Wayne State University
EDC Mechanical and Electrical Systems Upgrade
WSU Project Number 090-247931-4
Prevailing Wage Work

FOR:
Board of Governors
Wayne State University
Detroit, Michigan

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

Owner's Representative:
Omar Alhyari, Project Manager
Facilities Planning & Management
Design & Construction Services
5454 Cass
Wayne State University
Detroit, Michigan 48202

Consultant:
Peter Basso Associates
5145 Farmington Road, Suite 100
Troy, MI 48098

October 8, 2014
## TABLE OF CONTENTS

**Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract**

<table>
<thead>
<tr>
<th>Title</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information for Bidders</td>
<td>00005-1 thru 00005-2</td>
</tr>
<tr>
<td>Instructions to Bidders</td>
<td>00100-1 thru 00100-5</td>
</tr>
<tr>
<td>Notice of Pre-Bid Conference</td>
<td>00250-1 thru 00250-2</td>
</tr>
<tr>
<td>Form of Proposal &amp; Qualification Statement</td>
<td>00300-1 thru 00300-7</td>
</tr>
<tr>
<td>Prevailing Wage Rate Schedule</td>
<td>00410-1 thru 00410-3</td>
</tr>
<tr>
<td>Payment Package Document Requirements</td>
<td>00430-1</td>
</tr>
<tr>
<td>Agreement between Contractor and Owner for Construction</td>
<td>00500-1 thru 00500-9</td>
</tr>
<tr>
<td>Form of Guarantee</td>
<td>00510-1</td>
</tr>
<tr>
<td>General Conditions (A.I.A. A-201)</td>
<td>00700-1</td>
</tr>
<tr>
<td>WSU Supplementary General Conditions of the Contract for Construction</td>
<td>00800-1 thru 00800-12</td>
</tr>
<tr>
<td>Drawings</td>
<td>00850-1</td>
</tr>
</tbody>
</table>

**Division 1 - General Requirements**

<table>
<thead>
<tr>
<th>Title</th>
<th>Pages</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Requirements</td>
<td>01000-1 thru 01000-9</td>
</tr>
<tr>
<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: EDC Mechanical and Electrical Systems Upgrade
Project No. 090-247931-4

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

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

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

Architect: Peter Basso Associates
5145 Farmington Road, Suite 100
Troy, MI 48098

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: October 8, 2014

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 October 8, 2014. 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: 10:00am, local time, October 14, 2014 to be held at Wayne State University – Engineering School, 5050 Anthony Wayne Drive, Conference Room 1200, 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 October 17, 2014 at 12:00 Noon. All questions must be reduced to writing and emailed to the attention of Valerie Kreher, Senior Buyer at rfpteam2@wayne.edu, copy to Robert Kuhn, Senior Buyer

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 October 22, 2014, 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 qualifications.

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

All available information pertaining to this project will be posted to the Purchasing web site at http://www.forms.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: 
EDC Mechanical and Electrical Systems Upgrade
Project No. 090-247931-4

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

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

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 these 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 October 8, 2014 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).

3. Please note: Effective December 1, 2007, bid notices will be sent only to those Vendors registered to receive them via our Bid Opportunities list serve. To register, to
http://www.forms.purchasing.wayne.edu/Adv_bid/Adv_bid.html, and click on the “Join our Listserv” link at the top of the page.
NOTICE OF MANDATORY PRE-BID CONFERENCE

PROJECT: EDC Mechanical and Electrical Systems Upgrade,

PROJECT NOS.: WSU PROJECT NO. 090-247931-4

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
Engineering School, 5050 Anthony Wayne Drive,
Conference Room 1200
Detroit MI 48202

10:00 am, local time, October 14, 2014

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_cardLots.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 Valerie Kreher, Procurement & Strategic Sourcing. Discussion with other University members is seriously discouraged and could lead to disqualification from further consideration. All questions and answers will be recorded and emailed to all participants of the RFP.
   E. Due date for questions is October 17, 2014, 12:00 noon.

IV. Proposal Due Date- October 22, 2014, 2:00 p.m.

V. Final Comments

VI. Adjourn
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: EDC Mechanical and Electrical Systems Upgrade

PROJECT NO.:
WSU PROJECT NO. 090-247931-4

PROJECT TYPE:
General construction
Mechanical Contractors Work

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

OWNER'S REPRESENTATIVE:
Omar Alhyari, 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 EDC Mechanical and Electrical Systems Upgrade project (WSU Project No. 090-247931-4) 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.

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 February 28, 2014.

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 $150.00, One Hundred Fifty Dollars per day, and therefore the contractor shall pay as liquidated damages to the Owner the sum of $150.00, One Hundred Fifty 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
Addendum No. Date Addendum No. Date

FORM OF PROPOSAL FOR THE GENERAL CONTRACT 00300 - 2
CONTRACTOR'S PREQUALIFICATION STATEMENT & QUESTIONNAIRE:

Our Minimum Requirements for Construction Bids are:

WSU considers this project: General construction
Mechanical Contractors 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>
</tr>
</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>
</tr>
<tr>
<td>Unsuccessful Projects on Campus in last 3 years</td>
<td>None Allowed</td>
<td>None Allowed</td>
<td>None Allowed</td>
<td>None Allowed</td>
</tr>
<tr>
<td>Failure to comply with Prevailing Wage and/or Project Labor requirements</td>
<td>None Allowed</td>
<td>None Allowed</td>
<td>None Allowed</td>
<td>None Allowed</td>
</tr>
<tr>
<td>Withdrawn University Bid (with or without Bond forfeiture) within the last 3 years **</td>
<td>2 or less</td>
<td>2 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)

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: _________________________
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 #: 1417  
Requestor: Wayne State University  
Project Description: EDC Mechanical & Electrical Systems Upgrade  
Project Number: WSU 090-247931-4

Wayne County  
Official 2014 Prevailing Wage Rates for State Funded Projects  
Issue Date: 10/6/2014  
Contract must be awarded by: 1/4/2015  

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name</th>
<th>Description</th>
<th>Last Updated</th>
<th>Straight Time and a Half Time Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asbestos &amp; Lead Abatement Laborer</td>
<td>Asbestos &amp; Lead Abatement Laborer</td>
<td>MLDC</td>
<td>$40.25</td>
<td>$53.64 $67.03 H H X X X X D Y</td>
</tr>
<tr>
<td></td>
<td>4 ten hour days @ straight time allowed Monday-Saturday, must be consecutive calendar days</td>
<td>10/1/2014</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Asbestos & Lead Abatement, Hazardous Material Handler  
Asbestos and Lead Abatement, Hazardous Material Handler AS207  
10/1/2014

4 ten hour days @ straight time allowed Monday-Saturday,

Boilermaker  
Boilermaker BO169  
$54.70 $81.08 $107.45 H H H H H H D Y  
8/14/2009

Apprentice Rates:  
1st 6 months $40.31 $59.49 $78.67  
2nd 6 months $41.45 $61.21 $80.95  
3rd 6 months $42.57 $62.88 $83.19  
4th 6 months $43.69 $64.57 $85.43  
5th 6 months $44.81 $66.24 $87.67  
6th 6 months $49.53 $73.40 $97.26  
7th 6 months $49.32 $73.01 $96.69  
8th 6 months $51.58 $76.40 $101.21  

Official Request #: 1417  
Requestor: Wayne State University  
Project Description: EDC Mechanical & Electrical Systems Upgrade  
Project Number: WSU 090-247931-4  
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 Prevailing Wage Rates for State Funded Projects

### Issue Date: 10/6/2014

### Contract must be awarded by: 1/4/2015

#### Page 2 of 29

<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>
</tr>
</thead>
<tbody>
<tr>
<td>Bricklayer</td>
<td>Bricklayer, stone mason, pointer, cleaner, caulker</td>
<td>9/3/2013</td>
<td>$51.93</td>
<td>$77.90</td>
<td>$103.86</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>H H D D D D N</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Between October 1 and April 30, if lost time occurs due to inclement weather, Saturday may be worked as a make-up day @ straight time until forty hours are worked.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apprentice Rates:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First 6 months</td>
<td></td>
<td></td>
<td>$31.54</td>
<td>$47.32</td>
<td>$63.08</td>
</tr>
<tr>
<td>2nd 6 months</td>
<td></td>
<td></td>
<td>$33.39</td>
<td>$50.10</td>
<td>$66.78</td>
</tr>
<tr>
<td>3rd 6 months</td>
<td></td>
<td></td>
<td>$35.24</td>
<td>$52.87</td>
<td>$70.48</td>
</tr>
<tr>
<td>4th 6 months</td>
<td></td>
<td></td>
<td>$37.09</td>
<td>$55.64</td>
<td>$74.18</td>
</tr>
<tr>
<td>5th 6 months</td>
<td></td>
<td></td>
<td>$38.94</td>
<td>$58.42</td>
<td>$77.88</td>
</tr>
<tr>
<td>6th 6 months</td>
<td></td>
<td></td>
<td>$40.79</td>
<td>$61.20</td>
<td>$81.58</td>
</tr>
<tr>
<td>7th 6 months</td>
<td></td>
<td></td>
<td>$42.64</td>
<td>$63.97</td>
<td>$85.28</td>
</tr>
<tr>
<td>8th 6 months</td>
<td></td>
<td></td>
<td>$44.49</td>
<td>$66.74</td>
<td>$88.98</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>H H D D D D N</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Four 10s allowed M-Sat; double time due when over 12 hours worked per day</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apprentice Rates:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First 6 months</td>
<td></td>
<td></td>
<td>$24.23</td>
<td>$32.71</td>
<td>$41.18</td>
</tr>
<tr>
<td>2nd 6 months</td>
<td></td>
<td></td>
<td>$28.25</td>
<td>$38.73</td>
<td>$49.22</td>
</tr>
<tr>
<td>3rd 6 months</td>
<td></td>
<td></td>
<td>$30.35</td>
<td>$41.88</td>
<td>$53.42</td>
</tr>
<tr>
<td>4th 6 months</td>
<td></td>
<td></td>
<td>$32.44</td>
<td>$45.02</td>
<td>$57.60</td>
</tr>
<tr>
<td>5th 6 months</td>
<td></td>
<td></td>
<td>$34.54</td>
<td>$48.17</td>
<td>$61.80</td>
</tr>
<tr>
<td>6th 6 months</td>
<td></td>
<td></td>
<td>$36.63</td>
<td>$51.31</td>
<td>$65.98</td>
</tr>
<tr>
<td>7th 6 months</td>
<td></td>
<td></td>
<td>$38.74</td>
<td>$54.48</td>
<td>$70.20</td>
</tr>
<tr>
<td>8th 6 months</td>
<td></td>
<td></td>
<td>$40.82</td>
<td>$57.59</td>
<td>$74.36</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>H H D D D D N</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Official Request #: 1417

- Requestor: Wayne State University
- Project Description: EDC Mechanical & Electrical Systems Upgrade
- Project Number: WSU 090-247931-4
- 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 2 of 29
### Official 2014 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 10/6/2014  
**Contract must be awarded by:** 1/4/2015

