the following:
   1. Division 26 Section "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.3 SUBMITTALS
A. Field Quality-Control Test Reports
1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

B. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for types THHN/THWN-2, and SO.

C. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for Metal-clad cable, Type MC and Type SO with ground wire.

D. Power Cable for Variable Frequency Controlled Motors: 600V and 2000V, three conductor, XLPE cable with three symmetrical positioned ground conductors and a continuous impervious corrugated aluminum armor and overall PVC jacket. Cable shield transfer impedance shall be less than 10 ohms per meter up to 30 MHZ when tested in accordance with NEMA WC 61.

1. Approved manufacturers for VFC power cables:
   a. Southwire Armor-x
   b. Draka USA

2.2 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger, except VFC cable, which shall be extra flexible stranded.

C. Each feeder shall be of the same conductor and insulation material (phase, neutral, and parallel).

D. Use conductor not smaller than 12 AWG for power and lighting circuits. Unless indicated otherwise, all circuits shall be 2#12, 1#12G, $\frac{3}{4}$"C.

E. Use conductor not smaller than 14 AWG for control circuits, provided by Electrical Contractor.

3.2 CONDUCTOR AND INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Exposed Branch Circuits, including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.

B. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway. Type THHN/THWN-2, single conductors in raceway and metal-clad cable, Type MC, for branch circuit drops to devices and within partition walls. MC cable shall not be run in ceiling space in lengths greater than 6'-0".

C. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN/THWN-2, single conductors in raceway.

D. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel wire-mesh strain relief device at terminations to suit application.

E. Fire Alarm Circuits: Type THHN/THWN-2, in raceway and power-limited, fire-protective, signaling circuit cable.

F. Class 1 Control Circuits: Type THHN/THWN-2, in raceway.

G. Class 2 Control Circuits: Power-limited cable, concealed in building finishes.

H. Connection between Variable Frequency Controllers and Motors: Use 600V rated VFC power cable for circuit lengths less than 50 feet and 2000V rated VFC power cable for circuit lengths 50 feet and greater. Support 5’ on center, minimum. Terminate according to cable manufacturer’s recommendations.
3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 26 05 33 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

G. Complete cable tray systems installation according to Section 26 05 36 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

H. Support communication cables above accessible ceiling, using spring metal clips or plastic cable ties to support cables from structure. Do not rest cable on ceiling panels.

I. Neatly train and lace wiring inside boxes, equipment, and panelboards.

J. Branch circuits may be combined up to 3 circuits in a homerun conduit.

K. Provide a separate neutral conductor for each circuit.

L. Electrical Contractor shall be responsible for de-rating of conductors as required by N.E.C. when more than three current carrying conductors are installed in a single raceway or cable.

M. Type MC cable shall be supported and secured at intervals not exceeding 4'-0".

N. AC/MC cable shall not be used for home runs to receptacle or distribution panels.

O. Where AC/MC cable is stacked in cable tray, or bundled, without spacing, the contractor shall apply the appropriate de-rating factors to the conductors.

P. Between support, hangers and termination no more than 3" deflection from the bottom of the cable to a horizontal line between the support/hanger or termination.
Q. Do not route conductors across roof without prior approval from engineer. Where approved, conductors shall be installed in rigid steel conduit and shall be de-rated for ambient temperature per the NEC.

3.4 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.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.
   1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
   2. Use compression type terminations for aluminum conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

D. Clean conductor surfaces before installing lugs and connectors.

E. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

F. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and larger.

G. Use Sta-Kon connectors to terminate stranded conductors #10 AWG and smaller to screw terminals.

H. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

3.5 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 26 05 53 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping".
3.7 FIELD QUALITY CONTROL

A. Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing”

1. Visual and Mechanical Inspection
   a. Inspect cables for physical damage and proper connection in accordance with the one line diagram.
   b. Test cable mechanical connections with an infrared survey.
   c. Check cable color-coding against project Specifications and N.E.C. requirements.

END OF SECTION 26 05 19
SECTION 26 05 26
GROUNDING AND BONDING

PART 1 - GENERAL ................................................................. 1
  1.1 RELATED DOCUMENTS ......................................................... 1
  1.2 SUMMARY ........................................................................... 1
  1.3 REFERENCES ....................................................................... 1
  1.4 QUALITY ASSURANCE ......................................................... 2

PART 2 - PRODUCTS ................................................................... 3
  2.1 MANUFACTURERS .................................................................. 3
  2.2 GROUNDING CONDUCTORS ............................................... 3
  2.3 CONNECTOR PRODUCTS ........................................................ 3

PART 3 - EXECUTION ................................................................ 3
  3.1 EQUIPMENT GROUNDING ................................................... 3
  3.2 CONNECTIONS ..................................................................... 4
  3.3 INSTALLATION .................................................................. 5
  3.4 FIELD QUALITY CONTROL .................................................... 5

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 grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

B. Related Sections include the following:

1. Division 26 Section “Electrical General Requirements”.
2. Division 26 Section “Conductors and Cables”.

1.3 REFERENCES

A. ASTM B 3: Specification for Soft or Annealed Copper Wire.

B. ASTM B 8: Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.

C. ASTM B 33: Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.


L. NFPA 70B: Recommended Practice for Electrical Equipment Maintenance.


N. UL 467: Grounding and Bonding Equipment.

O. UL 486 A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: Refer to specification section “Electrical Testing.”

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

   1. Comply with UL 467.

C. Comply with NFPA 70; for overhead-line construction and medium-voltage underground construction, comply with IEEE C2.

D. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.

E. Comply with ANSI/TiA/EiA-607 “Standard for Commercial Building Grounding and Bonding Requirements for Telecommunications”.


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LABORATORY EQUIPMENT SPECIFICATIONS
GROUNDING AND BONDING
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Grounding Conductors and Cables:
   a. Refer to Division 26 Section “Conductors and Cables”.

2. Mechanical Connectors:
   b. Burndy.
   c. Chance/Hubbell.

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section "Conductors and Cables."

B. Material: Copper.

C. Equipment Grounding Conductors: Insulated with green-colored insulation.

2.3 CONNECTOR PRODUCTS

A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.

B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.

C. Welded Connectors: Exothermic-welded type, in kit form, and selected for the specific application per manufacturer’s written instructions.

D. Compression-Type Connectors: Pure, wrought copper, per ASTM B187.

PART 3 - EXECUTION

3.1 EQUIPMENT GROUNDING

A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.

B. In raceways, use insulated equipment grounding conductors.

C. Install equipment grounding conductors in all feeders and circuits. Terminate each end on suitable lugs, bus or bushing.
D. Computer Outlet Circuits: Install insulated equipment grounding conductor in branch-circuit runs from computer-area power panels or power-distribution units.

E. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

F. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.

G. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.

H. Verify specific equipment grounding requirements with the manufacturer’s recommendations.

3.2 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.

B. Equipment Grounding Conductor Terminations

1. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and larger.
2. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

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 noncontinuous 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.

3.3 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Install in conduit where routed above grade.

B. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.

C. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.

D. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.

E. Equipment Grounding: Provide a permanent and continuous bonding of conductor enclosures, equipment frames, power distribution equipment ground busses, cable trays, metallic raceways, and other non-current carrying metallic parts of the electrical system.

F. Bond together metal building elements not attached to grounded structure; bond to ground.

3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing”

1. Inspect grounding and bonding system conductors and connections for tightness and proper installation and for compliance with the Drawings and Specifications.
SECTION 26 05 29
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. This Section includes the following:
      1. Hangers and supports for electrical equipment and systems.

1.3 DEFINITIONS
   A. EMT: Electrical metallic tubing.
   B. IMC: Intermediate metal conduit.
   C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS
   A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

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HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS 260529 - 1
B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. ERICO International Corporation.
   d. GS Metals Corp.
   e. Thomas & Betts Corporation.
   f. Unistrut; Tyco International, Ltd.
   g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
4. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti Inc.
      4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      5) MKT Fastening, LLC.

2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

5. Toggle Bolts: All-steel springhead type.


2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70 or as scheduled in NECA 1. Minimum rod size shall be 1/4 inch in diameter.
C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with:

   a. Two-bolt conduit clamps
   b. Single-bolt conduit clamps

D. Support single runs of MC cable using spring-steel clamps from suspended ceiling hangers, hanger wire or building structure at intervals not to exceed three feet. Do not support MC cable from ceiling grid.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. To Steel:

   a. Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
   b. Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69
   c. Spring-tension clamps.

6. To Light Steel: Sheet metal screws.
7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel support systems attached to substrate.
E. Slotted support systems applications:
   1. Indoor dry and damp Locations: Painted Steel
   2. Corrosive Environments, including pool equipment rooms: Nonmetallic

F. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

G. Do not fasten supports to pipes, ducts, mechanical equipment, and conduit.

H. Obtain permission from Architect/Engineer before drilling or cutting structural members.

I. Fabricate supports from structural steel or steel channel. Rigidly weld members or use hexagon head bolts to present neat appearance with adequate strength and rigidity. Use spring lock washers under all nuts.

J. Install surface-mounted cabinets and panelboards with minimum of four anchors.

K. In wet and damp locations use steel channel supports to stand cabinets and panelboards one inch off wall.

L. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

M. The Contractor shall replace all supports and channels that sag, twist, and/or show signs of not providing proper structural support, to the equipment, it is intended for, as determined by the Owner and Architect/Engineer. All costs associated with replacing supports and steel channels shall be incurred by the Contractor.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

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

3.4 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
B. Touchup: Comply with requirements in Division 09 for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 26 05 29
SECTION 26 05 33
RACEWAYS AND BOXES

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 raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:

1. Division 07 Section, “Penetration Firestopping” for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
2. Division 26 Section “Wiring Devices” for devices installed in boxes and for floor-box service fittings, and for access floor boxes and service poles.
1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. FMC: Flexible metal conduit.
C. IMC: Intermediate metal conduit.
D. LFMC: Liquidtight flexible metal conduit.
E. RNC: Rigid nonmetallic conduit.
F. PVC: Polyvinyl Chloride.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Allied Tube Triangle Century.
4. Anamet Electrical, Inc.; Anaconda Metal Hose.
5. International Metal Hose.
6. Electri-Flex Co
7. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
8. LTV Steel Tubular Products Company – Manhattan/CDT/Cole-Flex.
11. Wheatland.

B. Rigid Steel Conduit: ANSI C80.1.
C. IMC: ANSI C80.6.
D. EMT: ANSI C80.3.
E. FMC: Zinc-coated steel.
F. LFMC: Flexible steel conduit with PVC jacket.
G. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
2. Fittings for EMT: Steel, set-screw type.
3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

2.2 FIRE ALARM EMT
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Allied Tube Triangle Century.
B. EMT conduit with bright red topcoat; Fire Alarm EMT.
C. EMT and Fittings: ANSI C80.3.

2.3 METAL WIREWAYS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hoffman.
   2. Square D.
B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

E. Wireway Covers: Screw-cover type.

F. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   b. Thomas & Betts Corporation.
   d. Wiremold Company (The); Electrical Sales Division.
   e. Mono-Systems, Inc.

B. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.5 BOXES, ENCLOSURES, AND CABINETS

A. Sheet Metal Outlet and Device Boxes: NEMA OS 1. Shall be used within walls or ceiling.

B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover. Shall be used in all exposed, non-recessed, locations.

C. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

D. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover. Shall be used in areas exposed to water.
2.6 SLEEVES FOR RACEWAYS
   A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
   B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
   C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch thickness as indicated and of length to suit application.
   D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 7 Section "Through-Penetration Firestop Systems."