#### Page 3 of 29

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name</th>
<th>Description</th>
<th>Rate Last Updated</th>
<th>Straight Time Hourly</th>
<th>Half Time</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carpenter</td>
<td></td>
<td>CA687Z1</td>
<td>$55.24</td>
<td>$79.04</td>
<td>$102.84</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name</th>
<th>Description</th>
<th>Rate Last Updated</th>
<th>Straight Time Hourly</th>
<th>Half Time</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apprentice Rates:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st year</td>
<td></td>
<td>CA687Z1</td>
<td>$33.82</td>
<td>$46.92</td>
<td>$60.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd 6 months</td>
<td></td>
<td></td>
<td>$36.21</td>
<td>$50.49</td>
<td>$64.78</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4th 6 months</td>
<td></td>
<td></td>
<td>$38.58</td>
<td>$54.05</td>
<td>$69.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5th 6 months</td>
<td></td>
<td></td>
<td>$40.97</td>
<td>$57.64</td>
<td>$74.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6th 6 months</td>
<td></td>
<td></td>
<td>$43.33</td>
<td>$61.17</td>
<td>$79.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7th 6 months</td>
<td></td>
<td></td>
<td>$45.72</td>
<td>$64.77</td>
<td>$83.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8th 6 months</td>
<td></td>
<td></td>
<td>$48.09</td>
<td>$68.32</td>
<td>$88.54</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Apprentice Rates:       |      |             |                   |                      |           |             |                    |                    |                    |                    |                    |
| 1st 6 months            |      | CA687Z1P    | $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    |             |                    |                    |                    |                    |                    |

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

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name</th>
<th>Description</th>
<th>Rate Last Updated</th>
<th>Straight Time Hourly</th>
<th>Half Time</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apprentice Rates:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st 6 months</td>
<td></td>
<td>br1cm</td>
<td>$49.30</td>
<td>$70.06</td>
<td>$90.81</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2nd 6 months</td>
<td></td>
<td></td>
<td>$30.74</td>
<td>$41.93</td>
<td>$53.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd 6 months</td>
<td></td>
<td></td>
<td>$34.79</td>
<td>$47.99</td>
<td>$61.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4th 6 months</td>
<td></td>
<td></td>
<td>$38.85</td>
<td>$54.05</td>
<td>$69.23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5th 6 months</td>
<td></td>
<td></td>
<td>$40.88</td>
<td>$57.07</td>
<td>$73.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6th 6 months</td>
<td></td>
<td></td>
<td>$44.93</td>
<td>$63.11</td>
<td>$81.30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cement Mason

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name</th>
<th>Description</th>
<th>Rate Last Updated</th>
<th>Straight Time Hourly</th>
<th>Half Time</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apprentice Rates:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1st 6 months</td>
<td></td>
<td>CE514</td>
<td>$46.30</td>
<td>$64.89</td>
<td>$83.48</td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td>2nd 6 months</td>
<td></td>
<td></td>
<td>$28.68</td>
<td>$38.91</td>
<td>$49.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3rd 6 months</td>
<td></td>
<td></td>
<td>$32.50</td>
<td>$44.59</td>
<td>$56.66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4th 6 months</td>
<td></td>
<td></td>
<td>$36.32</td>
<td>$50.26</td>
<td>$64.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5th 6 months</td>
<td></td>
<td></td>
<td>$38.24</td>
<td>$53.11</td>
<td>$67.98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6th 6 months</td>
<td></td>
<td></td>
<td>$42.06</td>
<td>$58.79</td>
<td>$75.51</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Official Request #: 1417  
Requestor: Wayne State University  
Project Description: EDC Mechanical & Electrical Systems Upgrade  
Project Number: WSU 090-247931-4  
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 2014 Prevailing Wage Rates for State Funded Projects

### Issue Date: 10/6/2014

**Contract must be awarded by:** 1/4/2015

**Page 4 of 29**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name Description</th>
<th>Last Updated</th>
<th>Straight Time and a Double Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Name</td>
<td>Updated</td>
<td>Hourly</td>
</tr>
<tr>
<td><strong>Drywall</strong></td>
<td>PT-22-D Drywall Taper</td>
<td>9/5/2014</td>
<td>$44.41</td>
</tr>
<tr>
<td></td>
<td>Four 10s allowed Monday-Thursday</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Apprentice Rates:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>First 3 months</td>
<td>$31.16</td>
<td>$37.79</td>
</tr>
<tr>
<td></td>
<td>Second 3 months</td>
<td>$33.81</td>
<td>$41.76</td>
</tr>
<tr>
<td></td>
<td>Second 6 months</td>
<td>$36.46</td>
<td>$45.73</td>
</tr>
<tr>
<td></td>
<td>Third 6 months</td>
<td>$39.11</td>
<td>$49.71</td>
</tr>
<tr>
<td></td>
<td>4th 6 months</td>
<td>$40.43</td>
<td>$51.69</td>
</tr>
</tbody>
</table>

| **Electrician**                         | EC-58-IW Inside Wireman           | 10/2/2014    | $58.91 | $77.39    | $95.87 H H H H D N |
| **Apprentice Rates:**                   |                                   |              |        |           |            |
|                                        | Period 1                          | $24.67       | $31.07 | $37.47    |            |
|                                        | Period 2                          | $25.95       | $32.99 | $40.03    |            |
|                                        | Period 3                          | $27.24       | $34.93 | $42.61    |            |
|                                        | Period 4                          | $28.51       | $36.83 | $45.15    |            |
|                                        | Period 5                          | $29.79       | $38.75 | $47.71    |            |
|                                        | Period 6                          | $31.07       | $40.67 | $50.27    |            |

| **Sound and Communication Installer/Technician** | EC-58-SC | 10/2/2014 | $37.48 | $50.29 | $63.09 H H H H D N |
| **Apprentice Rates:**                     |          |           |        |           |            |
|                                        | Period 1 | $24.67       | $31.07 | $37.47    |            |
|                                        | Period 2 | $25.95       | $32.99 | $40.03    |            |
|                                        | Period 3 | $27.24       | $34.93 | $42.61    |            |
|                                        | Period 4 | $28.51       | $36.83 | $45.15    |            |
|                                        | Period 5 | $29.79       | $38.75 | $47.71    |            |
|                                        | Period 6 | $31.07       | $40.67 | $50.27    |            |

| **Elevator Constructor**                 | EL 36 Elevator Constructor       | 8/7/2007     | $56.46 | $94.99    | D D D D D D D Y |
| **Apprentice Rates:**                    |                                   |              |        |           |            |
|                                        | 1st Year Apprentice               | $37.74       | $58.93 |           |            |
|                                        | 2nd Year Apprentice               | $41.90       | $66.94 |           |            |
|                                        | 3rd Year Apprentice               | $43.98       | $70.95 |           |            |
|                                        | 4th Year Apprentice               | $48.14       | $78.96 |           |            |

**Official Request #: 1417**

Requestor: Wayne State University

Project Description: EDC Mechanical & Electrical Systems Upgrade

Project Number: WSU 090-247931-4

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.
### Glazier

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Last Updated</th>
<th>Straight Time and a Half Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glazier GL-357</td>
<td></td>
<td>$47.35</td>
<td>H H H H D Y</td>
</tr>
</tbody>
</table>

If a four 10 hour day workweek is scheduled, four 10s must be consecutive, M-F.

#### Apprentice Rates:

<table>
<thead>
<tr>
<th></th>
<th>1st 6 months</th>
<th>2nd 6 months</th>
<th>3rd 6 months</th>
<th>4th 6 months</th>
<th>5th 6 months</th>
<th>6th 6 months</th>
<th>7th 6 months</th>
<th>8th 6 months</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$32.45</td>
<td>$33.94</td>
<td>$36.92</td>
<td>$38.41</td>
<td>$39.90</td>
<td>$41.39</td>
<td>$42.88</td>
<td>$45.86</td>
</tr>
</tbody>
</table>

#### Heat and Frost Insulator

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Last Updated</th>
<th>Straight Time and a Half Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spray Insulation AS25S</td>
<td></td>
<td>$20.14</td>
<td>H H H H N</td>
</tr>
</tbody>
</table>

#### Heat and Frost Insulator and Asbestos Worker

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Last Updated</th>
<th>Straight Time and a Half Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat and Frost Insulators and Asbestos Workers AS25</td>
<td></td>
<td>$60.25</td>
<td>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, Monday thru Friday will paid at time and one-half.

#### Apprentice Rates:

<table>
<thead>
<tr>
<th></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>
</tr>
</tbody>
</table>

#### Ironworker

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Last Updated</th>
<th>Straight Time and a Half Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fence, Sound Barrier &amp; Guardrail erection/installation and Exterior Signage work IR-25-F1</td>
<td></td>
<td>$34.20</td>
<td>X X X X D Y</td>
</tr>
</tbody>
</table>

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

#### Apprentice Rates:

<table>
<thead>
<tr>
<th></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>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$23.04</td>
<td>$24.37</td>
<td>$25.70</td>
<td>$27.02</td>
<td>$28.34</td>
<td>$29.67</td>
</tr>
</tbody>
</table>

Official Request #: 1417  
Requestor: Wayne State University  
Project Description: EDC Mechanical & Electrical Systems Upgrade  
Project Number: WSU 090-247931-4  
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>Last Updated</th>
<th>Straight Time</th>
<th>Half Time</th>
<th>Double Overtime</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siding, Glazing, Curtain Wall</td>
<td>IR-25-GZ2</td>
<td>9/4/2014</td>
<td>$46.41</td>
<td>$58.07</td>
<td>$69.73</td>
<td>X X H H H D Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-engineered Metal Work</td>
<td>IR-25-PE-Z1</td>
<td>6/3/2014</td>
<td>$45.24</td>
<td>$55.53</td>
<td>$65.81</td>
<td>X X X X D Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reinforced Iron Work</td>
<td>IR-25-RF</td>
<td>9/3/2014</td>
<td>$55.36</td>
<td>$82.91</td>
<td>$110.45</td>
<td>H H D D D D N</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rigging Work</td>
<td>IR-25-RIG</td>
<td>9/3/2014</td>
<td>$61.33</td>
<td>$91.67</td>
<td>$122.00</td>
<td>H H H H H D N</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Apprentice Rates:

1. **Siding, Glazing, Curtain Wall**
   - Level 1: $29.48, $36.09, $42.68
   - Level 2: $31.59, $38.83, $46.05
   - Level 3: $33.71, $41.58, $49.44
   - Level 4: $35.83, $44.33, $52.82
   - Level 5: $37.94, $47.07, $56.20
   - Level 6: $40.06, $49.82, $59.58

2. **Pre-engineered Metal Work**
   - 1st Year: $26.11, $31.58, $37.06
   - 3rd 6 month period: $28.23, $34.46, $40.68
   - 4th 6 month period: $30.36, $37.35, $44.33
   - 5th 6 month period: $32.48, $40.21, $47.95
   - 6th 6 month period: $34.61, $43.99, $53.37

3. **Reinforced Iron Work**
   - Level 1: $36.01, $53.89, $71.75
   - Level 2: $38.38, $57.43, $76.49
   - Level 3: $40.74, $60.98, $81.21
   - Level 4: $43.28, $64.78, $86.29
   - Level 5: $45.81, $68.59, $91.35
   - Level 6: $48.35, $72.39, $96.43

4. **Rigging Work**
   - 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

Official Request #: 1417
Requestor: Wayne State University
Project Description: EDC Mechanical & Electrical Systems Upgrade
Project Number: WSU 090-247931-4
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 2014 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 10/6/2014  
**Contract must be awarded by:** 1/4/2015

**Page 7 of 29**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name</th>
<th>Description</th>
<th>Last Updated</th>
<th>Straight Time and a Half</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decking</td>
<td>IR-25-SD</td>
<td>$53.29</td>
<td>$79.63</td>
<td>$105.96 X X H H H D D Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structural, ornamental, welder and pre-cast</td>
<td>IR-25-STR</td>
<td>$61.46</td>
<td>$91.84</td>
<td>$122.21 H H H H H D D Y</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Laborer:

- **Construction Laborer, Demolition Laborer, Mason Tender, Carpenter Tender, Drywall Handler, Concrete Laborer, Cement Finisher Tender, Concrete Chute, and Concrete Bucket Handler**

  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.

  **Apprentice Rates:**
  - 0-1,000 work hours: $37.60 | $53.03 | $68.45
  - 1,001 - 2,000 work hours: $38.79 | $54.81 | $70.83
  - 2,001 - 3,000 work hours: $39.98 | $56.60 | $73.21
  - 3,001 - 4,000 work hours: $42.35 | $60.15 | $77.95

**Official Request #:** 1417  
**Requestor:** Wayne State University  
**Project Description:** EDC Mechanical & Electrical Systems Upgrade  
**Project Number:** WSU 090-247931-4  
**County:** Wayne
### Official 2014 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 10/6/2014  
**Contract must be awarded by:** 1/4/2015

**Page 8 of 29**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name Description</th>
<th>Updated</th>
<th>Last Straight</th>
<th>Time and a Half</th>
<th>Double Overtime</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>7/16/2013</td>
<td>$43.80</td>
<td>$62.33</td>
<td>$80.85</td>
<td>H H H H H H Y</td>
</tr>
<tr>
<td></td>
<td>Signal Man (on sewer &amp; caisson work), Air, Electric or Gasoline Tool Operator, Concrete Vibrator Operator, Acetylene Torch &amp; Air Hammer Operator, Scaffold Builder, Caisson Worker</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></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.

|                | Furnace Battery Heater Tender, Burning Bar & Oxy-Acetylene Gun | 7/16/2013 | $44.04 | $62.69 | $81.33 | H H H H H H D Y |
|                | L33401-D-HH |         |         |         |         |                   |

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.

|                | Expediter Man, Top Man and/or Bottom Man (Blast Furnace Work or Battery Work) | 7/16/2013 | $44.79 | $63.81 | $82.83 | H H H H H H D Y |
|                | L33401-E-EX |         |         |         |         |                   |

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.

|                | Cleaner/Sweeper Laborer; Furniture Laborer | 7/16/2013 | $38.09 | $53.76 | $69.43 | H H H H H H D Y |
|                | L33401-F-CL |         |         |         |         |                   |

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.

|                | Lansing Burner, Blaster & Powder Man; Air, Electric or Gasoline Tool Operator (Blast Furance Work or Battery Work) | 7/16/2013 | $44.29 | $63.06 | $81.83 | X X H H H H D Y |
|                | L334C |         |         |         |         |                   |

---

**Official Request #: 1417**  
**Requestor:** Wayne State University  
**Project Description:** EDC Mechanical & Electrical Systems Upgrade

---

**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 2014 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 10/6/2014  
**Contract must be awarded by:** 1/4/2015  

### Classification

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

**Apprentice Rates:**

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

### Laborer - Hazardous

<table>
<thead>
<tr>
<th>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 &quot;D&quot; is required.</th>
<th>LHAZ-Z1-A</th>
<th>11/1/2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apprentice Rates:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 1,000 work hours</td>
<td>$37.60 $53.03 $68.45</td>
<td></td>
</tr>
<tr>
<td>1,001-2,000 work hours</td>
<td>$38.79 $54.81 $70.83</td>
<td></td>
</tr>
<tr>
<td>2,001-3,000 work hours</td>
<td>$39.98 $56.60 $73.21</td>
<td></td>
</tr>
<tr>
<td>3,001-4,000 work hours</td>
<td>$42.35 $60.15 $77.95</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class B performing work 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.</th>
<th>LHAZ-Z1-B</th>
<th>11/4/2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apprentice Rates:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0-1,000 work hours</td>
<td>$38.36 $54.17 $69.97</td>
<td></td>
</tr>
<tr>
<td>1,001-2,000 work hours</td>
<td>$39.59 $56.01 $72.43</td>
<td></td>
</tr>
<tr>
<td>2,001-3,000 work hours</td>
<td>$40.83 $57.87 $74.91</td>
<td></td>
</tr>
<tr>
<td>3,001-4,000 work hours</td>
<td>$43.30 $61.58 $79.85</td>
<td></td>
</tr>
</tbody>
</table>

Official Request #: 1417  
Requestor: Wayne State University  
Project Description: EDC Mechanical & Electrical Systems Upgrade  
Project Number: WSU 090-247931-4  
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 2014 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 10/6/2014  
**Contract must be awarded by:** 1/4/2015

#### Classification

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Last Updated</th>
<th>Straight Time and a Half</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Laborer Underground - Tunnel, Shaft &amp; Caisson</strong></td>
<td>LAUCT-Z1-1</td>
<td>$37.87</td>
<td>$48.66</td>
<td>X X X X X X D Y</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>9/6/2013</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**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.  

**LAUCT-Z1-2** | $37.98 | $48.82 | $59.66 X X X X X D Y | 9/6/2013

**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

Class III - Air tool operator (jack hammer man, bush hammer man and grinding man), first bottom man, second bottom man, cage tender, 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 man, 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.).  

**LAUCT-Z1-3** | $38.04 | $48.91 | $59.78 X X X X X D Y | 9/6/2013

**Apprentice Rates:**

- 0-1,000 work hours: $33.18, $41.62, $50.06
- 1,001-2,000 work hours: $34.15, $43.07, $52.00
- 2,001-3,000 work hours: $35.12, $44.53, $53.94
- 3,001-4,000 work hours: $37.07, $47.45, $57.84

---

**Official Request #:** 1417  
**Requestor:** Wayne State University  
**Project Description:** EDC Mechanical & Electrical Systems Upgrade  
**Project Number:** WSU 090-247931-4  
**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 2014 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 10/6/2014  
**Contract must be awarded by:** 1/4/2015

#### Page 11 of 29

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name Description</th>
<th>Last Updated</th>
<th>Straight Time and a Half Time</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class IV - Tunnel, shaft and caisson mucker, bracer man, liner plate man, long haul dinky driver and well point man.</td>
<td>LAUCT-Z1-4</td>
<td>$38.22 $49.18 $60.14 X X X X X X D Y</td>
<td></td>
<td></td>
<td>9/6/2013</td>
</tr>
</tbody>
</table>

**Apprentice Rates:**

- 0-1,000 work hours | $33.32 | $41.83 | $50.34 |
- 1,001-2,000 work hours | $34.30 | $43.30 | $52.30 |
- 2,001-3,000 work hours | $35.28 | $44.77 | $54.26 |
- 3,001-4,000 work hours | $37.24 | $47.71 | $58.18 |

| Class V - 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) | LAUCT-Z1-5 | $38.47 $49.56 $60.64 X X X X D Y | | | 9/6/2013 |

**Apprentice Rates:**

- 0-1,000 work hours | $33.50 | $42.10 | $50.70 |
- 1,001-2,000 work hours | $34.50 | $43.60 | $52.70 |
- 2,001-3,000 work hours | $35.49 | $45.09 | $54.68 |
- 3,001-4,000 work hours | $37.48 | $48.07 | $58.66 |

| Class VI - Dynamite man and powder man. | LAUCT-Z1-6 | $38.80 $50.05 $61.30 X X X X D Y | | | 9/6/2013 |

**Apprentice Rates:**

- 0-1,000 work hours | $33.75 | $42.47 | $51.20 |
- 1,001-2,000 work hours | $34.76 | $43.99 | $53.22 |
- 2,001-3,000 work hours | $35.77 | $45.51 | $55.24 |
- 3,001-4,000 work hours | $37.79 | $48.53 | $59.28 |

| Class VII - 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. | LAUCT-Z1-7 | $32.08 $39.97 $47.86 X X X X X D Y | | | 9/6/2013 |

**Apprentice Rates:**

- 0-1,000 work hours | $28.71 | $34.91 | $41.12 |
- 1,001-2,000 work hours | $29.38 | $35.92 | $42.46 |
- 2,001-3,000 work hours | $30.06 | $36.94 | $43.82 |
- 3,001-4,000 work hours | $31.41 | $38.97 | $46.52 |

---

**Official Request #:** 1417  
**Requestor:** Wayne State University  
**Project Description:** EDC Mechanical & Electrical Systems Upgrade  
**Project Number:** WSU 090-247931-4  
**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.
### Landscape Laborer

**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 & one half. Holidays paid at double time.

**Skilled Landscape Laborer: small power tool operator, lawn sprinkler installers' tender, material mover, truck driver when seeding, sodding, planting, cutting, trimming, backfilling, rough grading or maintaining of landscape projects occurs. Sundays paid at time & one half. Holidays paid at double time.**

### Marble Finisher

**Marble Finisher**

A 4 ten workweek may be worked Monday thru Thursday or Tuesday thru Friday.

### Apprentice Rates:

<table>
<thead>
<tr>
<th>Level</th>
<th>Hourly</th>
<th>Half Time</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>$18.80</td>
<td>$24.77</td>
<td>$30.73</td>
<td></td>
</tr>
<tr>
<td>Level 2</td>
<td>$19.99</td>
<td>$26.55</td>
<td>$33.11</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>$26.67</td>
<td>$33.52</td>
<td>$40.36</td>
<td></td>
</tr>
<tr>
<td>Level 4</td>
<td>$28.12</td>
<td>$35.69</td>
<td>$43.26</td>
<td></td>
</tr>
<tr>
<td>Level 5</td>
<td>$29.62</td>
<td>$37.37</td>
<td>$45.13</td>
<td></td>
</tr>
<tr>
<td>Level 6</td>
<td>$31.22</td>
<td>$39.37</td>
<td>$47.51</td>
<td></td>
</tr>
<tr>
<td>Level 7</td>
<td>$32.89</td>
<td>$41.08</td>
<td>$49.26</td>
<td></td>
</tr>
<tr>
<td>Level 8</td>
<td>$34.36</td>
<td>$42.95</td>
<td>$51.54</td>
<td></td>
</tr>
</tbody>
</table>
## Official 2014 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 10/6/2014  
**Contract must be awarded by:** 1/4/2015

### Page 13 of 29

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
<th>BR1-MM</th>
<th>Updated</th>
<th>Hourly</th>
<th>Half Time</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marble Mason</td>
<td>Marble Mason</td>
<td>BR1-MM</td>
<td>9/5/2013</td>
<td>$49.67</td>
<td>$63.74</td>
<td>$77.81</td>
<td>H H D D D Y</td>
</tr>
</tbody>
</table>

A 4 ten workweek may be worked Monday thru Thursday or Tuesday thru Friday.