2.7 GROUT
   A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION
   A. Provide raceways in interior and exterior locations in accordance with the "Raceway Application Matrix" included on the drawings.
   B. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.
   C. Minimum Raceway Size: 3/4-inch trade size.
   D. Raceway Fittings: Compatible with raceways and suitable for use and location.
      1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
      2. EMT: Use setscrew fittings. Comply with NEMA FB 2.10.
      3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Install surface raceways only where indicated on Drawings.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Install temporary closures to prevent foreign matter from entering raceways.

F. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.

G. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.

H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

I. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.

J. Support conduit within 12 inches of enclosures to which attached.

K. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
1. Run parallel or banked raceways together on common supports.
2. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

N. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.

O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

P. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.

Q. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer’s written instructions.

R. Terminations:

1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.

S. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

T. Provide pull string and 25% spare capacity in every branch circuit conduit.
U. Telephone and Signal System Raceways, 2-Inch Trade Size and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

1. Electrical condulet (LB’s) are not permitted.
2. Conduits shall have no more than two 90 degree bends between pull points or pull boxes.
3. Conduits shall contain no continuous sections longer than 100 ft. without a pull point/box.
4. The bend radius of conduit must be at least 6 times the internal diameter for a conduit 2 inches or less and a radius of 10 times the diameter for a conduit greater than two inches.
5. All conduit ends shall have an insulated bushing.

V. Install raceway sealing fittings at suitable, approved, and 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:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where conduits route through, to, or from a hazardous classified space (Class I or II), provide proper seal offs when exiting or entering the hazardous classified space.
3. Where conduits pass between spaces that are maintained at two different vapor pressures.
4. Where otherwise required by NFPA 70.

W. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.

X. Flexible Conduit Connections: Comply with NEMA RV3. Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.
Y. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals. Provide cover clips to cover space between connecting pieces.

Z. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

AA. Locate boxes so that cover or plate will not span different building finishes.

BB. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

CC. Do not route feeders across roof.

DD. Provide a pull box (a handhole for outdoor applications) for each conduit run that exceeds 250 feet. Provide two pull boxes (handholes for outdoor applications) for runs that exceed 500 feet.

EE. Outlet boxes within hazardous locations shall be of the proper class and division as noted in the N.E.C.

3.3 SLEEVE INSTALLATION FOR ELECTRICAL AND COMMUNICATIONS PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Through-Penetration Firestop Systems."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:
   1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
   2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.
E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both surfaces of walls.

G. Extend sleeves installed in floors 2 inches above finished floor level.

H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 7 Section "Through-Penetration Firestop Systems."

L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

3.4 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Through-Penetration Firestop Systems."

3.5 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.6 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 26 05 33
SECTION 26 05 53
ELECTRICAL IDENTIFICATION

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. Identification for raceway and metal-clad cable.
   2. Identification for conductors and communication and control cable.
   3. Equipment identification labels.

1.3 QUALITY ASSURANCE
A. Comply with NFPA 70.

1.4 COORDINATION
A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer’s wiring...

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. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Color for Printed Legend:

1. Power Circuits: Black letters on an orange field.
2. Legend: Indicate system or service and voltage, if applicable.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.2 CONDUCTOR, COMMUNICATION AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.3 EQUIPMENT IDENTIFICATION LABELS


2.4 WIRING DEVICE IDENTIFICATION

A. Description: Self adhesive label with black upper case letters on clear polyester label, font size 7.
PART 3 - EXECUTION

3.1 APPLICATION

A. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:

1. Fire Alarm System: Red.
3. Telecommunication System: Green and yellow.
4. Control Wiring: Green and red.

B. Power-Circuit Conductor Identification: For conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use color-coding conductor tape and marker tape. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

C. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use marker tape. Identify each ungrounded conductor according to source and circuit number as indicated on Drawings. Identify control circuits by control wire number as indicated on shop drawings.

D. Branch-Circuit Conductor Identification: Mark junction box covers in indelible ink with the panel and breaker numbers of other circuits contained within.

E. Conductor Identification: Locate at each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection or termination point.


1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

G. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:
a. Indoor Equipment: Engraved, laminated acrylic or melamine label mechanically secured.

2. Equipment to Be Labeled: If included on project. All items may not be on project.
   a. Access doors and panels for concealed electrical items.
   b. Disconnect switches.
   c. Enclosed circuit breakers.
   d. Motor starters.
   e. Remote-controlled switches, dimmer modules, and control devices.

H. Wiring Device Identification Labels: On each faceplate install circuit designation label that is consistent with panelboard directories, and as-built plan drawings. Apply labels to receptacle faceplates centered below bottom outlet. Apply labels to toggle switch faceplates on backside.

3.2 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location:
   1. Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
   2. Conduit Markers: Provide identification for each power conduit containing conductors rated 400A or greater.

C. Apply identification devices to surfaces after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.

G. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
   1. Color shall be factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.
   2. Colors for 208/120-V Circuits:
a. Phase A: Black.
b. Phase B: Red.
c. Phase C: Blue.

3. Colors for 480/277-V Circuits:
   b. Phase B: Orange.
   c. Phase C: Yellow.

4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

H. Label information arrangement for 3 lines of text.
   1. Line one shall describe the panel or equipment. Line one example: “DP-XX,” “RP-XX,” “T-XX,” “EF-XX,” etc.
   2. Line two shall describe the first disconnecting means feeding this panel or equipment. Line two example: “Fed from DP-XX,” “Fed from RP-XX,” etc.
   3. Line three indicates that location of the disconnecting means as identified in line two. Line three example: “First Floor Elect. Rm #XXX.”
   4. Line four shall include “Via T-XX” when panel or equipment is fed from a transformer.

I. Examples:

<table>
<thead>
<tr>
<th>RP-1A</th>
<th>EF-1</th>
<th>LP-1A</th>
</tr>
</thead>
<tbody>
<tr>
<td>FED FROM DP-1A</td>
<td>FED FROM MCC-1A</td>
<td>LOCATED IN</td>
</tr>
<tr>
<td>ELECTRICAL ROOM A100</td>
<td>MECHANICAL ROOM F101</td>
<td>ELECTRICAL ROOM A100</td>
</tr>
<tr>
<td>VIA T-1A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

J. Degrease and clean surface to receive nameplates.

K. Install nameplate and labels parallel to equipment lines.

L. Secure nameplate to equipment front using screws.

M. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

N. Identify conduit using field painting where required.

O. Paint red colored band on each fire alarm conduit and junction box if fire alarm EMT is not used.

P. Paint bands 10 feet on center, and 4 inches minimum in width.

END OF SECTION 26 05 53
SECTION 26 0573
OVERCURRENT DEVICE COORDINATION STUDY/ARC FLASH HAZARD ANALYSIS

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 work of this section.

1.2 SCOPE
A. The contractor shall furnish short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in NFPA 70E - Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D prepared by the electrical equipment manufacturer.

C. The scope of the studies shall include all new distribution equipment supplied by the equipment Manufacturer under this contract.

1.3 REFERENCES

1.4 SUBMITTALS FOR REVIEW/APPROVAL

1.5 SUBMITTALS FOR CONSTRUCTION

1.6 QUALIFICATIONS

1.7 COMPUTER SOFTWARE PROGRAMS

PART 2 - PRODUCTS

2.1 STUDIES

2.2 DATA COLLECTION

2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

2.4 PROTECTIVE DEVICE COORDINATION STUDY

2.5 ARC FLASH HAZARD ANALYSIS

2.6 REPORT SECTIONS

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

3.2 ARC FLASH WARNING LABELS
1.3 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
6. IEEE 1584 -Guide for Performing Arc-Flash Hazard Calculations

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis

C. The National Fire Protection Association (NFPA)

1. NFPA 70 -National Electrical Code, latest edition
2. NFPA 70E – Standard for Electrical Safety in the Workplace

1.4 SUBMITTALS FOR REVIEW/APPROVAL

A. The short-circuit and protective device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.5 SUBMITTALS FOR CONSTRUCTION

A. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. Five (5) bound copies of the complete final report shall be submitted. Additional copies of the short-circuit input and output data, where required, shall be provided on CD in PDF format.
B. The report shall include the following sections:

1. Executive Summary.
2. Descriptions, purpose, basis and scope of the study.
3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties.
4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.
5. Fault current calculations including a definition of terms and guide for interpretation of the computer printout.
6. Details of the incident energy and flash protection boundary calculations.
7. Recommendations for system improvements, where needed.
8. One-line diagram.

C. Arc flash labels shall be provided in hard copy and a copy of the computer analysis software viewer program is required to provide arc flash labels in electronic format.

1.6 QUALIFICATIONS

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

B. The Registered Professional Electrical Engineer shall be a full-time employee of the equipment manufacturer.

C. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.

D. The equipment manufacturer shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analysis it has performed in the past year.

1.7 COMPUTER SOFTWARE PROGRAMS

A. Computer Software Programs: Subject to compliance with requirements, provide products by one of the following:

1. EDSA Micro Corporation.
2. SKM Systems Analysis, Inc.
3. ESA Inc.
4. CGI CYME.
5. Operation Technology, Inc.
PART 2 - PRODUCTS

2.1 STUDIES

A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E - Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D prepared by the equipment manufacturer.

2.2 DATA COLLECTION

A. Contractor shall furnish all data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination may include present and future motors and generators.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner.

D. If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data to satisfy the study requirements.

2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY


B. Transformer design impedances shall be used when test impedances are not available.

C. Provide the following:

1. Calculation methods and assumptions
2. Selected base per unit quantities
3. One-line diagram of the system being evaluated
4. Source impedance data, including electric utility system and motor fault contribution characteristics
5. Tabulations of calculated quantities
6. Results, conclusions, and recommendations.
D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:

1. Electric utility’s supply termination point
2. Incoming switchgear
3. Unit substation primary and secondary terminals
4. Low voltage switchgear
5. Motor control centers
6. Standby generators and automatic transfer switches
7. Branch circuit panelboards
8. Other significant locations throughout the system.

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

F. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short circuit ratings
2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
3. Notify design engineer in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.

2.4 PROTECTIVE DEVICE COORDINATION STUDY

A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

B. Include on each TCC graph, a complete title and one-line diagram with legend identifying the specific portion of the system covered.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the TCC graphs, where applicable:

1. Electric utility’s overcurrent protective device
2. Medium voltage equipment overcurrent relays
3. Medium and low voltage fuses including manufacturer’s minimum melt, total clearing, tolerance, and damage bands
4. Low voltage equipment circuit breaker trip devices, including manufacturer’s tolerance bands
5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
6. Conductor damage curves
7. Ground fault protective devices, as applicable
8. Pertinent motor starting characteristics and motor damage points, where applicable
9. Pertinent generator short-circuit decrement curve and generator damage point
10. The largest feeder circuit breaker in each motor control center and applicable panelboard.

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.

B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.

C. The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA where work could be performed on energized parts.

D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm².

E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.

G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).

H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.

I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

2.6 REPORT SECTIONS

A. Input data shall include, but not be limited to the following:

1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
3. Generation contribution data, (synchronous generators and Utility), including short-circuit reactance (X"d), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
4. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.