### Apprentice Rates:

<table>
<thead>
<tr>
<th>Level</th>
<th>Hourly</th>
<th>Half Time</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>$24.83</td>
<td>$32.24</td>
<td>$39.65</td>
<td></td>
</tr>
<tr>
<td>Level 2</td>
<td>$27.85</td>
<td>$36.04</td>
<td>$44.23</td>
<td></td>
</tr>
<tr>
<td>Level 3</td>
<td>$33.00</td>
<td>$41.45</td>
<td>$49.90</td>
<td></td>
</tr>
<tr>
<td>Level 4</td>
<td>$35.70</td>
<td>$45.09</td>
<td>$54.49</td>
<td></td>
</tr>
<tr>
<td>Level 5</td>
<td>$37.94</td>
<td>$47.57</td>
<td>$57.21</td>
<td></td>
</tr>
<tr>
<td>Level 6</td>
<td>$41.55</td>
<td>$52.91</td>
<td>$64.27</td>
<td></td>
</tr>
<tr>
<td>Level 7</td>
<td>$42.21</td>
<td>$53.72</td>
<td>$65.22</td>
<td></td>
</tr>
<tr>
<td>Level 8</td>
<td>$43.13</td>
<td>$55.10</td>
<td>$67.06</td>
<td></td>
</tr>
</tbody>
</table>

### Operating Engineer

| Crane with boom & jib or leads 120' or longer | EN-324-A120 | 6/12/2014 | $57.11 | $74.62 | $92.13 | X X H H D D D Y |
| Crane with boom & jib or leads 140' or longer | EN-324-A140 | 6/12/2014 | $57.93 | $75.85 | $93.77 | 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 | EN-324-A220 | 6/12/2014 | $58.23 | $76.30 | $94.37 | X X H H D D D Y |
| Crane with boom & jib or leads 300' or longer | EN-324-A300 | 6/12/2014 | $59.73 | $78.55 | $97.37 | X X H H D D D Y |
| Crane with boom & jib or leads 400' or longer | EN-324-A400 | 6/12/2014 | $61.23 | $80.80 | $100.37 | X X H H D D D Y |

Compressor or welding machine  
Work in excess of 12 per day M-F shall be paid at double time.
## Official 2014 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 10/6/2014  
**Contract must be awarded by:** 1/4/2015

### Page 14 of 29

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
<th>Last Updated</th>
<th>Straight Time</th>
<th>Half Time</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forklift, lull, extend-a-boom forklift</td>
<td>EN-324-FL</td>
<td>6/12/2014</td>
<td>$53.57</td>
<td>$69.31</td>
<td>$85.05</td>
<td>X X H D D D Y</td>
</tr>
<tr>
<td>Fireman or oiler</td>
<td>EN-324-FO</td>
<td>6/12/2014</td>
<td>$45.23</td>
<td>$56.80</td>
<td>$68.37</td>
<td>X X H D D D Y</td>
</tr>
<tr>
<td>Regular crane, job mechanic, concrete pump with boom</td>
<td>EN-324-RC</td>
<td>6/12/2014</td>
<td>$56.25</td>
<td>$73.33</td>
<td>$90.41</td>
<td>X X H D D D Y</td>
</tr>
<tr>
<td>Regular engineer, hydro-excavator, remote controlled concrete breaker</td>
<td>EN-324-RE</td>
<td>6/12/2014</td>
<td>$55.28</td>
<td>$71.88</td>
<td>$88.47</td>
<td>X X H D D D Y</td>
</tr>
</tbody>
</table>

**Apprentice Rates:**

- 0-999 hours: $44.32, $55.94, $67.55
- 1,000-1,999 hours: $45.99, $58.45, $70.89
- 2,000-2,999 hours: $47.64, $60.92, $74.19
- 3,000-3,999 hours: $49.30, $63.41, $77.51
- 4,000-4,999 hours: $50.96, $65.90, $80.83
- 5,000-5,999 hours: $52.62, $68.39, $84.15

**Operating Engineer - DIVER**

Diver/Wet Tender/Tender/Rov Pilot/Rov Tender | GLF-D | 4/2/2014 | $52.80 | $79.20 | $105.60 | H H H H H D N |

**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 D Y |

Holiday pay = $124.55 per hour, wages & fringes

**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 D Y |

Holiday pay = $120.80 per hour, wages & fringes

---

**Official Request #:** 1417  
**Requestor:** Wayne State University  
**Project Description:** EDC Mechanical & Electrical Systems Upgrade  
**Project Number:** WSU 090-247931-4  
**County:** Statewide  

---

**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.
### Classification: Subdivision of county
All Great Lakes, islands therein, & connecting & tributary waters

#### Friction, Lattice Boom or Crane License Certification
GLF-2B

<table>
<thead>
<tr>
<th>Last Updated</th>
<th>Straight Time &amp; a Half</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/12/2014</td>
<td>$64.50</td>
<td>$84.10</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$103.70</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D</td>
<td>Y</td>
</tr>
</tbody>
</table>

Holiday pay = $123.30

#### 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

<table>
<thead>
<tr>
<th>Last Updated</th>
<th>Straight Time &amp; a Half</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/12/2014</td>
<td>$59.30</td>
<td>$76.30</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$93.30</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D</td>
<td>Y</td>
</tr>
</tbody>
</table>

Holiday pay = $110.30 per hour, wages & fringes

#### Deck Equipment Operator, (Machineryman/Fireman), (4 equipment units or more), Off Road Trucks, Deck Hand, Tug Engineer, & Crane Maintenance 50 ton capacity and under or Backhoe 115,000 lbs or less, Assistant Tug Operator
GLF-4

<table>
<thead>
<tr>
<th>Last Updated</th>
<th>Straight Time &amp; a Half</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>2/12/2014</td>
<td>$53.60</td>
<td>$67.75</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$81.90</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D</td>
<td>Y</td>
</tr>
</tbody>
</table>

Holiday pay = $96.05 per hour, wages & fringes

#### Operating Engineer Hazardous Waste Class I
Level A - Fully encapsulating chemical resistant suit w/ pressure demand, full face piece SCBA or pressure demand supplied air respirator w/ escape SCBA. The highest available level of respiratory, skin and eye protection.
EN-324-HWCI-Z1A

<table>
<thead>
<tr>
<th>Last Updated</th>
<th>Straight Time &amp; a Half</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/20/2012</td>
<td>$51.84</td>
<td>$67.86</td>
<td>$83.87</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td></td>
<td>H</td>
<td>H</td>
</tr>
<tr>
<td></td>
<td></td>
<td>D</td>
<td>Y</td>
</tr>
</tbody>
</table>

Four 10 hour days may be worked Monday-Thursday with Friday as a straight-time make up day.

### Apprentice Rates:

<table>
<thead>
<tr>
<th>Time Period</th>
<th>1st 6 months</th>
<th>2nd 6 months</th>
<th>3rd 6 months</th>
<th>4th 6 months</th>
<th>5th 6 months</th>
<th>6th 6 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st 6 months</td>
<td>$41.63</td>
<td>$43.23</td>
<td>$44.83</td>
<td>$46.43</td>
<td>$48.03</td>
<td>$49.64</td>
</tr>
<tr>
<td>2nd 6 months</td>
<td>$52.85</td>
<td>$55.25</td>
<td>$57.64</td>
<td>$60.04</td>
<td>$62.44</td>
<td>$64.86</td>
</tr>
<tr>
<td>3rd 6 months</td>
<td>$64.05</td>
<td>$67.25</td>
<td>$70.45</td>
<td>$73.65</td>
<td>$76.85</td>
<td>$80.07</td>
</tr>
</tbody>
</table>

---

Official Request #: 1417
Requestor: Wayne State University
Project Description: EDC Mechanical & Electrical Systems Upgrade
Project Number: WSU 090-247931-4
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 2014 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 10/6/2014  
**Contract must be awarded by:** 1/4/2015

### Page 16 of 29

<table>
<thead>
<tr>
<th>Classification</th>
<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>Level B &amp; C protection. B - Pressure demand, full face SCBA or pressure demand supplied air respirator w/ escape SCBA w/chemical resistant clothing. C - Full face piece, air purifying canister-equipped respirator w/chemical resistant clothing.</td>
<td>EN-324-HWCI-Z1B</td>
<td>$50.89</td>
<td>$66.43</td>
<td>$81.97</td>
<td>H H H H H H D Y</td>
<td></td>
</tr>
</tbody>
</table>

Four 10 hour days may be worked Monday-Thursday with Friday as a straight-time make up day.

**Apprentice Rates:**

- 1st 6 months: $40.97  
- 2nd 6 months: $42.52  
- 3rd 6 months: $44.07  
- 4th 6 months: $45.64  
- 5th 6 months: $47.19  
- 6th 6 months: $48.74

| Level D - Coveralls, safety boots, glasses or chemical splash goggles and hard hats. | EN-324-HWCI-Z1D | $49.59 | $64.48 | $79.37 | H H H H H H D Y |

Four 10 hour days may be worked Monday-Thursday with Friday as a straight-time make up day.

**Apprentice Rates:**

- 1st 6 months: $40.06  
- 2nd 6 months: $41.54  
- 3rd 6 months: $43.04  
- 4th 6 months: $44.53  
- 5th 6 months: $46.02  
- 6th 6 months: $47.50

| Level D When Capping Landfill Coveralls, safety boots, glasses or chemical splash goggles and hard hats. | EN-324-HWCI-Z1DCL | $49.34 | $64.11 | $78.87 | H H H H H H D Y |

Four 10 hour days may be worked Monday-Thursday with Friday as a straight-time make up day.

**Apprentice Rates:**

- 1st 6 months: $39.89  
- 2nd 6 months: $41.36  
- 3rd 6 months: $42.83  
- 4th 6 months: $44.31  
- 5th 6 months: $45.79  
- 6th 6 months: $47.27

---

**Official Request #:** 1417  
**Requestor:** Wayne State University  
**Project Description:** EDC Mechanical & Electrical Systems Upgrade  
**Project Number:** WSU 090-247931-4  
**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.
### Operating Engineer Hazardous Waste Class II

**Level A** - Fully encapsulating chemical resistant suit w/ pressure demand, full face piece SCBA or pressure demand supplied air respirator w/ escape SCBA. The highest available level of respiratory, skin and eye protection.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Hourly</th>
<th>Half Time</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN-324-HWCI1-Z1A</td>
<td>$47.61 $61.51 $75.41 H H H H H D Y</td>
<td>1/20/2012</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Four 10 hour days may be worked Monday-Thursday with Friday as a straight-time make up day.

**Level B & C** protection. **B** - Pressure demand, full face SCBA or pressure demand supplied air respirator w/ escape SCBA. **C** - Full face piece, air purifying canister-equipped respirator w/chemical resistant clothing.

***Level B*** - Pressure demand, full face SCBA or pressure demand supplied air respirator w/ escape SCBA. The highest available level of respiratory, skin and eye protection.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Hourly</th>
<th>Half Time</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN-324-HWCI1-Z1B</td>
<td>$46.66 $60.09 $73.51 H H H H H D Y</td>
<td>1/20/2012</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Four 10 hour days may be worked Monday-Thursday with Friday as a straight-time make up day.

**Level C** - Full face piece, air purifying canister-equipped respirator w/chemical resistant clothing.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Hourly</th>
<th>Half Time</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN-324-HWCI1-Z1D</td>
<td>$45.36 $58.14 $70.91 H H H H H D Y</td>
<td>1/20/2012</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Four 10 hour days may be worked Monday-Thursday with Friday as a straight-time make up day.

**Level D** - Coveralls, safety boots, glasses or chemical splash goggles and hard hats.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Hourly</th>
<th>Half Time</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN-324-HWCI1-Z1DCL</td>
<td>$45.11 $57.76 $70.41 H H H H H D Y</td>
<td>1/20/2012</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Four 10 hour days may be worked Monday-Thursday with Friday as a straight-time make up day.