B. Short-Circuit Output Data shall include, but not be limited to the following reports:

1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
a. Voltage
b. Calculated fault current magnitude and angle
c. Fault point X/R ratio
d. Equivalent impedance

2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

a. Voltage
b. Calculated symmetrical fault current magnitude and angle
c. Fault point X/R ratio
d. Calculated asymmetrical fault currents
   1) Based on fault point X/R ratio
   2) Based on calculated symmetrical value multiplied by 1.6
   3) Based on calculated symmetrical value multiplied by 2.7
e. Equivalent impedance

3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:

a. Voltage
b. Calculated symmetrical fault current magnitude and angle
c. Fault point X/R ratio
d. No AC Decrement (NACD) Ratio
e. Equivalent impedance
f. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a symmetrical basis
g. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a total basis

C. Recommended Protective Device Settings:

1. Phase and Ground Relays:
   a. Current transformer ratio
   b. Current setting
   c. Time setting
   d. Instantaneous setting
   e. Recommendations on improved relaying systems, if applicable.

2. Circuit Breakers:
   a. Adjustable pickups and time delays (long time, short time, ground)
   b. Adjustable time-current characteristic
   c. Adjustable instantaneous pickup
d. Recommendations on improved trip systems, if applicable.

D. Incident energy and flash protection boundary calculations

1. Arcing fault magnitude
2. Protective device clearing time
3. Duration of arc
4. Arc flash boundary
5. Working distance
6. Incident energy
7. Hazard Risk Category
8. Recommendations for arc flash energy reduction

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

A. The contractor shall adjust relay and protective device settings according to the recommended settings table provided by the coordination study.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify design engineer in writing of any required major equipment modifications.

3.2 ARC FLASH WARNING LABELS

A. The contractor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.

B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.

C. The label shall include the following information, at a minimum:

1. Location designation
2. Nominal voltage
3. Flash protection boundary
4. Hazard risk category
5. Incident energy
6. Working distance
7. Engineering report number, revision number and issue date.

D. Labels shall be machine printed, with no field markings.
E. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.

1. For each 480 and applicable 208 volt panelboard, one arc flash label shall be provided.
2. For each motor control center, one arc flash label shall be provided.
3. For each low voltage switchboard, one arc flash label shall be provided.
4. For each switchgear, one flash label shall be provided.
5. For medium voltage switches one arc flash label shall be provided.

F. Labels shall be field installed by the contractor.

END OF SECTION 26 0573
SECTION 26 09 23
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 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following lighting control devices:
   1. Indoor photoelectric control.
   2. Occupancy sensors.

B. Related Sections include the following:
   1. Division 26 Section “Electrical General Requirements”.
   2. Division 26 Section “Wiring Devices” for wall-box dimmers and manual light switches.
1.3 REFERENCES

E. UL 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.
F. UL 1449: Transient Voltage Surge Suppressors.
G. UL 1598: Luminaires.
H. NECA 130-2010: Installing and Maintaining Wiring Devices.

1.4 DEFINITIONS

A. LED: Light-emitting diode.
B. PIR: Passive infrared.
C. ULTRASONIC: Active emission of at least 35 kHz sound waves, using Doppler reflectance to detect motion.
D. MICROPHONIC: Passive reception to listen for continued occupancy, with circuitry to filter out white noise.
E. MULTI-Tech: Using PIR and ultrasonic or microphonic technologies in one sensor.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated including physical data and electrical performance.
B. Shop Drawings: Show installation details for occupancy and light-level sensors.
   1. Lighting plan showing location, orientation, and coverage area of each sensor.
   2. Interconnection diagrams showing field-installed wiring.
C. Field quality-control test reports.
D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. Include the following:

1. Description of operation and servicing procedures.
2. List of major components.
3. Recommended spare parts.
4. Programming instructions and system operation procedures.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.7 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

B. Coordinate interface of lighting control devices with temperature controls specified in Division 23.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the site under provisions of Division 26 Section “Electrical General Requirements”.

B. Store and protect products under provisions of Division 26 Section “Electrical General Requirements”.

PART 2 - PRODUCTS

2.1 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS

A. Line-Voltage Surge Protection: An integral part of the devices for 120- and 277-V solid-state equipment. For devices without integral line-voltage surge protection, field-mounting surge protection shall comply with IEEE C62.41 and with UL 1449.

2.2 OCCUPANCY SENSORS

A. General
1. Coordinate occupancy sensor locations, coverages and required quantities with manufacturer’s recommendations. Coverage areas indicated on the Drawings are for minor motion (6 to 8 inches of hand movement). Provide additional occupancy sensors and control units as required to achieve complete minor motion coverage of the space indicated.

2. Adjust occupancy sensors and test that complete minor motion coverage is obtained in accordance with Part 3. Provide written confirmation of testing to owner, architect and engineer.

3. Provide occupancy sensors with a bypass switch to override the “ON” function in the event of sensor failure.

4. Provide occupancy sensors with an LED indicator indicating when motion is being detected during testing and normal operation of the sensor.

5. Provide occupancy sensors and occupancy sensor control units from single manufacturer.

B. Wall Switch Passive Infrared Occupancy Sensor

1. Manufacturers:
   a. Wattstopper PW-100.
   c. Greengate OSW-P-0451-W.
   d. Sensorswitch WSD.
   e. Philips LRS2210.

2. Description: Wall mounted, 180° coverage, passive infrared sensing occupancy sensor.
   a. Electrical Characteristics: Capable of switching up to 800W fluorescent or incandescent lighting loads at 120V and 1200 watts fluorescent loads at 277V.
   c. Adjustments: User adjustable sensitivity and time delay. Time delay shall be adjustable from 30 seconds to 30 minutes. Ambient light sensing shall be adjustable from 20FC to 300FC, with override.
   d. Ambient Light Sensor: Integral ambient light sensor to switch off lights when sufficient daylight is present.
   e. Device Body: White, plastic with momentary on/off override pushbutton designed to mount in a standard switch box with “decora” style switch plate.

3. Dual Level Switching: Provide occupancy sensor capable of controlling two switch legs independently where dual level switching is indicated.
   a. Manufacturers:
      1) Perfect Sense PWD.
      2) Wattstopper PW-200.
4) Greengate OSW-P-0451-DMV.
5) Sensorswitch WSD-2P.
6) Philips LRS2215.
7) Leviton ODSOD-IDW.

C. 360° Ceiling Mounted Dual Technology Occupancy Sensor

1. Manufacturers:
   a. Wattstopper DT 300
   c. Greengate OMC-DT-2000-R.
   d. Sensorswitch CM-PDT-R.
   e. Philips LRM2255.

2. Description: Ceiling mounted, 360° coverage, multi-tech sensing occupancy sensor.
   a. Housing: White, thermoplastic, tamper resistant ceiling mount.
   b. Functions: Automatic ON must sense motion from both ultrasonic and infrared sensing elements. Either technology shall maintain ON, with adjustable time delays.
   c. Adjustments: User adjustable sensitivity adjustment shall be provided for each sensing technology. Time delay shall be adjustable from 30 seconds to 30 minutes.
   d. Sensor shall operate on 24V DC power through control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.
   e. Manual override function.

D. 110° Wall Mounted Dual Technology Occupancy Sensor

1. Manufacturers:
   a. Wattstopper DT-200
   c. Sensorswitch WV-PDT-R/WV-BR.
   d. Philips LRM2265.

2. Description: Wall mounted, 110° coverage, multi-tech occupancy sensor.
   a. Housing: White, thermoplastic, tamper resistant with swivel bracket for wall or ceiling mounting.
   b. Functions: Automatic ON must sense motion from both sensing elements. Either technology shall maintain ON, with adjustable time delays.
   c. Adjustments: User adjustable sensitivity adjustment shall be provided for each sensing technology. Time delay shall be adjustable from 30 seconds to 15 minutes.
d. Sensor Orientation: Orient sensor in room such that sensor will not detect motion through open door which could cause false activation.

e. Sensor shall operate on 24V DC power through control unit which supplies DC power to the sensor and provides relay contacts to control the lighting load and auxiliary contacts.


E. Occupancy Sensor Control Units:

1. Description: Transformer and relay combined in single unit to provide 24DC power to sensors and provide 20A contact(s) for control of lighting loads at 120 or 277V. Control unit input power shall be from unswitched leg of lighting circuit it is controlling.

a. Control units shall be provided as required to power ceiling mounted occupancy sensors, control lighting loads and provide a minimum of one auxiliary contact.

b. Occupancy sensor control units shall mount external to 4" sq junction box in the ceiling space. Wiring between control unit and occupancy sensor shall be plenum rated.

c. Locate control unit in accessible location in gyp-board ceilings, adjacent to return air grilles, or provide access panel.

d. Additional auxiliary relay modules shall be provided as required to provide control of all lighting circuits and additional auxiliary contacts as required.

e. It is acceptable to provide controls and auxiliary contacts as required integral to the ceiling sensor, provided all required contacts are provided.

f. Maximum of 3 sensors per power pack. Verify exact quantities required with manufacturer.

PART 3 - EXECUTION

3.1 OCCUPANCY SENSOR INSTALLATION

A. Install wall mounted occupancy sensors as noted on plan. Arrange occupancy sensors with adjacent switch devices so that device plates line-up and are equally spaced.

B. Install ceiling mounted sensors at approximate locations as indicated on plan. Sensor manufacturer shall provide quantity of sensors as required to provide complete coverage for rooms.

C. Locate sensors such that motion through open doors will not falsely activate sensors.

D. Do not locate ultrasonic sensors within six feet of supply air diffusers.

E. Locate infrared sensors to avoid obstructions.
F. Provide the services of a manufacturer's representative for commissioning of occupancy sensor installation. This shall include consultation on layout and location prior to installing sensors, testing of each sensor for compliance with Contract Documents and field adjustment and fine tuning after installation is complete. Provide written confirmation of testing to the Owner, Architect and Engineer.

G. Field adjustments shall take place in the presence of the owner and the engineer. This shall include owner training on adjustment techniques for the occupancy sensors.

3.2 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Conductors and Cables".

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

E. 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.

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Electrical Identification."

B. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.

2. Operational Test: Verify actuation of each sensor and adjust time delays.

B. Remove and replace lighting control devices where test results indicate that they do not comply with specified requirements.
C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

END OF SECTION 260923
SECTION 26 09 99
ELECTRICAL TESTING

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 work of this section.

B. Related Sections include the following:
   1. Division 26 Section “Electrical General Requirements.”
   2. Division 26 Section “Grounding and Bonding.”
   3. Division 26 Section “Enclosed Switches.”
   4. Division 26 Section “Fuses.”

1.2 SECTION INCLUDES
A. A recognized corporately independent N.E.T.A. certified testing firm will be contracted separately by the Owner for the purpose of performing inspections and tests as herein specified. The Electrical Contractor shall be familiar with the work required by the testing agency, fully cooperate with implementation of the acceptance testing program, and provide any work in this section specifically required by the Electrical Contractor.

B. It is the intent of these tests to assure that all tested electrical equipment is operational and within industry and manufacturer’s tolerances and is installed in accordance with design Specifications.

C. The test and inspections shall determine suitability for energization.
D. Equipment to be tested and inspected shall be the equipment shown on the one line diagram and schedules as required by part three of each individual Specification Section. In addition, all equipment that is part of an emergency distribution system shall be tested.

1.3 REFERENCES

A. All inspections and tests shall be in accordance with the latest version of the following codes and standards except as provided otherwise herein.

1. National Electrical Manufacturer's Association - NEMA
3. Institute of Electrical and Electronic Engineers - IEEE
7. State and Local Codes and Ordinances
8. Insulated Cable Engineers Association - ICEA
9. Association of Edison Illuminating Companies - AEIC
10. Occupational Safety and Health Administration
11. National Fire Protection Association - NFPA
   a. ANSI/NFPA 70: National Electrical Code
   b. ANSI/NFPA 70B: Electrical Equipment Maintenance
   c. NFPA 70E: Electrical Safety Requirements for Employee Workplaces

1.4 QUALIFICATIONS

A. The testing firm shall be a corporately independent testing organization, which can function as an unbiased testing authority, professionally independent of the manufacturers, suppliers, and installers of equipment or systems evaluated by the testing firm.

B. The testing firm shall be regularly engaged in the testing of electrical equipment devices, installations, and systems.

C. The lead, on site, technical person and at least 50% of the on site crew shall be currently certified by the InterNational Electrical Testing Association (NETA) or National Institute for Certification in Engineering Technologies in Electrical Power Distribution System Testing.

D. The testing firm shall only utilize technicians who are regularly employed by the firm on a full-time basis for testing services.
E. The Contractor shall submit proof of the above qualifications with bid proposal.

F. The terms used herewithin such as Test Agency, Test Contractor, Testing Laboratory, or Contractor Test Company, shall be construed to mean the testing organization.

G. Acceptable Testing Firms:
   1. Northern Electrical Testing; Phone (248) 689-8980.
   2. Utilities Instrumentation Services; Phone (734) 482-1450.
   3. Emerson/High Voltage Maintenance Corporation; Phone (248) 305-5596.
   4. Powertech Services, Inc.; Phone (810) 720-2280.
   5. Magna Electric; Phone (248) 667-9492.

1.5 PERFORMANCE REQUIREMENTS

A. The Electrical Contractor shall supply a suitable and stable source of electrical power to each test site. The testing firm shall specify the power requirements.

B. The Electrical Contractor shall notify the testing firm when equipment becomes available for acceptance tests. Work shall be coordinated to expedite project scheduling.

C. The testing firm shall notify the Owner's Representative prior to commencement of any testing.

D. Any system, material or workmanship, which is found defective on the basis of acceptance tests, shall be reported to the Engineer. The Electrical Contractor shall correct all defects.

E. The testing organization shall maintain a written record of all tests and shall assemble and certify a final test report.

F. Safety and Precautions
   1. Safety practices shall include, but are not limited to, the following requirements:
      a. Occupational Safety and Health Act.
      c. Applicable state and local safety operating procedures.
      d. NETA Safety/Accident Prevention Program.
      e. Owner's safety practices.
      f. National Fire Protection Association - NFPA 70E.
      g. American National Standards for Personnel Protection.
   2. All tests shall be performed with apparatus de-energized except where otherwise specifically required.
3. The testing organization shall have a designated safety representative on the project to supervise operations with respect to safety.

1.6 TEST INSTRUMENT CALIBRATION

A. Test Instrument Calibration

1. The testing firm shall have a calibration program, which assures that all applicable test instruments are maintained within rated accuracy.
2. The accuracy shall be directly traceable to the National Institute of Standards and Technology.
3. Instruments shall be calibrated in accordance with the following frequency schedule:
   a. Field instruments: Analog - 6 months maximum Digital - 12 months maximum
   b. Laboratory instruments: 12 months
   c. Leased specialty equipment: 12 months
      (Where accuracy is guaranteed by Lessor)
4. Dated calibration labels shall be visible on all test equipment.
5. Records must be kept up-to-date which show date and results of instruments calibrated or tested.
6. An up-to-date instrument calibration instruction and procedures shall be maintained for each test instrument.
7. Calibrating standard shall be of higher accuracy than that of the instrument tested.

B. Field Test Instrument Standards

1. All equipment used for testing and calibration procedures shall exhibit the following characteristics:
   a. Maintained in good visual and mechanical condition.
   b. Maintained in safe, operating condition.

C. Suitability of Test Equipment

1. All test equipment shall be in good mechanical and electrical condition.
2. Selection of metering equipment should be based on knowledge of the waveform of the variable being measured. Digital multi-meters may be average of RMS sensing and may include or exclude the dc component. When the variable contains harmonics of dc offset and, in general, any deviation from a pure sine wave, average sensing, average measuring RMS scaled meters may be misleading. Use of RMS measuring meters is recommended.
3. Field test metering used to check power system meter calibration must have any accuracy higher than that of the instrument being checked.
4. Accuracy of metering in test equipment shall be appropriate for the test being performed.
5. Waveshape and frequency of test equipment output waveforms shall be appropriate for the test and tested equipment.

1.7 TEST REPORTS

A. A test report shall be generated for each piece of major equipment or groups of equipment and shall include the following:

1. A list of visual and mechanical inspections required by Division 26 Specification Sections in a checklist or similar format.
2. Test reports, including test values where applicable, for all required electrical tests. Clearly indicate where test values fall outside of the limits of recommended values.
3. Summary and interpretation of test results detailing problems located and recommended corrective measures.
4. Record of infrared scan and photos showing potential problem locations.
5. Signed and dated by the testing firm field superintendent stating that all required tests have been completed.

B. Test reports shall be furnished to the Architect/Engineer within 14 days of the completion each test on an ongoing basis. Original copies of the reports shall be furnished directly to the Architect/Engineer by the testing company prior to formal submittal via the Contractors.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 THERMOGRAPHIC SURVEY

A. Visual and Mechanical Inspection

1. Remove all necessary covers prior to scanning.
2. Inspect for physical, electrical, and mechanical condition.

B. Equipment to be Scanned

1. All components of the distribution system down to and including branch circuit panelboards and motor control centers. Return 3 months after equipment has been energized and loaded to do a final scan of all equipment.

C. Provide report indicating the following:
1. Problem area (location of “hot spot”).
2. Temperature rise between “hot spot” and normal or reference area.
3. Cause of heat rise.
4. Phase unbalance, if present.
5. Areas scanned.

D. Test Parameters

1. Scanning distribution system with ability to detect 1°C between subject area and reference at 30°C.
2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
3. Infrared surveys should be performed during periods of maximum possible loading but not less than twenty percent (20%) of rated load of the electrical equipment being inspected.

E. Test Results

1. Interpretation of temperature gradients requires an experienced technician. Some general guidelines are:
   a. Temperature gradients of 37°F to 44.6°F indicate possible deficiency and warrant investigation.
   b. Temperature gradients of 37°F to 59°F indicate deficiency; repair as time permits.
   c. Temperature gradients of 61°F and above indicate major deficiency; repair immediately.

END OF SECTION 26 09 99
SECTION 262416
PANELBOARDS

PART 1 - GENERAL ........................................................................................................ 1
1.1 RELATED DOCUMENTS ........................................................................................ 1
1.2 SUMMARY ............................................................................................................. 1
1.3 DEFINITIONS ......................................................................................................... 1
1.4 SUBMITTALS ......................................................................................................... 2
1.5 QUALITY ASSURANCE ......................................................................................... 3
1.6 PROJECT CONDITIONS ....................................................................................... 3
1.7 COORDINATION .................................................................................................. 4
1.8 EXTRA MATERIALS .............................................................................................. 4

PART 2 - PRODUCTS .................................................................................................... 4
2.1 MANUFACTURERS ............................................................................................... 4
2.2 MANUFACTURED UNITS ................................................................................... 4
2.3 PANELBOARD SHORT-CIRCUIT RATING ......................................................... 5
2.4 DISTRIBUTION PANELBOARDS ......................................................................... 5
2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS .................. 6
2.6 OVERCURRENT PROTECTIVE DEVICES .......................................................... 6
2.7 ACCESSORY COMPONENTS AND FEATURES .................................................... 7

PART 3 - EXECUTION .................................................................................................. 7
3.1 INSTALLATION .................................................................................................... 7
3.2 IDENTIFICATION .................................................................................................. 7
3.3 CONNECTIONS ................................................................................................... 8
3.4 FIELD QUALITY CONTROL ................................................................................ 8
3.5 CLEANING .......................................................................................................... 9

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. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.
B. GFCI: Ground-fault circuit interrupter.
C. GFEP: Ground-fault equipment protection.
D. SPDT: Single pole, double throw.

1.4 SUBMITTALS

A. Product Data: For each type of panelboard, overcurrent protective device, surge protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Related Submittals:
   1. Provide overcurrent device coordination study to demonstrate proper overcurrent device ratings, adjustments, and settings.

C. Shop Drawings: For each panelboard and related equipment.
   1. Dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Enclosure types and details for types other than NEMA 250, Type 1.
      b. Bus configuration, current, and voltage ratings.
      c. Short-circuit current rating of panelboards and overcurrent protective devices.
      d. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

   2. Wiring Diagrams: Power, signal, and control wiring.

D. Field quality-control test reports including the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

F. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1, include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
2. Time-current curves, including selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of panelboards and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Owner no fewer than seven days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner’s written permission.

1.7 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Keys: Six spares for each type of panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Panelboards, Overcurrent Protective Devices, Controllers, Contactors, and Accessories:
   a. Eaton Corporation; Cutler-Hammer Products.
   c. Siemens Industries, Inc.
   d. Square D.

2.2 MANUFACTURED UNITS

A. Enclosures: Mounting as noted on panel schedules. NEMA PB 1, Type 1.

1. Cabinet Front: Flush or surface cabinet as noted on the Drawings.
   a. Siemens/Eaton – Figure 4 hinge to box w/piano hinge.
b. GE – FGB (front hinge to box).
c. Square D – Continuous piano hinge trim.

2. Finish: Manufacturer’s standard enamel finish over corrosion-resistant treatment or primer coat.

B. Phase and Ground Buses:
   2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

C. Conductor Connectors: Suitable for use with conductor material.
   1. Main and Neutral Lugs: Mechanical type.
   2. Ground Lugs and Bus Configured Terminators: Compression type.
   3. Feed-Through Lugs: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

D. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.

E. Surge Protective Devices: Where indicated, provide manufactured units with direct bus connected type as specified in Division 26 Section "Surge Protective Devices."

2.3 PANELBOARD SHORT-CIRCUIT RATING
   A. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 DISTRIBUTION PANELBOARDS
   A. Main bus bars, neutral and ground, shall be copper and sized in accordance with U.L. Standards to limit temperature rise on any current carrying part to the maximums as indicated in UL67.
   
B. Doors: Secured with vault-type latch with tumbler lock; keyed alike. Omit for fused-switch panelboards.

C. Main Overcurrent Protective Devices: Circuit breaker.

D. Branch Overcurrent Protective Devices:
   1. For Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.
2. For Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
3. Fused switches.

2.5 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Main bus bars, neutral and ground, shall be copper and sized in accordance with U.L. Standards to limit temperature rise on any current carrying part to the maximums as indicated in UL67.

B. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

2.6 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 3, with interrupting capacity to meet available fault currents.
      a. Circuit Breakers 250A and Larger: Magnetic trip element with front-mounted, field-adjustable trip setting with restricted access cover.

2. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
3. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
4. AFCI Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.
   1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
   2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
   4. Do not use tandem circuit breakers.
   5. Provide lock on devices for circuit breakers when called out on panel schedules with “LOD” designation.
   6. Provide type GFEP circuit breakers for all self-regulating heating (snow melting and heat trace) cables branch circuits and where noted on panel schedules with “GFEP” designation.
   7. Provide GFCI circuit breaker when called out on panel schedules with “GFCI” designation.
8. Provide Arc-Fault Circuit Interrupters where indicated on panel schedule with “AFCI” designation.
9. Provide shunt trip breakers when called out on panel schedules with “STB” designation.
10. Provide smart controllable circuit breakers when called out on panel schedules with “SMT” designation.

C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.

D. Fuses are specified in Division 26 Section "Fuses."

2.7 ACCESSORY COMPONENTS AND FEATURES

A. Furnish accessory set including tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessories according to NEMA PB 1.1.

B. Comply with mounting and anchoring requirements specified in Division 26 Section “Hangers and Supports for Electrical Systems.”