**Level D When Capping Landfill** Coveralls, safety boots, glasses or chemical splash goggles and hard hats.

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Hourly</th>
<th>Half Time</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN-324-HW140-Z1A</td>
<td>$54.49 $71.83 $89.17 H H H H H D Y</td>
<td>1/20/2012</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Four 10 hour days may be worked Monday-Thursday with Friday as a straight-time make up day.
### Official 2014 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 10/6/2014  
**Contract must be awarded by:** 1/4/2015

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name</th>
<th>Description</th>
<th>Updated Hourly</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level B &amp; C protection. B - Pressure demand, full face SCBA or pressure demand supplied air respirator w/ escape SCBA w/chemical resistant clothing. C - Full face piece, air purifying canister-equipped respirator w/chemical resistant clothing.</td>
<td>EN-324-HW140-Z1B</td>
<td>$53.54</td>
<td>$70.41</td>
<td>$87.27</td>
<td>H H H H H D Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level D Coveralls, safety boots, glasses or chemical splash goggles and hard hats.</td>
<td>EN-324-HW140-Z1D</td>
<td>$52.24</td>
<td>$68.46</td>
<td>$84.67</td>
<td>H H H H H D Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level D When Capping Landfill Coveralls, safety boots, glasses or chemical splash goggles and hard hats.</td>
<td>EN-324-HW140-Z1DCL</td>
<td>$51.99</td>
<td>$68.08</td>
<td>$84.17</td>
<td>H H H H H D Y</td>
</tr>
<tr>
<td>Operating Engineer Hazardous Waste Crane w/ Boom &amp; Jib leads 220' or longer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level A - Fully encapsulating chemical resistant suit w/ pressure demand, full face piece SCBA or pressure demand supplied air respirator w/ escape SCBA. The highest available level of respiratory, skin and eye protection.</td>
<td>EN-324-HW220-Z1A</td>
<td>$54.79</td>
<td>$72.28</td>
<td>$89.77</td>
<td>H H H H H D Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level B &amp; C protection. B - Pressure demand, full face SCBA or pressure demand supplied air respirator w/ escape SCBA w/chemical resistant clothing. C - Full face piece, air purifying canister-equipped respirator w/chemical resistant clothing.</td>
<td>EN-324-HW220-Z1B</td>
<td>$53.84</td>
<td>$70.86</td>
<td>$87.87</td>
<td>H H H H H D Y</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Level D Coveralls, safety boots, glasses or chemical splash goggles and hard hats.</td>
<td>EN-324-HW220-Z1D</td>
<td>$52.54</td>
<td>$68.91</td>
<td>$85.27</td>
<td>H H H H H D Y</td>
</tr>
</tbody>
</table>

---

**Official Request #:** 1417  
**Requestor:** Wayne State University  
**Project Description:** EDC Mechanical & Electrical Systems Upgrade  
**Official Rate Schedule**  
Every contractor and subcontractor shall keep posted on the construction site, a copy of all prevailing wage and fringe benefit rates.
prescribed in a contract.
Official 2014 Prevailing Wage Rates for State Funded Projects

Issue Date: 10/6/2014
Contract must be awarded by: 1/4/2015

Page 19 of 29

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name</th>
<th>Hourly</th>
<th>Half Time</th>
<th>Straight Time and a Half</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level D When Capping Landfill Coveralls, safety boots, glasses or chemical splash goggles and hard hats.</td>
<td>EN-324-HW220-Z1DCL</td>
<td>$52.29</td>
<td>$68.53</td>
<td>$84.77</td>
<td>H H H H H H D Y</td>
<td></td>
</tr>
</tbody>
</table>

Four 10 hour days may be worked Monday-Thursday with Friday as a straight-time make up day.

Operating Engineer Hazardous Waste Regular Crane, Job Mechanic, Dragline Operator, Boom Truck Operator, Power Shovel Operator and Concrete Pump with boom

| Level D When Capping Landfill Coveralls, safety boots, glasses or chemical splash goggles and hard hats. | EN-324-HWRC-Z1DCL | $49.69 | $64.63 | $79.57 | H H H H H H D Y |

Four 10 hour days may be worked Monday-Thursday with Friday as a straight-time make up day.

Operating Engineer Hazardous Waste Regular Crane, Job Mechanic, Dragline Operator, Boom Truck Operator, Power Shovel Operator and Concrete Pump with Boom Operator

| Level D - Coveralls, safety boots, glasses or chemical splash goggles and hard hats. | EN-324-HWRC-Z1D | $50.56 | $65.94 | $81.31 | H H H H H H D Y |

Four 10 hour days may be worked Monday-Thursday with Friday as a straight-time make up day.

Operating Engineer Hazardous Waste Regular Crane, Job Mechanic, Dragline Operator, Boom Truck Operator, Power Shovel Operator and Concrete Pump with booms

| Level B & C protection. B - Pressure demand, full face SCBA or pressure demand supplied air respirator w/ escape SCBA w/chemical resistant clothing. C - Full face piece, air purifying canister-equipped respirator w/chemical resistant clothing. | EN-324-HWRC-Z1B | $51.86 | $67.89 | $83.91 | H H H H H H D Y |

Four 10 hour days may be worked Monday-Thursday with Friday as a straight-time make up day.

Operating Engineer Hazardous Waste Regular Crane, Job Mechanic, Dragline Operator, Boom Truck Operator, Power Shovel Operators and Concrete Pump with booms

| Level A - Fully encapsulating chemical resistant suit w/ pressure demand, full face piece SCBA or pressure demand supplied air respirator w/ escape SCBA. The highest available level of respiratory, skin and eye protection. | EN-324-HWRC-Z1A | $52.81 | $69.31 | $85.81 | H H H H H H D Y |

Four 10 hour days may be worked Monday-Thursday with Friday as a straight-time make up day.

Official Request #: 1417
Requestor: Wayne State University
Project Description: EDC Mechanical & Electrical Systems Upgrade

Every contractor and subcontractor shall keep posted on the construction site, in a conspicuous place, a copy

Official Rate Schedule
of all prevailing wage and fringe benefit rates prescribed in a contract.
## Official 2014 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 10/6/2014  
**Contract must be awarded by:** 1/4/2015

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
<th>Name</th>
<th>Hourly</th>
<th>Half Time</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Engineer Steel Work</td>
<td>Forklift, 1 Drum Hoist</td>
<td>EN-324-ef</td>
<td>$58.16</td>
<td>$76.37</td>
<td>$94.58</td>
<td>H H D H H D D Y</td>
</tr>
<tr>
<td></td>
<td>Crane w/ 120’ boom or longer</td>
<td>EN-324-SW120</td>
<td>$60.86</td>
<td>$80.42</td>
<td>$99.98</td>
<td>H H D H H D D Y</td>
</tr>
<tr>
<td></td>
<td>Crane w/ 120’ boom or longer w/ Oiler</td>
<td>EN-324-SW120-O</td>
<td>$61.86</td>
<td>$81.92</td>
<td>$101.98</td>
<td>H H D H H D D Y</td>
</tr>
<tr>
<td></td>
<td>Crane w/ 140’ boom or longer</td>
<td>EN-324-SW140</td>
<td>$62.04</td>
<td>$82.19</td>
<td>$102.34</td>
<td>H H D H H D D Y</td>
</tr>
<tr>
<td></td>
<td>Crane w/ 140’ boom or longer W/ Oiler</td>
<td>EN-324-SW140-O</td>
<td>$63.04</td>
<td>$83.69</td>
<td>$104.34</td>
<td>H H D H H D D Y</td>
</tr>
<tr>
<td></td>
<td>Boom &amp; Jib 220’ or longer</td>
<td>EN-324-SW220</td>
<td>$62.31</td>
<td>$82.60</td>
<td>$102.88</td>
<td>H H D H H D D Y</td>
</tr>
<tr>
<td></td>
<td>Crane w/ 220’ boom or longer w/ Oiler</td>
<td>EN-324-SW220-O</td>
<td>$63.31</td>
<td>$84.10</td>
<td>$104.88</td>
<td>H H D H H D D Y</td>
</tr>
<tr>
<td></td>
<td>Boom &amp; Jib 300’ or longer</td>
<td>EN-324-SW300</td>
<td>$63.81</td>
<td>$84.85</td>
<td>$105.88</td>
<td>H H D H H D D Y</td>
</tr>
<tr>
<td></td>
<td>Crane w/ 300’ boom or longer w/ Oiler</td>
<td>EN-324-SW300-O</td>
<td>$64.81</td>
<td>$86.35</td>
<td>$107.88</td>
<td>H H D H H D D Y</td>
</tr>
<tr>
<td></td>
<td>Boom &amp; Jib 400’ or longer</td>
<td>EN-324-SW400</td>
<td>$65.31</td>
<td>$87.10</td>
<td>$108.88</td>
<td>H H D H H D D Y</td>
</tr>
<tr>
<td></td>
<td>Crane w/ 400’ boom or longer w/ Oiler</td>
<td>EN-324-SW400-O</td>
<td>$66.31</td>
<td>$88.60</td>
<td>$110.88</td>
<td>H H D H H D D Y</td>
</tr>
<tr>
<td></td>
<td>Crane Operator, Job Mechanic, 3 Drum Hoist &amp; Excavator</td>
<td>EN-324-SWCO</td>
<td>$60.50</td>
<td>$79.88</td>
<td>$99.26</td>
<td>H H D H H D D Y</td>
</tr>
</tbody>
</table>

### Apprentice Rates:

- 0-999 hours: $47.87, $61.43, $75.00
- 1000-1999 hours: $49.81, $64.35, $78.88
- 2000-2999 hours: $51.74, $67.24, $82.74
- 3000-3999 hours: $53.68, $70.15, $86.62
- 4000-4999 hours: $55.62, $73.07, $90.50
- 5,000 hours: $57.56, $75.97, $94.38

---

**Official Request #:** 1417  
**Requestor:** Wayne State University  
**Project Description:** EDC Mechanical & Electrical Systems Upgrade  
**Project Number:** WSU 090-247931-4  
**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 Request #:** 1417  
**Requestor:** Wayne State University  
**Project Description:** EDC Mechanical & Electrical Systems Upgrade  
**Project Number:** WSU 090-247931-4  
**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 Request #:** 1417  
**Requestor:** Wayne State University  
**Project Description:** EDC Mechanical & Electrical Systems Upgrade  
**Project Number:** WSU 090-247931-4  
**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 Request #:** 1417  
**Requestor:** Wayne State University  
**Project Description:** EDC Mechanical & Electrical Systems Upgrade  
**Project Number:** WSU 090-247931-4  
**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 Request #:** 1417  
**Requestor:** Wayne State University  
**Project Description:** EDC Mechanical & Electrical Systems Upgrade  
**Project Number:** WSU 090-247931-4  
**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 Request #:** 1417  
**Requestor:** Wayne State University  
**Project Description:** EDC Mechanical & Electrical Systems Upgrade  
**Project Number:** WSU 090-247931-4  
**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 Request #:** 1417  
**Requestor:** Wayne State University  
**Project Description:** EDC Mechanical & Electrical Systems Upgrade  
**Project Number:** WSU 090-247931-4  
**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 Request #:** 1417  
**Requestor:** Wayne State University  
**Project Description:** EDC Mechanical & Electrical Systems Upgrade  
**Project Number:** WSU 090-247931-4  
**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 Request #:** 1417  
**Requestor:** Wayne State University  
**Project Description:** EDC Mechanical & Electrical Systems Upgrade  
**Project Number:** WSU 090-247931-4  
**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 Request #:** 1417  
**Requestor:** Wayne State University  
**Project Description:** EDC Mechanical & Electrical Systems Upgrade  
**Project Number:** WSU 090-247931-4  
**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 Request #:** 1417  
**Requestor:** Wayne State University  
**Project Description:** EDC Mechanical & Electrical Systems Upgrade  
**Project Number:** WSU 090-247931-4  
**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 2014 Prevailing Wage Rates for State Funded Projects