C. Mount top of trim 74 inches above finished floor, unless otherwise indicated.

D. Mount plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

E. Install overcurrent protective devices and controllers.

1. Set field-adjustable switches and circuit-breaker trip ranges.

F. Install filler plates in unused spaces.

G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section “Electrical Identification.”
B. Create a directory to indicate installed circuit loads after balancing panelboard loads or created by retrofitting. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Coordinate final directory room names and numbers with Owner.

C. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding."

B. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

B. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing"
   1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters. Perform electrical tests on all breakers and switches 200A and above or that constitute a component of an emergency distribution system. Main circuit breakers in branch circuit panelboards 225A and below are not required to be tested.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
   1. Measure as directed during period of normal system loading.
   2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
   3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
   4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.
D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scanning of each panelboard. Remove panel fronts so joints and connections are accessible to portable scanner.

   1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   2. Record of Infrared Scanning: Prepare a certified report that identifies panelboards checked and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

E. Testing and Certification (Isolation Power Panels)

   1. Provide manufacturer’s engineer or technician for final testing of Isolated Power Panel and the related system as follows.

      a. Simulate faults at each receptacle to ascertain correct function of the L.I.M.
      b. Check the calibration of the L.I.M. meter and record readings.
      c. Record and date all data in permanent log book.
      d. Certify that the system is properly installed and in correct working order.
      e. Turn over to the hospital maintenance department a set of test equipment consisting of a ground integrity tester, current leakage tester, and plug in the L.I.M. tester.

3.5 CLEANING

   A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 262416
SECTION 26 27 26
WIRING DEVICES

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. Single and duplex receptacles
   2. Ground-fault circuit interrupter receptacles
   4. Device wall plates.
   5. Receptacles with integral USB charger.
1.3 DEFINITIONS

A. EMI: Electromagnetic interference.
B. GFCI: Ground-fault circuit interrupter.
C. PVC: Polyvinyl chloride.
D. RFI: Radio-frequency interference.
E. UTP: Unshielded twisted pair.

1.4 REFERENCES

D. NEMA FB 11: Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations.
E. NEMA WD 1: General Requirements for Wiring Devices.
G. UL 20: General-Use Snap Switches.
H. UL 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.
I. UL 498: Electrical Attachment Plugs and Receptacles.
J. UL 943: Ground Fault Circuit Interrupters.
K. NECA 130-2010: Installing and Maintaining Wiring Devices.

1.5 SUBMITTALS

A. Product Data: Provide manufacturer’s catalog information showing dimensions, colors, and configurations for each type of product indicated.
1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

1.7 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
   1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 RECEPTACLES

A. Straight-Blade-Type Receptacles: Comply with NEMA WD 1, NEMA WD 6, DSCC W-C-596G, and UL 498. Configuration 5-20R duplex receptacle.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hubbell Incorporated; Wiring Device-Kellems 5352.
      b. ArrowHart Wiring Devices 5352.
      c. Bryant CBR20.
      d. Pass & Seymour/Legrand; Wiring Devices Division PS5352.

B. GFCI Receptacles: Straight blade, non-feed-through type, with integral NEMA WD 6, Configuration 5-20R duplex receptacle; complying with UL 498 and UL 943. Design units for installation in a 2-3/4-inch- (70-mm-) deep outlet box without an adapter.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Hubbell Incorporated; Wiring Device-Kellems GF5352.
      b. Cooper Wiring Devices VGF20.
      c. Pass & Seymour/Legrand; Wiring Devices Division 2084.

C. Commercial Grade Tamper Resistant Receptacles with integral USB charger:
   a. 20A circuit feed through.
   b. Comply with UL 498 and UL 1310.
   c. Comply with Part 16 of the FCC rules

2. USB Charging 2.1A, 5VDC dual ports.
   a. Comply with battery charging specification USB BC1.2
   b. Compatible with USB 1.1/2.0/3.0 devices, including Apple products.
   c. LED USB power light to indicate charging available

3. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Hubbell Wiring Device- USB20X2-x
   b. Arrow Hart Wiring Devices – TR7746-x.
   c. Legrand Pass & Seymour TR5362USB-W.

2.2 PENDANT CORD/CONNECTOR DEVICES

A. Description: Matching, locking-type plug and receptacle body connector, NEMA WD 6, device configurations as indicated on drawings, heavy-duty grade.
   2. External Cable Grip: Woven wire-mesh type made of high-strength galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

2.3 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.
   1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.

2.4 WALL SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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WIRING DEVICES

262726 - 4
1. Hubbell Incorporated; Wiring Device-Kellems 1220 Series.
2. ArrowHart Wiring Devices AH1220 Series.
4. Pass & Seymour/Legrand; Wiring Devices Division PS20AC Series.

B. Device body: Plastic handle.


D. Snap Switches: Heavy Duty specification grade, quiet type; rated 20A., 120-277 V AC.

E. Provide single-pole, two-pole, three-way and four-way switches as indicated.

F. Provide pilot light where indicated.

G. Provide key type where indicated. Furnish four keys to Owner.

H. Combination Switch and Receptacle: Both devices in a single gang unit with plaster ears and removable tab connector that permit separate or common feed connection.
   2. Receptacle: NEMA WD 6, Configuration 5-20R.

2.5 DIMMER SWITCHES

A. General:
   1. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on/off switches and audible frequency and EMI/RFI filters.
   2. Dimmer switches shall provide full-range, variable control of light intensity utilizing a continuous Square Law dimming curve.
   3. Provide protected memory during temporary power failures that restores lights to same level of intensity set prior to power interruption.
   4. Provide dimmer switches UL listed for the type of load being served (incandescent, fluorescent, magnetic low voltage transformer, electronic low voltage transformer). Universal load-type dimmer switches shall not be acceptable.
   5. Provide dimmers that provide no adverse effects on other components of the electrical system being served (low voltage transformers, ballasts, lamps, etc.).

2.6 WALL PLATES

A. Manufacturers:
   1. Provide wall plates and corresponding wiring devices from same manufacturer.

B. Single and combination types to match corresponding wiring devices.
1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces:
   a. 0.035-inch- (1-mm-) thick, satin-finished stainless steel
3. Material for Unfinished Spaces:
   a. Galvanized steel
4. Material for Wet Locations: Gasketed Cast aluminum with spring-loaded cover, and listed and labeled for use in "wet locations."
   a. Manufacturers:
      1) Red Dot Model CKSUV, Thomas & Betts.
      2) ArrowHart WIUM-Series.

2.7 FINISHES
A. Color:
   1. Wiring Devices Connected to Normal Power System: As selected by Architect, unless otherwise indicated or required by NFPA 70.
   2. Wall Switches: As selected by Architect, unless otherwise indicated.
   3. Dimmer Switches: As selected by Architect, unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Install products in accordance with manufacturer's instructions.
B. Prior to installation of devices, verify wall openings are neatly cut and will be completely covered by wall plates, clean debris from outlet boxes and provide extension rings to bring outlet boxes flush with finished surface.
C. Install devices and assemblies level, plumb, and square with building lines.
D. Install wall dimmers to achieve full rating specified and indicated after derating for ganging according to manufacturer's written instructions.
E. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' written instructions.
F. Arrangement of Devices:
1. Coordinate locations of outlet boxes provided under Division 26 Section “Raceways and Boxes” to obtain mounting heights indicated on Drawings.

2. Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top.

3. Where multiple switches, dimmers, and/or occupancy sensors are adjacent to each other, provide a single cover plate. Custom fabricate, if required, for all combinations. Provide separate boxes or barriers as required for the application.

4. Install horizontally mounted receptacles with grounding pole on the left.

5. Install GFCI receptacles so that the “Push To Test” and “Reset” designations can be read correctly. If printed in both directions, install with ground pole on top.

6. Install switches with OFF position down.

G. Install cover plates on switch, receptacle, and blank outlets in finished areas.

H. Use oversized plates for outlets installed in masonry walls.

I. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

J. Remove wall plates and protect devices and assemblies during painting.

K. Coordinate installation of access floor boxes with access floor system provided by Architectural trades.

L. Install properly oriented access floor boxes into cutouts in access floor tiles and secure to tiles per Manufacturer’s instructions.

M. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

N. Adjust devices and wall plates to be flush and level. Three corners of wall plates must be in contact with wall surfaces. Devices shall be solidly mounted against the box.

3.2 IDENTIFICATION

A. Comply with Division 26 Section “Electrical Identification.”

1. Receptacles: Identify panelboard and circuit number from which served. Use adhesive label as specified in Division 26 Section “Electrical Identification” with black-filled lettering on face of wall plate, and durable wire markers or tags inside outlet boxes.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section “Grounding and Bonding.” Connect wiring device grounding terminal to outlet box with bonding jumper. Use of quick ground strap or screw is not acceptable.

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WIRING DEVICES 262726 - 7
B. Connect wiring according to Division 26 Section "Conductors and Cables." Connect wiring devices by wrapping conductor around screw terminal or by using back wiring and tightening the screw securely.

C. 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. Inspect each wiring device for defects.
2. Operate each wall switch with circuit energized and verify proper operation.
3. After installing wiring devices and after electrical circuitry has been energized, test each receptacle for proper polarity, ground continuity, and compliance with requirements.
4. Test each GFCI receptacle for proper operation with both local and remote fault simulations according to manufacturer's written instructions.

B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION 26 27 26
SECTION 26 28 13
FUSES

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. Cartridge fuses rated 600 V and less for use in switches, controllers, and motor-control centers.

1.3 SUBMITTALS
A. Product Data: Include the following for each fuse type indicated:

1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.

B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals.

PART 1 - PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1.2 SUMMARY

1.3 SUBMITTALS
1. In addition to items specified in Division 1 Section “Closeout Procedures,” include the following:
   a. Let-through current curves for fuses with current-limiting characteristics.
   b. Time-current curves, coordination charts and tables, and related data.
   c. Ambient temperature adjustment information.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with:
   1. NEMA FU 1 – Low Voltage Cartridge Fuses.
   2. NFPA 70 – National Electrical Code.
   3. UL 198C – High-Interrupting-Capacity Fuses, Current-Limiting Types.
   4. UL 198E – Class R Fuses.
   5. UL 512 – Fuseholders.

1.5 PROJECT CONDITIONS

A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer’s ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Bussmann, Inc.
   2. Ferraz Shawmut, Inc.
2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

1. Motor Branch Circuits: Class RK5, time delay.
2. Other Branch Circuits: Class RK1, time delay.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

B. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 INSTALLATION

A. Fuses shall be shipped separately. Any fuses shipped installed in equipment, shall be replaced by the Electrical Contractor with new fuses as specified above prior to energization at no additional expense to Owner. All fuses shall be stored in moisture free packaging at job site and shall be installed immediately prior to energization of the circuit in which it is applied.

B. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

C. Install spare-fuse cabinet(s).

3.3 IDENTIFICATION

A. Install labels indicating fuse rating and type on outside of the door on each fused switch.

END OF SECTION 26 28 13
SECTION 26 28 16
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

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

B. Related Sections include the following:
   1. Division 26 Section “Fuses”.

1.2 SUMMARY
A. This Section includes the following individually mounted, enclosed switches and circuit breakers:
   1. Fusible switches.
   2. Nonfusible switches.
4. Enclosures.

1.3 DEFINITIONS

A. GD: General duty.
B. GFCI: Ground-fault circuit interrupter.
C. HD: Heavy duty.
D. RMS: Root mean square.
E. SPDT: Single pole, double throw.