#### Issue Date: 10/6/2014
Contract must be awarded by: 1/4/2015

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name Description</th>
<th>Last Updated</th>
<th>Straight Time and a Half</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hourly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crane Operator w/ Oiler</td>
<td>EN-324-SWCO-O</td>
<td>9/5/2014</td>
<td>$61.50</td>
<td>$81.38</td>
<td>$101.26</td>
</tr>
<tr>
<td>Compressor or Welder Operator</td>
<td>EN-324-SWCW</td>
<td>9/5/2014</td>
<td>$53.15</td>
<td>$68.86</td>
<td>$84.56</td>
</tr>
<tr>
<td>Hoisting Operator, 2 Drum Hoist, &amp; Rubber Tire Backhoe</td>
<td>EN-324-SWHO</td>
<td>9/5/2014</td>
<td>$59.86</td>
<td>$78.92</td>
<td>$97.98</td>
</tr>
<tr>
<td>Oiler</td>
<td>EN-324-SWO</td>
<td>9/5/2014</td>
<td>$51.64</td>
<td>$66.59</td>
<td>$81.54</td>
</tr>
<tr>
<td>Tower Crane &amp; Derrick where work is 50' or more above first level</td>
<td>EN-324-SWTD50</td>
<td>9/5/2014</td>
<td>$61.59</td>
<td>$81.52</td>
<td>$101.44</td>
</tr>
<tr>
<td>Tower Crane &amp; Derrick 50' or more w/ Oiler where work station is 50' or more above first level</td>
<td>EN-324-SWTD50-O</td>
<td>9/5/2014</td>
<td>$62.59</td>
<td>$83.02</td>
<td>$103.44</td>
</tr>
</tbody>
</table>

#### Operating Engineer Underground

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name Description</th>
<th>Last Updated</th>
<th>Straight Time and a Half</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hourly</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating Engineer Underground Class I Equipment</td>
<td>EN-324A1-UC1</td>
<td>9/13/2013</td>
<td>$50.34</td>
<td>$65.33</td>
<td>$80.32</td>
</tr>
</tbody>
</table>

**Apprentice Rates:**

|                |                  |                  |                      |              |                    |
| 0-999 hours    | $40.75           | $51.25           | $61.74               |             |                    |
| 1,000-1,999 hours | $42.24           | $53.48           | $64.72               |             |                    |
| 2,000-2,999 hours | $43.75           | $55.75           | $67.74               |             |                    |
| 3,000-3,999 hours | $45.24           | $57.98           | $70.72               |             |                    |
| 4,000-4,999 hours | $46.74           | $60.23           | $73.72               |             |                    |
| 5,000-5,999 hours | $48.25           | $62.50           | $76.74               |             |                    |

|                |                  |                  |                      |              |                    |
| Class II Equipment | EN-324A1-UC2 | 9/13/2013 | $45.61 | $58.24 | $70.86 | H H H H H D Y |
| Class III Equipment | EN-324A1-UC3 | 9/13/2013 | $44.88 | $57.14 | $69.40 | H H H H H D Y |
| Class IV Equipment | EN-324A1-UC4 | 9/13/2013 | $44.31 | $56.29 | $68.26 | H H H H H D Y |
| Master Mechanic | EN-324A1-UMM | 9/13/2013 | $50.59 | $65.71 | $80.82 | H H H H H D Y |

Official Request #: 1417
Requestor: Wayne State University
Project Description: EDC Mechanical & Electrical Systems Upgrade
Project Number: WSU 090-247931-4
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 2014 Prevailing Wage Rates for State Funded Projects**

**Issue Date:** 10/6/2014  
**Contract must be awarded by:** 1/4/2015  
**Page 22 of 29**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name Description</th>
<th>Last Updated</th>
<th>Straight Time and a Half</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Painter</td>
<td>Painter (8 hours of repaint work performed on Sunday shall be paid time &amp; one half rate)</td>
<td>6/18/2012</td>
<td>$41.32</td>
<td>$53.78</td>
<td>$66.23 H H D H D D Y</td>
</tr>
<tr>
<td></td>
<td>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.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Apprentice Rates:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>First 6 months</td>
<td>6/18/2012</td>
<td>$28.87</td>
<td>$35.10</td>
<td>$41.33</td>
</tr>
<tr>
<td></td>
<td>Second 6 months</td>
<td></td>
<td>$32.60</td>
<td>$40.69</td>
<td>$48.79</td>
</tr>
<tr>
<td></td>
<td>Third 6 months</td>
<td></td>
<td>$33.85</td>
<td>$42.57</td>
<td>$51.29</td>
</tr>
<tr>
<td></td>
<td>Fourth 6 months</td>
<td></td>
<td>$35.09</td>
<td>$44.33</td>
<td>$53.77</td>
</tr>
<tr>
<td></td>
<td>Fifth 6 months</td>
<td></td>
<td>$36.34</td>
<td>$46.31</td>
<td>$56.27</td>
</tr>
<tr>
<td></td>
<td>Final 6 months</td>
<td></td>
<td>$37.58</td>
<td>$48.17</td>
<td>$58.75</td>
</tr>
<tr>
<td>Pipe and Manhole Rehab</td>
<td>General Laborer for rehab work or normal cleaning and CCTV work-top man, scaffold man, CCTV assistant, jetter-vac assistant</td>
<td>TM247</td>
<td>$27.20</td>
<td>$36.70</td>
<td>H H H H H H H H</td>
</tr>
<tr>
<td></td>
<td>Tap cutter/CCTV Tech/Grout Equipment Operator: unit driver and operator of CCTV; grouting equipment and tap cutting equipment</td>
<td>TM247-2</td>
<td>$31.70</td>
<td>$43.45</td>
<td>H H H H H H H H</td>
</tr>
<tr>
<td></td>
<td>CCTV Technician/Combo Unit Operator: unit driver and operator of CCTV unit or combo unit in connection with normal cleaning and televising work</td>
<td>TM247-3</td>
<td>$30.45</td>
<td>$41.57</td>
<td>H H H H H H H H</td>
</tr>
<tr>
<td></td>
<td>Boiler Operator: unit driver and operator of steam/water heater units and all ancillary equipment associated</td>
<td>TM247-4</td>
<td>$32.20</td>
<td>$44.20</td>
<td>H H H H H H H H</td>
</tr>
<tr>
<td></td>
<td>Combo Unit driver &amp; Jetter-Vac Operator</td>
<td>TM247-5</td>
<td>$32.20</td>
<td>$44.20</td>
<td>H H H H H H H H</td>
</tr>
<tr>
<td></td>
<td>Pipe Bursting &amp; Slip-lining Equipment Operator</td>
<td>TM247-6</td>
<td>$33.20</td>
<td>$45.70</td>
<td>H H H H H H H H</td>
</tr>
</tbody>
</table>

**Official Request #:** 1417

Requestor: Wayne State University  
Project Description: EDC Mechanical & Electrical Systems Upgrade  
Project Number: WSU 090-247931-4  
County: Statewide

**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 2014 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 10/6/2014  
**Contract must be awarded by:** 1/4/2015

### Page 23 of 29

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name</th>
<th>Description</th>
<th>Updated Date</th>
<th>Straight Time</th>
<th>Half Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipefitter</td>
<td>Pipefitter</td>
<td>PF-636</td>
<td>6/30/2014</td>
<td>$66.73</td>
<td>$87.93</td>
<td>$105.13</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>H H D D D</td>
<td>D D D D Y</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Apprentice Rates:</td>
<td></td>
<td>6/30/2014</td>
<td>$26.93</td>
<td>$35.28</td>
<td>$42.28</td>
</tr>
<tr>
<td></td>
<td>1st &amp; 2nd periods</td>
<td></td>
<td></td>
<td>$28.93</td>
<td>$38.28</td>
<td>$46.28</td>
</tr>
<tr>
<td></td>
<td>3rd period</td>
<td></td>
<td></td>
<td>$30.18</td>
<td>$40.16</td>
<td>$48.78</td>
</tr>
<tr>
<td></td>
<td>4th period</td>
<td></td>
<td></td>
<td>$31.43</td>
<td>$42.03</td>
<td>$51.28</td>
</tr>
<tr>
<td></td>
<td>5th period</td>
<td></td>
<td></td>
<td>$32.68</td>
<td>$43.90</td>
<td>$53.78</td>
</tr>
<tr>
<td></td>
<td>6th period</td>
<td></td>
<td></td>
<td>$33.93</td>
<td>$45.78</td>
<td>$56.28</td>
</tr>
<tr>
<td></td>
<td>7th period</td>
<td></td>
<td></td>
<td>$34.93</td>
<td>$47.28</td>
<td>$58.28</td>
</tr>
<tr>
<td></td>
<td>8th period</td>
<td></td>
<td></td>
<td>$35.93</td>
<td>$48.78</td>
<td>$60.28</td>
</tr>
<tr>
<td></td>
<td>9th period</td>
<td></td>
<td></td>
<td>$37.36</td>
<td>$50.92</td>
<td>$63.14</td>
</tr>
<tr>
<td>Plasterer</td>
<td>Plasterer</td>
<td>BR1P</td>
<td>11/1/2012</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</td>
<td>D N</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Apprentice Rates:</td>
<td></td>
<td>11/1/2012</td>
<td>$32.11</td>
<td>$48.17</td>
<td>$64.22</td>
</tr>
<tr>
<td></td>
<td>1st 6 months</td>
<td></td>
<td></td>
<td>$33.40</td>
<td>$50.10</td>
<td>$66.80</td>
</tr>
<tr>
<td></td>
<td>2nd 6 months</td>
<td></td>
<td></td>
<td>$34.69</td>
<td>$52.04</td>
<td>$69.38</td>
</tr>
<tr>
<td></td>
<td>3rd 6 months</td>
<td></td>
<td></td>
<td>$37.28</td>
<td>$55.92</td>
<td>$74.56</td>
</tr>
<tr>
<td></td>
<td>4th 6 months</td>
<td></td>
<td></td>
<td>$39.87</td>
<td>$59.81</td>
<td>$79.74</td>
</tr>
<tr>
<td></td>
<td>5th 6 months</td>
<td></td>
<td></td>
<td>$42.45</td>
<td>$63.68</td>
<td>$84.90</td>
</tr>
<tr>
<td></td>
<td>6th 6 months</td>
<td></td>
<td></td>
<td>$44.72</td>
<td>$60.11</td>
<td>$75.50</td>
</tr>
<tr>
<td></td>
<td>Apprentice Rates:</td>
<td></td>
<td>9/8/2010</td>
<td>$29.33</td>
<td>$37.02</td>
<td>$44.72</td>
</tr>
<tr>
<td></td>
<td>1st 6 months</td>
<td></td>
<td></td>
<td>$30.87</td>
<td>$39.34</td>
<td>$47.80</td>
</tr>
<tr>
<td></td>
<td>2nd 6 months</td>
<td></td>
<td></td>
<td>$32.41</td>
<td>$41.64</td>
<td>$50.88</td>
</tr>
<tr>
<td></td>
<td>3rd 6 months</td>
<td></td>
<td></td>
<td>$35.49</td>
<td>$46.26</td>
<td>$57.04</td>
</tr>
<tr>
<td></td>
<td>4th 6 months</td>
<td></td>
<td></td>
<td>$38.56</td>
<td>$51.16</td>
<td>$63.76</td>
</tr>
<tr>
<td></td>
<td>5th 6 months</td>
<td></td>
<td></td>
<td>$41.64</td>
<td>$55.49</td>
<td>$69.34</td>
</tr>
</tbody>
</table>