1.4 REFERENCES

C. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum).
D. NEMA AB 1: Molded Case Circuit Breakers and Molded Case Switches.
E. NEMA FU 1: Low Voltage Cartridge Fuses.
F. NEMA KS 1: Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
G. NEMA PB1.1: General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.
H. NEMA PB2.1: General Instructions for Proper Installation, Operation, and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.

1.5 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers’ technical data on features, performance, electrical characteristics, ratings, and finishes.
1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
4. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Qualification Data: For testing agency.

D. Field quality-control test reports including the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

E. Manufacturer's field service report.

F. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Sections, include the following:
   1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
   2. Time-current curves, including selectable ranges for each type of circuit breaker.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.
1.7 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
2. Altitude: Not exceeding 6600 feet.

1.8 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

A. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electric Co.; Electrical Distribution & Control Division.
3. Siemens Industries, Inc.
4. Square D/Group Schneider.

B. Fusible Switch: NEMA KS 1, quick make, quick-break load interrupter enclosed knife switch Type HD, with clips or bolt pads to accommodate specified fuses, externally operable lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

C. Nonfusible Switch: NEMA KS 1, quick make, quick-break load interrupter enclosed knife switch Type HD, externally operable lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.

D. Accessories:
1. Provide early break auxiliary contacts in motor disconnect switches for motors that are fed from variable frequency controllers.

2. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

3. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.

4. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.

2.3 TOGGLE DISCONNECT SWITCH

A. Manufacturers:

1. Double Pole:
   a. Hubbell 1372.
   b. Leviton 6808G-DAC.
   c. Pass & Seymour 7812.
   d. Bryant 30102.

2. Three Pole:
   a. Hubbell 1379.
   b. Leviton 7810GD.
   c. Pass & Seymour 7813.
   d. Bryant 30103.

B. Description: Heavy duty, 30A, 600 volt, double or three pole as required, single throw, motor rated switch without overload protection. Provide NEMA 1 enclosure and padlock attachment.

2.4 ENCLOSURES

A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.

   1. Indoor Dry Locations: NEMA 250, Type 1.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.

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

A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.

B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.

C. Install switches with off position down.

D. Install NEMA KS 1 enclosed switch where indicated for motor loads ½ HP and larger and equipment loads greater than 30A.

E. Install toggle disconnect switch, surface mounted, where indicated for motor loads less than ½ HP and equipment loads 30A. and less.

F. Install fuses in fusible disconnect switches.

G. Install flexible liquid tight conduit from toggle disconnect switch to portable equipment. Leave a 6'-0" (1830 mm) whip.

H. Install flexible liquid tight conduit from toggle disconnect switch to stationary equipment.

I. Install control wiring from early break contacts in motor disconnect switch to variable frequency controllers to shut down controller when switch is open.

J. Install equipment on exterior foundation walls at least one inch (25 mm) from wall to permit vertical flow of air behind breaker and switch enclosures.

K. Support enclosures independent of connecting conduit or raceway system.

L. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."

B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 26 Section "Electrical Identification."

C. Provide adhesive label as specified in Division 26 Section "Electrical Identification" on inside door of each switch indicating UL fuse class and size for replacement.
3.4 FIELD QUALITY CONTROL

A. Prepare for acceptance testing as follows:

1. Inspect mechanical and electrical connections.
2. Verify switch and relay type and labeling verification.
3. Verify rating of installed fuses.
4. Inspect proper installation of type, size, quantity, and arrangement of mounting or anchorage devices complying with manufacturer's certification.

B. Testing Agency: Engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

C. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.5 for switches. Certify compliance with test parameters.
2. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.6 for molded-case circuit breakers. Test all NEMA AB1, molded case circuit breakers with thermal magnetic trip or auxiliary, solid-state trip units 100A and larger. Certify compliance with test parameters.

   a. Visual and Mechanical Inspection

      1) Circuit breaker shall be checked for proper mounting and compare nameplate data to Drawings and Specifications.
      2) Operate circuit breaker to ensure smooth operation.
      3) Inspect case for cracks or other defects.
      4) Check internals on unsealed units.

   b. Electrical Tests

      1) Perform a contact resistance test.
      2) Perform an insulation resistance test at 1000 volts dc from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase.
      3) Perform long time delay time-current characteristic tests by passing three hundred percent (300%) rated current through each pole separately. Record trip time. Make external adjustments as required to meet time current curves.
      4) Determine short time pickup and delay by primary current injection.
      5) Determine ground fault pickup and time delay by primary current injection.
      6) Determine instantaneous pickup current by primary injection using run-up or pulse method.
      7) Perform adjustments for final settings in accordance with coordination study.
      8) For circuit breakers 800A and larger, verify all functions of trip unit by means of secondary injection in lieu of primary injection.
c. Test Values

1) Compare contact resistance or millivolt drop values to adjacent poles and similar breakers. Investigate deviations of more than fifty percent (50%). Investigate any value exceeding manufacturer's recommendations.

2) Insulation resistance shall not be less than 100 megohms.

3) Trip characteristic of breakers shall fall within manufacturer's published time-current characteristic tolerance band, including adjustment factors.

4) All trip times shall fall within N.E.T.A. Acceptance Testing Specifications, Table 10.7 Circuit breakers exceeding specified trip time at three hundred percent (300%) of pickup shall be tagged defective.

5) Instantaneous pickup values shall be within values shown on N.E.T.A. Acceptance Testing Specifications, Table 10.8 or manufacturer's recommendations.

3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.5 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip and time delay settings to values as determined by the protective device coordination study.

3.6 CLEANING

A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.

B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION 26 28 16
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 ac, enclosed controllers rated 600 V and less, of the following types:

1. Across-the-line, manual and magnetic controllers.
B. Related Sections include the following:

1. Division 26 Section "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
2. Division 20 Section "Variable Frequency Controllers" for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on constant torque loads in ranges up to 200 hp.

1.3 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each enclosed controller.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
   a. Each installed unit's type and details.
   b. Nameplate legends.
   c. Short-circuit current rating of integrated unit.
   d. UL listing for series rating of overcurrent protective devices in combination controllers.
   e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around enclosed controllers where pipe and ducts are prohibited. Show enclosed controller layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Qualification Data: For manufacturer and testing agency.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures," include the following:

1. Routine maintenance requirements for enclosed controllers and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

G. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

1.4 REFERENCES

A. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

B. ANSI/UL 198C - High-Intensity Capacity Fuses; Current-Limiting Types.

C. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service.

D. FS W-F-870 - Fuseholders (For Plug and Enclosed Cartridge Fuses).

E. FS W-S-865 - Switch, Box, (Enclosed), Surface-Mounted.


G. NEMA AB 1 - Molded Case Circuit Breakers.

H. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.

I. NEMA KS 1 - Enclosed Switches.


1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles (160 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
C. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prior to beginning work on any system, verify all existing conditions that affect the work and coordinate with all other trade Contractors. Determine that the work can be installed as indicated or immediately report to the Architect/Engineer errors, inconsistencies or ambiguities.

B. Deliver products to site under provisions of Section 26 01 00. Store and protect products under provisions of Section 26 01 00.

C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle in accordance with manufacturer’s written instructions. Lift large equipment only with lugs provided for the purpose. Handle carefully to avoid damage to motor control center components, enclosure, and finish.

E. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.7 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of each contactor and indicate circuits controlled. Submit under provisions of 26 0100.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of electrical service.
2. Indicate method of providing temporary utilities.
3. Do not proceed with interruption of electrical service without Owner's written permission.

1.9 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

C. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
2. Indicating Lights: Two of each type installed.
3. Keys: Furnish 2 of each to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Corporation; Cutler-Hammer Products.
2. General Electrical Company; GE Industrial Systems.
3. Siemens/Furnas Controls.
4. Square D.
2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."

1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.

B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.

1. Control Circuit: 120 V; obtained from integral control power transformer with sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 20 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
3. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 20 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.

1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.

2.3 VARIABLE FREQUENCY CONTROLLERS

A. Refer to Division 20 "Variable Frequency Controllers."

B. Equipment furnished by mechanical trades and installed by electrical trades.
2.4 ENCLOSURES

A. Description: Flush- or surface-mounted cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.

1. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
2. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.5 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights: NEMA ICS 2, heavy-duty type.

C. Indicating Lights: Run (Red), off or ready (Green).

D. Auxiliary Contacts: Provide two normally open (N.O.) and two normally closed (N.C.) contacts.

E. Selector Switch: NEMA ISC 2, mounted in front cover to read “hand/off/auto,” provide auxiliary contact for auto position monitoring.

F. Control Relays: Auxiliary and adjustable time-delay relays.

G. Elapsed Time Meters: Heavy duty with digital readout in hours.

2.6 FACTORY FINISHES

A. Finish: Manufacturer’s standard gray paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 APPLICATIONS

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

B. Comply with mounting and anchoring requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."

C. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

D. Install motor control equipment and contactors in accordance with manufacturer’s instructions.

E. Select and install heater elements in motor starters to match installed motor characteristics.

F. Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

3.4 IDENTIFICATION

A. Identify enclosed controller, components, and control wiring according to Division 26 Section "Electrical Identification."

3.5 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Division 26 Section "Grounding and Bonding."
3.6 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

B. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing”

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.7 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers. Refer to Division 1 Sections.

END OF SECTION 26 29 13
SECTION 26 51 00
INTERIOR LIGHTING

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 lighting fixtures with lamps and ballasts.
   2. Exit signs.

B. Related Sections include the following:
1. Division 26 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.
2. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

A. BF: Ballast factor. Ratio of light output of a given lamp(s) operated by the subject ballast to the light output of the same lamp(s) when operated on an ANSI reference circuit.

B. CRI: Color rendering index.

C. CU: Coefficient of utilization.

D. LER: Luminaire efficiency rating, which is calculated according to NEMA LE 5. This value can be estimated from photometric data using the following formula:

   1. LER is equal to the product of total rated lamp lumens times BF times luminaire efficiency, divided by input watts.

E. RCR: Room cavity ratio.

1.4 SUBMITTALS

A. Product Data: For each type of lighting fixture scheduled, arranged in order of fixture designation. Submit as one package, bound together. Include data on features, accessories, finishes, and the following:

   1. Physical description of fixture, including dimensions and verification of indicated parameters.
   2. Emergency lighting unit battery and charger.
   3. Photometric performance data.

B. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

   1. Suspended ceiling components.

D. Product Certificates: For each type of ballast for dimmer-controlled fixtures, signed by product manufacturer.

E. Source quality-control test reports.
F. Field quality-control test reports.

G. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Sections include the following:

1. Catalog data for each fixture. Include the diffuser, ballast, and lamps installed in that fixture.

H. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with:

1. NFPA 70 - National Electrical Code.

C. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.6 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.7 WARRANTY

A. Special Warranty for Fluorescent Ballasts: Manufacturer's standard form in which ballast manufacturer agrees to repair or replace ballasts that fail in materials or workmanship within specified warranty period.

B. Manufacturer's Special Warranty for T8 Fluorescent Lamps: Manufacturer’s standard form, made out to Owner and signed by lamp manufacturer agreeing to replace
lamps that fail in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.

1. Warranty Period: One year from date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.

2. Battery and Charger: One for each emergency lighting unit.

PART 2 - PRODUCTS

2.1 FIXTURES AND COMPONENTS, GENERAL

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Metal Parts: Free of burrs and sharp corners and edges.

C. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

E. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.
4. Laminated Silver Metallized Film: 90 percent.

F. Plastic Diffusers, Covers, and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

   a. Lens Thickness: At least 0.125 inch minimum unless different thickness is scheduled.
b. UV stabilized.