---

**Official Request #:** 1417  
**Requestor:** Wayne State University  
**Project Description:** EDC Mechanical & Electrical Systems Upgrade  
**Project Number:** WSU 090-247931-4  
**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 23 of 29**
## Official 2014 Prevailing Wage Rates for State Funded Projects

### Issue Date: 10/6/2014

**Contract must be awarded by:** 1/4/2015

**Page 24 of 29**

<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>Plumber</td>
<td>Plumber</td>
<td>7/18/2013</td>
<td>$64.45 $84.87 $101.29 H H H H D D D Y</td>
</tr>
<tr>
<td></td>
<td>Apprentice Rates:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Period 1</td>
<td>$19.93</td>
<td>$26.43 $32.93</td>
</tr>
<tr>
<td></td>
<td>Period 2</td>
<td>$23.90</td>
<td>$31.40 $38.90</td>
</tr>
<tr>
<td></td>
<td>Period 3</td>
<td>$30.60</td>
<td>$39.19 $47.77</td>
</tr>
<tr>
<td></td>
<td>Period 4</td>
<td>$31.23</td>
<td>$40.13 $49.03</td>
</tr>
<tr>
<td></td>
<td>Period 5</td>
<td>$32.39</td>
<td>$41.87 $51.35</td>
</tr>
<tr>
<td></td>
<td>Period 6</td>
<td>$33.54</td>
<td>$43.59 $53.65</td>
</tr>
<tr>
<td></td>
<td>Period 7</td>
<td>$34.69</td>
<td>$45.32 $55.95</td>
</tr>
<tr>
<td></td>
<td>Period 8</td>
<td>$35.86</td>
<td>$47.07 $58.29</td>
</tr>
<tr>
<td></td>
<td>Period 9</td>
<td>$37.01</td>
<td>$48.80 $60.59</td>
</tr>
<tr>
<td></td>
<td>Period 10</td>
<td>$38.16</td>
<td>$50.53 $62.89</td>
</tr>
<tr>
<td>Roofer</td>
<td>Commercial Roofer</td>
<td>8/18/2008</td>
<td>$48.46 $62.29 $76.62 H H H H D D D N</td>
</tr>
<tr>
<td></td>
<td>Apprentice Rates:</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Apprentice 1</td>
<td>$32.62</td>
<td>$39.86 $48.04</td>
</tr>
<tr>
<td></td>
<td>Apprentice 2</td>
<td>$36.80</td>
<td>$44.80 $53.30</td>
</tr>
<tr>
<td></td>
<td>Apprentice 3</td>
<td>$38.22</td>
<td>$46.93 $56.14</td>
</tr>
<tr>
<td></td>
<td>Apprentice 4</td>
<td>$39.25</td>
<td>$48.48 $58.20</td>
</tr>
<tr>
<td></td>
<td>Apprentice 5</td>
<td>$40.47</td>
<td>$50.30 $60.64</td>
</tr>
<tr>
<td></td>
<td>Apprentice 6</td>
<td>$41.87</td>
<td>$52.40 $63.44</td>
</tr>
<tr>
<td>Sewer Relining</td>
<td>Class I-Operator of audio visual CCTV system including remote in-ground cutter and other equipment used in conjunction with CCTV system.</td>
<td>5/6/2014</td>
<td>$42.26 $57.09 $71.91 H H H H H D D N</td>
</tr>
<tr>
<td></td>
<td>Class II-Operator of hot water heaters and circulation system; water jetters; and vacuum and mechanical debris removal systems and those assisting.</td>
<td>5/6/2014</td>
<td>$40.73 $54.79 $68.85 H H H H H D D N</td>
</tr>
</tbody>
</table>

---

**Official Request #:** 1417

**Requestor:** Wayne State University

**Project Description:** EDC Mechanical & Electrical Systems Upgrade

**Project Number:** WSU 090-247931-4

**County:** Statewide

**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 24 of 29
# Official 2014 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 10/6/2014  
**Contract must be awarded by:** 1/4/2015

## Page 25 of 29

### Classification: Sheet Metal Worker

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Last Updated</th>
<th>Straight Time and a Half Time Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheet Metal Worker</td>
<td>SHM-80</td>
<td></td>
<td>$61.83 $78.74 $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
  - 1st Period: $39.18 $46.79 $54.40
- 3rd & 4th Periods Indentured after 6-1-11
  - 2nd Period: $40.88 $49.34 $57.80
- 5th & 6th Periods Indentured after 6-1-11
  - 3rd Period: $42.56 $51.86 $61.16
- 7th & 8th Periods Indentured after 6-1-11
  - 4th Period: $44.25 $54.40 $64.54
- 9th & 10th Periods Indentured before 6-1-11
  - 5th Period: $51.92 $64.44 $76.96

#### Siding and decking

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Last Updated</th>
<th>Straight Time and a Half Time Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Siding and decking</td>
<td>SHM-80-SD</td>
<td></td>
<td>$42.07 $54.28 $66.48 H H H H H D Y</td>
</tr>
</tbody>
</table>

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

### Classification: Sprinkler Fitter

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Last Updated</th>
<th>Straight Time and a Half Time Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprinkler Fitter</td>
<td>SP 704</td>
<td></td>
<td>$64.32 $85.38 $106.43 H H D H D D D Y</td>
</tr>
</tbody>
</table>

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

#### Apprentice Rates:

- 1st Period: $28.05 $36.47 $44.89
- 2nd Period: $41.16 $50.63 $60.11
- 3rd Period: $43.27 $53.80 $64.33
- 4th Period: $45.37 $56.95 $68.53
- 5th Period: $47.48 $60.11 $72.75
- 6th Period: $49.58 $63.27 $76.95
- 7th Period: $51.69 $66.43 $81.17
- 8th Period: $53.79 $69.58 $85.37
- 9th Period: $55.90 $72.75 $89.59
- 10th Period: $58.00 $75.89 $93.79

---

**Official Request #: 1417**  
**Requestor:** Wayne State University  
**Project Description:** EDC Mechanical & Electrical Systems Upgrade  
**Project Number:** WSU 090-247931-4  
**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 2014 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 10/6/2014  
**Contract must be awarded by:** 1/4/2015

#### Page 26 of 29

<table>
<thead>
<tr>
<th>Classification</th>
<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>Terrazzo</td>
<td>Terrazzo Finisher</td>
<td>BR1-TRF</td>
<td></td>
<td>$43.43 $54.38 $65.33 H H D D D D Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Terrazzo Worker</td>
<td>BR1-TRW</td>
<td></td>
<td>$49.11 $62.90 $76.69 H H D D D D Y</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tile</td>
<td>Tile Finisher</td>
<td>BR1-TF</td>
<td></td>
<td>$42.96 $53.68 $64.39 H H D D D D Y</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Apprentice Rates:**

- **Terrazzo Finisher**  
  Level 1: $18.80 $24.77 $30.73  
  Level 2: $19.99 $26.55 $33.11  
  Level 3: $26.67 $33.52 $40.36  
  Level 4: $28.12 $35.69 $43.26  
  Level 5: $29.62 $37.37 $45.13  
  Level 6: $31.22 $39.37 $47.51  
  Level 7: $32.89 $41.08 $49.26  
  Level 8: $34.36 $42.95 $51.54

- **Terrazzo Worker**  
  Level 1: $24.83 $32.24 $39.65  
  Level 2: $27.85 $36.04 $44.23  
  Level 3: $33.00 $41.45 $49.90  
  Level 4: $35.70 $45.09 $54.49  
  Level 5: $37.94 $47.57 $57.21  
  Level 6: $41.55 $52.91 $64.27  
  Level 7: $42.21 $53.72 $65.22  
  Level 8: $43.13 $55.10 $67.06

- **Tile Finisher**  
  Level 1: $18.80 $24.77 $30.73  
  Level 2: $19.99 $26.55 $33.11  
  Level 3: $26.67 $33.52 $40.36  
  Level 4: $28.12 $35.69 $43.26  
  Level 5: $29.62 $37.37 $45.13  
  Level 6: $31.22 $39.37 $47.51  
  Level 7: $32.89 $41.08 $49.26  
  Level 8: $34.36 $42.95 $51.54

**Official Request #:** 1417  
**Requestor:** Wayne State University  
**Project Description:** EDC Mechanical & Electrical Systems Upgrade  
**Project Number:** WSU 090-247931-4  
**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 26 of 29
## Official 2014 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 10/6/2014  
**Contract must be awarded by:** 1/4/2015

### Page 27 of 29

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name</th>
<th>Description</th>
<th>Last Updated</th>
<th>Straight Time and a Half</th>
<th>Double Time</th>
<th>Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tile Layer</td>
<td>BR1-TL</td>
<td>$49.06</td>
<td>$62.83</td>
<td>$76.59</td>
<td>H H H D D D D Y</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>A 4 ten workweek may be worked Monday thru Thursday or Tuesday thru Friday.</td>
<td>9/5/2013</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Apprentice Rates:

- **Level 1**: $24.83 | $32.24 | $39.65
- **Level 2**: $27.85 | $36.04 | $44.23
- **Level 3**: $33.00 | $41.45 | $49.90
- **Level 4**: $35.70 | $45.09 | $54.49
- **Level 5**: $37.94 | $47.57 | $57.21
- **Level 6**: $41.55 | $52.91 | $64.27
- **Level 7**: $42.21 | $53.72 | $65.22
- **Level 8**: $43.13 | $55.10 | $67.06

<table>
<thead>
<tr>
<th>Truck Driver</th>
<th>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)</th>
<th>TM-RB1</th>
<th>$41.92</th>
<th>$37.85</th>
<th>H H H H H H Y</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8/8/2013</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>of all trucks of 8 cubic yard capacity or over</td>
<td>TM-RB1A</td>
<td>$41.30</td>
<td>$38.00</td>
<td>H H H H H H Y</td>
</tr>
<tr>
<td></td>
<td>8/8/2013</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>on euclid type equipment</td>
<td>TM-RB1B</td>
<td>$41.45</td>
<td>$38.23</td>
<td>H H H H H H Y</td>
</tr>
<tr>
<td></td>
<td>8/8/2013</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underground Laborer Open Cut, Class I</td>
<td>Construction Laborer</td>
<td>LAUC-Z1-1</td>
<td>$37.72</td>
<td>$48.43</td>
<td>$59.14</td>
</tr>
<tr>
<td></td>
<td>9/5/2013</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Apprentice Rates:

- **0-1,000 work hours**: $32.94 | $41.26 | $49.58
- **1,001-2,000 work hours**: $33.90 | $42.70 | $51.50
- **2,001-3,000 work hours**: $34.85 | $44.13 | $53.40
- **3,001-4,000 work hours**: $36.76 | $46.99 | $57.22

---

**Official Request #: 1417**  
**Requestor:** Wayne State University  
**Project Description:** EDC Mechanical & Electrical Systems Upgrade  
**Project Number:** WSU 090-247931-4  
**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.
### Underground Laborer Open Cut, Class II
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.