2. Glass: Annealed crystal glass, unless otherwise indicated.

G. General:

1. Install ballasts, and specified accessories at factory.
2. Install lamps on project site after fixture installation.
3. Provide factory installed ballast disconnecting means required by NFPA 70.

2.2 LIGHTING FIXTURES

A. Provide lighting fixtures as included in specification 26 5100A “Lighting Fixture Product Data.” This section contains product data sheets from the basis of design manufacturer with annotations.

B. Acceptable alternate manufacturers are indicated on the product data sheets. Alternate manufacturer products shall be equal in all respects including materials, finishes, photometric performance and energy performance and shall include all options, features, and accessories identified.

C. The lighting fixture schedule shown on the drawings is supplemental provided for convenience and reference only. The requirements of this section and 26 5100A shall govern.

2.3 FLUORESCENT LAMP BALLASTS

A. Description: Include the following features, unless otherwise indicated:

1. Designed for type and quantity of lamps indicated at full light output except for emergency lamps powered by in-fixture battery-packs.
2. Externally fused with slow-blow type rated between 2.65 and 3.0 times the line current.

B. Program rapid start electronic ballasts for linear lamps shall include the following features, unless otherwise indicated:

1. Products:
   a. Advance/Phillips.
   b. Sylvania/Motorola.
2. Comply with NEMA C82.11.
3. Ballast Type: Programmed rapid start, unless otherwise indicated.
4. Programmed Start: Ballasts with two-step lamp starting to extend life of frequently started lamps.
5. Sound Rating: A.
6. Total harmonic distortion rating of less than 10 percent according to NEMA C82.11. Input current third harmonic content shall not exceed 10%.

7. Transient Voltage Protection: IEEE C62.41, Category A.

8. Operating Frequency: 25 kHz or higher, and operate without visible flicker.


10. Parallel Lamp Circuits: Multiple lamp ballasts connected to maintain full light output on surviving lamps if one or more lamps fail.

11. Power factor shall be 90% minimum.

12. Ballast factor shall be .85 to 1.00.

2.4 EXIT SIGNS

A. General: Comply with UL 924; for sign colors and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. Lamps: Light-emitting diodes, 70,000 hours minimum of rated lamp life.

C. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

1. Battery: Sealed, maintenance-free, nickel-cadmium type with special warranty.
2. Charger: Fully automatic, solid-state type with sealed transfer relay.
3. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

D. Provide edge lit signs with a mirror plaque background.

2.5 FLUORESCENT EMERGENCY LIGHTING FIXTURES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Internal Type:

   b. Iota.
   c. Dual Lite.
   d. Lithonia.
   e. Cooper Lighting.

2. Description: Self-contained, modular, battery-inverter unit factory mounted within fixture body. Comply with UL 924.
3. Emergency Connection: Operate one or two fluorescent lamps continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to fixture ballast.
   a. For any area where only one luminare is provided for emergency operation, two lamps shall operate under loss of normal power.

4. Night Light Connection: Operate one or two fluorescent lamps continuously.
   a. For any area where a night light also operates as an emergency light and only one luminare is provided for night light/emergency operation, two lamps shall operate under loss of normal power.

5. Test Switch and Light-Emitting-Diode Indicator Light: Visible and accessible without opening fixture or entering ceiling space. Install remote test switch and plate in adjacent ceiling tile.


8. Lamp Ratings:

<table>
<thead>
<tr>
<th>Lamp Type</th>
<th>Minimum Lumen Output (one or two lamps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F32T8</td>
<td>1350*</td>
</tr>
</tbody>
</table>

   * Indicates ratings for minimum output for one and two lamps.


10. Universal transformer to operate at 120 volt or 277 volt.

B. Central Type: Factory installed, full light output, fluorescent emergency ballast to operate lamps indicated from a remote emergency power source.

2.6 FLUORESCENT LAMPS

A. Low-Mercury Lamps: Comply with Federal toxic characteristic leaching procedure test, and yield less than 0.2 mg of mercury per liter, when tested according to NEMA LL 1.

B. T8 rapid-start low-mercury lamps, rated 32 W maximum, nominal length of 48 inches 1219 mm, 2800 initial lumens (minimum), CRI greater than 80, color temperature of 4100 K, and average rated life of 20,000 hours, unless otherwise indicated.

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

D. Fluorescent Lamp Manufacturers:
1. Osram Sylvania.
2. General Electric.
3. Philips.

2.7 FIXTURE SUPPORT COMPONENTS
A. Comply with Division 26 Section "Electrical Supports" for channel- and angle-iron supports and nonmetallic channel and angle supports.
C. Wires For Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gauge.
D. Rod Hangers: 3/16-inch- minimum diameter, cadmium-plated, threaded steel rod.
E. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

2.8 FINISHES
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
B. Fixtures: Manufacturers’ standard, unless otherwise indicated.
   1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.

2.9 SOURCE QUALITY CONTROL
A. Provide services of a qualified, independent testing and inspecting agency to factory test fixtures with ballasts and lamps; certify results for electrical ratings and photometric data.
B. Factory test fixtures with ballasts and lamps; certify results for electrical ratings and photometric data.

PART 3 - EXECUTION

3.1 INSTALLATION
B. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.

C. Fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

D. Support luminaires independent of ceiling framing. Support recessed grid luminaries from two opposite corners directly to structure. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

E. Exposed Grid Ceilings: Support surface mounted luminaires on grid ceiling directly from building structure.

F. Install recessed luminaires to permit removal from below.

G. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.

H. Suspended Fixture Support: As follows:
   1. Install suspended luminaires and exit signs using pendants supported from swivel hangers except where noted to use chain hangers. Provide pendant length required to suspend luminaire at indicated height.

I. Adjust aimable fixtures to provide required light intensities.

J. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines and with each other. Secure to prohibit movement.

K. Emergency lighting units and fluorescent emergency lighting fixtures with unit battery inverters shall be circuited to unswitched hot leg of adjacent circuit and shall activate on loss of primary power.

3.2 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.

B. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.

C. Bond products and metal accessories to branch circuit equipment grounding conductor.

D. Connect luminaires to branch circuit outlet boxes provided under Division 26 Section "Raceways and Boxes" using 1/2" flexible conduit.
3.3 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Examine each luminaire to determine suitability for lamps specified.

C. Verify normal operation of each fixture after installation.

D. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify normal transfer to battery power source and retransfer to normal.

E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

F. Corroded Fixtures: During warranty period, replace fixtures that show any signs of corrosion.

G. Check for variance in lamp color temperature throughout project.

H. Spot check for lamp output level from start up through 10 minute duration and make rotation.

3.4 ADJUSTING

A. Aim and adjust luminaires as directed by the Architect/Engineer.

B. Adjust exit sign directional arrows as indicated on Drawings.

C. Adjust all “low end trim” settings of dimming switches prior to punchlist.

D. Adjust and calibrate all dimming system controls until the system works as designed. Contact the Architect/Engineer when dimming is complete and demonstrate operation to owner’s representative and Architect/Engineer.

3.5 CLEANING

A. Clean electrical parts to remove conductive and deleterious materials.

B. Remove dirt and debris from enclosures and lenses.

C. Clean photometric control surfaces as recommended by manufacturer.

D. Clean finishes and touch up damage.

END OF SECTION 26 51 00
SECTION 28 31 00
FIRE ALARM

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 include the following:
   1. Division 26 Section “Electrical General Requirements.”

1.2 SUMMARY
A. This Section includes design and installation of new devices onto an existing new fire alarm system.
1.3 DEFINITIONS

A. FACP: Fire alarm control panel.
B. LED: Light-emitting diode.
C. NICET: National Institute for Certification in Engineering Technologies.
D. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.4 SYSTEM DESCRIPTION

A. Fire alarm system shall consist of the following:
   1. All new fire alarm devices, and wiring as applicable connected to existing fire alarm system.
   2. System smoke detection above all control panels and notification appliance power supply panels.
   3. System smoke detection as required at air handling units, smoke rated transfer openings, and smoke damper locations.
   4. All flow and tamper switches to monitor fire sprinkler and standpipe systems and report appropriate alarm and supervisory signals.
   5. Manual fire alarm boxes at each building exit (prior to entering exit stairwells at each floor).
   6. Audible and visual notification appliances in all public and common areas of the building
   7. Fire pump monitoring.

1.5 PERFORMANCE REQUIREMENTS

A. Comply with NFPA 72.
B. A complete functional system meeting the requirements of this specification, including alarm initiating devices and notification appliances at locations and ratings to meet the requirements of the Authorities Having Jurisdiction and all applicable codes shall be provided.
C. Coordinate and avoid conflicts with casework, markerboards, feature walls, and other areas where fire alarm devices would interfere with furnishings, finishes, etc.
D. Fire alarm system vendor shall provide sound pressure level calculations demonstrating compliance with NFPA 72 and establish quantities and tap settings of audible devices.
E. No additional charges for work or equipment required for a code compliant system approved by the Authority Having Jurisdiction will be allowed.
F. Premises protection includes Business Group.
1. Refer to drawings for complete code analysis including construction type, use groups, special occupancy types, rated walls, smoke barriers and partitions, etc.

G. System functional performance shall be as indicated on the fire alarm matrix on the drawings.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings:

1. Shop Drawings shall be prepared by persons with the following qualifications:
   a. Trained and certified by manufacturer in fire alarm system design.
   b. Fire alarm certified by NICET, minimum Level III.

2. System Operation Description: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.

3. Device Address List: Include address descriptions that will appear on the FACP display.

4. System riser diagram with device addresses, conduit sizes, and cable and wire types and sizes.

5. Wiring Diagrams: Power, signal, and control wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Show wiring color code.

6. Batteries: Provide battery sizing calculations. Battery size shall be a minimum of 125% of the calculated requirement.

7. Duct Smoke Detectors: Performance parameters and installation details for each detector, verifying that each detector is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

8. Voice/Alarm Signaling Service: Equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.

9. Floor Plans: Indicate final outlet locations showing address of each addressable device. Show device layout, size and route of cable and conduits.

C. Qualification Data: For Installer.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For fire alarm system to include in emergency, operation, and maintenance manuals. Comply with NFPA 72, Appendix A, recommendations for Owner's manual. Include abbreviated operating instructions for mounting at the FACP.
F. Submittals to Authorities Having Jurisdiction: In addition to distribution requirements for submittals specified in Division 1 Section "Submittals," make an identical submittal to authorities having jurisdiction. To facilitate review, include copies of annotated Contract Drawings as needed to depict component locations. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Architect for review.

1. Contractor to be responsible for all applications and fees associated with required plan review and permits.

G. Documentation:

1. Approval and Acceptance: Provide the "Record of Completion" form according to NFPA 72 to Owner, Architect, and Authorities Having Jurisdiction.
2. Record of Completion Documents: Provide the "Permanent Records" according to NFPA 72 to Owner, Architect, and authorities having jurisdiction. Format of the written sequence of operation shall be the optional input/output matrix.
   a. Hard copies on paper to Owner, Architect, and Authorities Having Jurisdiction.
   b. Electronic media may be provided to Architect.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Installer Qualifications: Personnel certified by NICET as Fire Alarm Level III.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Fire Alarm Service: Do not interrupt fire alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:

1. Notify Architect, Construction Manager and Owner no fewer than seven days in advance of proposed interruption of fire alarm service.
2. Do not proceed with interruption of fire alarm service without Architect, Construction Manager and Owner written permission.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. FACP and Equipment:
   a. National Time and Signal.

2.2 FACP

A. General Description:

1. Modular, power-limited design with electronic modules, UL 864, 9th edition, listed.
2. Addressable initiation devices that communicate device identity and status.
3. Addressable control circuits for operation of mechanical equipment.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands; and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Circuits:

1. Signaling Line Circuits between control panels: NFPA 72, Class A, Style 7
2. Signaling Line Circuits from control panel to devices: NFPA 72, Class B, Style 4.
   a. System Layout: Install no more than 50 addressable devices on each signaling line circuit.

3. Notification-Appliance Circuits: NFPA 72, Class B, Style Y.
4. Actuation of alarm notification appliances, emergency voice communications, annunciation, shall occur within 10 seconds after the activation of an initiating device.
5. Electrical monitoring for the integrity of wiring external to the FACP for mechanical equipment shutdown and magnetic door-holding circuits is not required, provided a break in the circuit will cause doors to close and mechanical equipment to shut down.

D. Smoke-Alarm Verification:
1. Initiate audible and visible indication of an "alarm verification" signal at the FACP.
2. Activate a listed and approved "alarm verification" sequence at the FACP and the detector.
3. Sound general alarm if the alarm is verified.
4. Cancel FACP indication and system reset if the alarm is not verified.

E. Power Supply for Supervision Equipment: Supply for audible and visual equipment for supervision of the ac power shall be from a dedicated dc power supply, and power for the dc component shall be from the ac supply.

F. Alarm Silencing, Trouble, and Supervisory Alarm Reset: Manual reset at the FACP after initiating devices are restored to normal.
   1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
   2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.
   3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.

G. Walk Test: A test mode to allow one person to test alarm and supervisory features of initiating devices. Enabling of this mode shall require the entry of a password. The FACP and annunciators shall display a test indication while the test is underway. If testing ceases while in walk-test mode, after a preset delay, the system shall automatically return to normal.

H. Transmission to WSU Department of Public Safety Station: Automatically transmit alarm and trouble signals to WSU Department of Public Safety station through a security control panel. Provide (2) two normally closed contacts in the FACP.

I. Voice/Alarm Signaling Service: A central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as part of the remote annunciator panel.
   1. Indicated number of alarm channels for automatic, simultaneous transmission of different announcements to different zones, or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall be UL 1711 listed.
      a. Allow the application of an evacuation signal to indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
      b. Programmable tone and message sequence selection.
      c. Standard digitally recorded messages for "Evacuation" and "All Clear."
d. Generate tones to be sequenced with audio messages of the type recommended by NFPA 72 and that are compatible with tone patterns of the notification-appliance circuits of the FACP.

2. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

2.3 SYSTEM SMOKE DETECTORS

A. General Description:

1. UL 268 listed, operating at 24-V dc, nominal.
2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
3. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection of building wiring.
4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
5. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status.

B. Photoelectric Smoke Detectors:

1. Sensor: LED or infrared light source with matching silicon-cell receiver.
2. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.

C. Duct Smoke Detectors:

1. Photoelectric Smoke Detectors:
   a. Sensor: LED or infrared light source with matching silicon-cell receiver.
   b. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.

2. UL 268A listed, operating at 24-V dc, nominal.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.
   a. Weatherproof Duct Housing Enclosure: UL listed for use with the supplied detector. The enclosure shall comply with NEMA 250 requirements for Type 4X.
5. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status. Provide remote status and alarm indicator and test station where required.
7. Each sensor shall have multiple levels of detection sensitivity.
8. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.
9. Relay Fan Shutdown: Provide two (2) sets of contacts rated to interrupt fan motor-control circuit.

2.4 HEAT DETECTORS

A. General: UL 521 listed.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or rate-of-rise of temperature that exceeds 15 deg F per minute, unless otherwise indicated.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

2.5 NOTIFICATION APPLIANCES

A. Description: Equipped for mounting as indicated and with screw terminals for system connections.

B. Voice/Tone Speakers:
   1. UL 1480 listed.
   2. High-Range Units: Rated 2 to 15 W.
   3. Low-Range Units: Rated 1 to 2 W.
   4. Matching Transformers: Tap range matched to the acoustical environment of the speaker location.

C. Visible Alarm Devices: Xenon strobe lights listed under UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.
   1. Rated Light Output: 15, 30, 60, 75, 110, 135, 185 candela as required to meet NFPA 72 requirements.
   2. Strobe Leads: Factory connected to screw terminals.
2.6 REMOTE STATUS AND ALARM INDICATORS

A. Remote status and alarm indicator and test stations, with LED indicating lights. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single-gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector or valve is located. For water-flow switches, the identification plate also designates protected spaces downstream from the water-flow switch.

2.7 ADDRESSABLE CONTROL MODULE

A. Provide for integration of auxiliary control functions into the analog signaling circuit. Intelligent analog signaling circuit control module shall have the following capabilities:

1. Communication interaction with the analog signaling circuit having the capability of initiating a control function to an auxiliary device based on a specified event.
2. Provide NO/NC contact pairs rated at 2 amps 120 VAC or 24 VDC.

2.8 WIRE AND CABLE

A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.

B. Fire alarm wire and cable shall be as specified by the system manufacturer including conductor gage, conductor quantity, conductor twists and shielding required to meet NFPA class and style performance specified.

C. Signaling Line Circuits and other power limited fire alarm circuits (PLFA):

1. PLFA circuits installed in conduit or raceway: U.L. Listed type FPL
2. PLFA circuit cable installed exposed in accessible ceiling spaces, risers and elsewhere: U.L. Listed type FPLP.

D. Non-Power-Limited Fire Alarm Circuits (NPLFA):

1. NPLFA circuits installed in conduit: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
   a. Low-Voltage Circuits: No. 16 AWG, minimum.
   b. Line-Voltage Circuits: No. 12 AWG, minimum.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Connecting to Existing Equipment: Verify that existing fire alarm system is operational before making changes or connections.
1. Connect new equipment to the existing control panel in the existing part of the building.
2. Connect new equipment to the existing monitoring equipment at the Supervising Station.
3. New components shall be capable of merging with the existing configuration without degrading the performance of either system.

B. Smoke or Heat Detector Spacing:
   1. Smooth ceiling spacing shall not exceed 30 feet

C. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.

D. Duct Smoke Detectors: Comply with NFPA 72. Install sampling tubes so they extend the full width of the duct.

E. Remote Status and Alarm Indicators: Install near each smoke detector, each duct detector and each sprinkler water-flow switch and valve-tamper switch that is above 10'-0' aff, concealed, or otherwise not readily visible from normal viewing position. Coordinate exact locations with local fire department and submit to architect for approval.

F. Audible Alarm Notification Appliances: Install wall mounted appliances not less than 6 inches below the ceiling.

G. Visible Alarm Notification Appliances: Install wall mounted appliances at 96” AFF or 6 inches below the ceiling, whichever is less.

H. Coordinate ceiling mounted appliances with reflected ceiling plans. Do not install visual appliances where pendant mounted or suspended lighting fixtures will obstruct intended viewing angles.

I. Install wall mounted and ceiling mounted notification appliances flush on recessed j-box or back box for all new work and on existing gyp-board partition walls.

J. Device Location-Indicating Lights: Locate in public space near the device they monitor.

K. FACP: Surface mounted with tops of cabinets not more than 72 inches above the finished floor.
   1. Install smoke detector above panel. Install on ceiling for ceilings under 10 ft. For ceilings above 10', wall mount a smoke detector listed for releasing service 10' AFF or 1' below finished ceiling (whichever is lower).

3.2 WIRING INSTALLATION

A. Install wiring according to the following:
1. NECA 1.
2. TIA/EIA 568-A.

B. Wiring Method:

1. Fire alarm circuits shall consist of plenum rated multi-conductor cables installed in accessible ceiling spaces.
2. Drops to surface mounted devices shall be installed in conduit. No exposed cable shall be visible below the ceiling. Where the ceiling is exposed, route the conduit or raceway up to the structural member that will conceal the cable.
3. Drops to devices recessed in partition walls shall be installed in conduit.
4. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
5. Fire alarm circuit cables shall be in conduit in exposed areas or below ceilings.

C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

E. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

3.3 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals according to Division 26 Section “Electrical Identification.”

B. Install instructions frame in a location visible from the FACP.

C. Paint power-supply disconnect switch red and label “FIRE ALARM.”

3.4 GROUNDING

A. Ground the FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to the FACP.
3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Before requesting final approval of the installation, submit a written statement using the form for Record of Completion shown in NFPA 72.
2. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters. All tests shall be conducted under the direct supervision of a NICET technician certified under the Fire Alarm Systems program at Level III.
   a. Include the existing system in tests and inspections.
3. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.
4. Testing: Follow procedure and record results complying with requirements in NFPA 72.
   a. Detectors that are outside their marked sensitivity range shall be replaced.
5. Test and Inspection Records: Prepare according to NFPA 72, including demonstration of sequences of operation by using the matrix-style form in Appendix A in NFPA 70.

3.6 PROGRAMMING

A. Coordinate final address descriptions for alarm, supervisory and trouble indication that appear on FACP and Annunciator displays with the Owners representative. This shall include all room names, room numbers, building areas for fire protection zones, exit door descriptions and similar items. This coordination shall take place and be implemented in the programming prior to Demonstration and Owner Training.

3.7 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project outside normal occupancy hours for this purpose.

B. Follow-Up Tests and Inspections: After date of Substantial Completion, test the fire alarm system complying with testing and visual inspection requirements in NFPA 72. Perform tests and inspections listed for three monthly, and one quarterly, periods.
3.8 WARRANTY

A. All newly installed equipment shall be warranted by the contractor for a period of one year following acceptance. The warranty shall include parts, labor, prompt field service, pickup and delivery.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain the fire alarm system, appliances, and devices. Refer to Division 1 Section “Demonstration and Training.”

END OF SECTION 28 31 00
# Laboratory Equipment Specifications

## Table of Contents

**Division 20 - Common Mechanical Requirements**
- 200500 Mechanical General Requirements
- 200510 Basic Mechanical Materials and Methods
- 200519 Meters and Gages
- 200523 Valves
- 200529 Hangers and Supports
- 200553 Mechanical Identification
- 200700 Mechanical Insulation

**Division 21 - Fire Suppression**
- 211100 Fire Suppression

**Division 22 - Plumbing**
- 221116 Domestic Water Piping
- 221119 Domestic Water Piping Specialties
- 221316 Sanitary Waste and Vent Piping
- 221319 Drainage Piping Specialties
- 224200 Plumbing Fixtures
- 226113 Laboratory Air, Gas and Vacuum Piping
- 226119 Laboratory Vacuum Equipment
- 226653 Chemical-Waste Piping

**Division 23 - Heating Ventilating and Air Conditioning**
- 230593 Testing, Adjusting, and Balancing
- 230933 Temperature Controls
- 233113 Metal Ducts
- 233300 Duct Accessories
- 233713 Diffusers, Registers, and Grilles
- 238219 Fan-Coil Units

**Division 26 - Electrical**
- 260010 Electrical General Requirements
- 260519 Conductors and Cables
- 260526 Grounding and Bonding
- 260529 Hangers and Supports for Electrical Systems
- 260533 Raceways and Boxes
- 260553 Electrical Identification
- 260573 Overcurrent Device Coordination Study/Arc Flash Hazard Analysis
- 260923 Lighting Control Devices
- 260999 Electrical Testing
- 262416 Panelboards
- 262726 Wiring Devices
- 262813 Fuses
- 262816 Enclosed Switches and Circuit Breakers
- 262913 Enclosed Controllers
- 265100 Interior Lighting

**Division 28 - Electronic Safety and Security**
- 283100 Fire Alarm