Apprentice Rates:
- 0-1,000 work hours: $37.83
- 1,001-2,000 work hours: $37.98
- 2,001-3,000 work hours: $38.95
- 3,001-4,000 work hours: $39.87

### Underground Laborer Open Cut, Class III
Air, gasoline and electric tool operator, vibrator operator, drillers, pump man, tar kettle operator, bracers, rodder, reinforced steel or mesh man (e.g. wire mesh, steel mats, dowel bars, etc.), cement finisher, welder, pipe jacking and boring man, wagon drill and air track operator and concrete saw operator (under 40 h.p.), windlass and tugger man, and directional boring man.

Apprentice Rates:
- 0-1,000 work hours: $37.88
- 1,001-2,000 work hours: $37.99
- 2,001-3,000 work hours: $38.92
- 3,001-4,000 work hours: $39.99

### Underground Laborer Open Cut, Class IV
Trench or excavating grade man.

Apprentice Rates:
- 0-1,000 work hours: $37.96
- 1,001-2,000 work hours: $38.09
- 2,001-3,000 work hours: $38.06
- 3,001-4,000 work hours: $38.99

### Underground Laborer Open Cut, Class V
Pipe Layer

Apprentice Rates:
- 0-1,000 work hours: $38.02
- 1,001-2,000 work hours: $38.14
- 2,001-3,000 work hours: $38.11
- 3,001-4,000 work hours: $38.07

---

Official Request #: 1417
Requestor: Wayne State University
Project Description: EDC Mechanical & Electrical Systems Upgrade
Project Number: WSU 090-247931-4
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 2014 Prevailing Wage Rates for State Funded Projects

**Issue Date:** 10/6/2014  
**Contract must be awarded by:** 1/4/2015

### Classification

<table>
<thead>
<tr>
<th>Classification</th>
<th>Name Description</th>
<th>Updated</th>
<th>Last Straight Time and Overtime Provision</th>
</tr>
</thead>
<tbody>
<tr>
<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>
<td>9/5/2013</td>
<td>$35.47 $45.06 $54.64 X X X X X X D Y</td>
</tr>
</tbody>
</table>

**Apprentice Rates:**

- 0-1,000 work hours: $31.25 $38.73 $46.20
- 1,001-2,000 work hours: $32.10 $40.00 $47.90
- 2,001-3,000 work hours: $32.94 $41.26 $49.58
- 3,001-4,000 work hours: $34.63 $43.79 $52.96

| Underground Laborer Open Cut, Class VII       | 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. | 9/5/2013 | $32.09 $39.99 $47.88 X X X X X X D Y |

**Apprentice Rates:**

- 0-1,000 work hours: $28.72 $34.93 $41.14
- 1,001-2,000 work hours: $29.39 $35.93 $42.48
- 2,001-3,000 work hours: $30.07 $36.95 $43.84
- 3,001-4,000 work hours: $31.42 $38.98 $46.54

---

**Official Request #:** 1417  
**Requestor:** Wayne State University  
**Project Description:** EDC Mechanical & Electrical Systems Upgrade  
**Project Number:** WSU 090-247931-4  
**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.
WAYNE STATE UNIVERSITY
PAYMENT PACKAGE 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, sub-contractors, 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.)
- 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.
PAYMENT PACKAGE DOCUMENT 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
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

EDC Mechanical and Electrical Systems Upgrade
5050 Anthony Wayne Drive
WSU Project No. 090-247931-4
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 **Upgrade the electrical and mechanical systems in engineering development center** 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 **February 28, 2014**.

**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>
</tr>
</thead>
<tbody>
<tr>
<td>Alternate #1</td>
<td></td>
</tr>
<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>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
</tr>
</tbody>
</table>

**Article 4 - The Contract Documents**

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

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

**Article 5 – Examination of Premises**

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

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

**Article 6 - The Architect/Engineer**

6.1 The Architect/Engineer for this project is:

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

Peter Basso Associates
5145 Farmington Road, Suite 100
Troy, MI 48098

(Architect Phone No / Fax No)

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 superseded by this Article.

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

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

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

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

Article 9 - Termination for Convenience

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

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

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

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

Article 10 - Progress Payments

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

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

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

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

Article 11 - Acceptance and Final Payments

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

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

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

**Article 12 - Non-Discrimination**

12.1 The Contractor agrees that it will not discriminate against any employee or applicant for employment, to be employed in the performance of this Agreement, with respect to hire, tenure, terms, conditions or privileges of employment or any matter directly or indirectly related to employment, because of race, color, religion, sex, age, national origin, or ancestry. Breach of this covenant may be regarded as material breach of this Agreement.

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

**Article 13 – Laborers and Mechanics**

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

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

**Article 14 - Prevailing Wages**

14.1 The Contractor and each subcontractor shall pay to each class of mechanics and laborers not less than the wage and fringe benefit rates prevailing in the Detroit Metropolitan Area, as determined by the 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
Agreement or subagreement by separate agreement with another Contractor or otherwise, in which case the Contractor and its sureties shall be liable to the University for any excess costs incurred by the University.

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

**Article 15 - Save Harmless**

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

**Article 16 - Liquidated Damages**

16.1 It is understood and agreed that, if the project is not completed within the time specified in the Agreement plus any extension of time allowed pursuant thereto, the actual damages sustained by the University because of any such delay will be uncertain and difficult to ascertain, and it is agreed that the reasonable foreseeable value of the use of said project by the University would be the sum of **$150.00, One Hundred Fifty Dollars** per day. Therefore, the Contractor shall pay as liquidated damages to the University the sum of **$150.00, One Hundred Fifty 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 **October 8, 2014**, and the following List of Drawings represents the scope of work as defined in the Contract Documents from Article 4.

<table>
<thead>
<tr>
<th>Drawing No.</th>
<th>Description</th>
<th>dated</th>
</tr>
</thead>
</table>
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
FORM OF GUARANTEE

PROJECT:  EDC Mechanical and Electrical Systems Upgrade

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:

EDC Mechanical and Electrical Systems Upgrade (090-247931-4)

For:  Board of Governors, Wayne State University

In conformity with drawings and specifications prepared by Architect or Engineer, Peter Basso Associates, 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
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 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
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 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 The Contractor hereby agrees to indemnify, protect and save harmless the Architect and the Owner from and against any and all liability, loss or damage, and to reimburse the Owner and the Architect for any expenses, including legal fees and disbursements to which the Owner or the Architect may be put because of claims of litigation on account of infringement or alleged infringement of any letters patent or patent rights by reason of the work or materials, equipment, or other items used by the Contractor in its performance.

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 3-22-2012)

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. Comprehensive General Liability</td>
<td>Bodily Injury: $500,000 each person, $1,000,000 aggregate</td>
</tr>
<tr>
<td></td>
<td>Property Damage: $500,000 each occurrence, $1,000,000 aggregate, $2,000,000 combined single limit (CSL)</td>
</tr>
<tr>
<td>2. Fire Legal Liability</td>
<td>$100,000</td>
</tr>
<tr>
<td>3. Comprehensive Automobile Liability</td>
<td>Bodily Injury: $500,000 each person, $1,000,000 each accident</td>
</tr>
<tr>
<td>(including Hired and non-owned vehicles)</td>
<td>Property Damage: $500,000 each accident, $2,000,000 combined single limit (CSL)</td>
</tr>
<tr>
<td>4. Workers' Compensation (Employer's Liability)</td>
<td>Statutory - Michigan $100,000</td>
</tr>
<tr>
<td>5. Property - All Risk</td>
<td>In an amount sufficient to cover the total value of the contractor's property in the care, custody or control of WSU.</td>
</tr>
</tbody>
</table>

B. Maximum Acceptable Deductibles

<table>
<thead>
<tr>
<th>Type of Insurance</th>
<th>Maximum Deductible</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensive General Liability</td>
<td>$5,000</td>
</tr>
<tr>
<td>Fire Legal Liability</td>
<td>$5,000</td>
</tr>
<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 1.2.4 shall be as limited in the Contract Documents. Unit price of Subparagraph 12.1.3.2 shall represent total unit cost to the Owner and shall include the Contractor's markup for overhead and profit.

ARTICLE 14 - TERMINATION OF THE CONTRACT

14.1 TERMINATION BY THE CONTRACTOR

14.1.1 If the work is stopped for a period of thirty days under any order of any court or other public authority having jurisdiction, or as a result of any act of government, such as a declaration of a national emergency making materials unavailable, through no act or fault of the 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 October 8, 2014 and the following List of Drawings represent the scope of work as defined in the Contract Documents from Article 4.

<table>
<thead>
<tr>
<th>Drawing No.:</th>
<th>Description</th>
</tr>
</thead>
</table>
GENERAL REQUIREMENTS

GENERAL

A. CONTRACTOR'S RESPONSIBILITY

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

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

B. CODES AND STANDARDS

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

C. PERMITS, FEES AND NOTICES

See Supplementary General Conditions.

D. MEASUREMENTS

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

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

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

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

E. CONTRACTOR'S MEASUREMENTS

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

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

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

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

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

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

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

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

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

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

1. Compliance with WSU Standards for Communications Infrastructure
   A. All applicable work, products, materials and methods shall comply with the latest version of the "WSU Standards for Communications Infrastructure" except as where noted.

   B. This document is available at the following website/URL: http://networks.wayne.edu/WSU-Communications-Standards.pdf

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

   B. Copyright for the Program Code shall be assigned to the UNIVERSITY for purposes of system maintenance.

PROTECTION OF OCCUPANCY (Revised 3-2006)

A. FIRE PRECAUTIONS

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

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

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

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

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

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

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

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

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

B. GENERAL SAFETY AND BUILDING PRECAUTIONS

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

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

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

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

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

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

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

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

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

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

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

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

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

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

CONTRACTOR'S REPRESENTATION AND COORDINATION

A. FIELD SUPERINTENDENT

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

B. MEETINGS

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

C. COORDINATION

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

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

D. CONSTRUCTION SCHEDULE

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

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

TEMPORARY FACILITIES
A. GENERAL

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

B. CONTRACTOR'S OFFICE

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

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

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

C. STORAGE OF MATERIALS

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

D. PARKING

1. GENERAL

University parking regulations will be strictly enforced.

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

2. STANDING AND UNLOADING/LOADING VEHICLES

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

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

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

3. COMPLIMENTARY PARKING

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

4. WAYNE STATE UNIVERSITY PUBLIC/STUDENT PARKING AREAS

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

E. TOILET FACILITIES

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

F. TELEPHONE USE

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

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

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

H. HEAT AND VENTILATION

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

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

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

I. WATER SERVICE

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

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

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

J. ELECTRICAL SERVICES

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

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

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

INSPECTIONS AND TESTS

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

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

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

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

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

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

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

**PROJECT CLOSE-OUT**

A. **RECORD DRAWINGS**

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

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

B. **OPERATING AND MAINTENANCE DATA**

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

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


C. **FINAL INSPECTION**

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

D. **GUARANTEES (See Sections 00510 and 01781)**

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

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

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

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

KEYS

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

PROJECT: EDC Mechanical and Electrical Systems Upgrade
WSU PROJECT NO.: 090-247931-4
PROJECT MANAGER: Omar Alhyari

1. EXAMINATION

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

2. Description of Work – Project includes The Scope of work includes upgrade and repair of the mechanical & electrical systems in EDC to enhance the performance per the WSU study identifying this specific issues. Fire exhaust system, lab exhaust, safety system and cooling system issues.

3. The building is located at

   Wayne State University
   5050 Anthony Wayne Drive
   Detroit, Michigan 48202
Marvin I. Danto Engineering Development
Center Upgrades

WSU Project No. 090-247931

ISSUED FOR BIDS

September 30, 2014

PBA Project No. 2014.0242.00
### SPECIFICATIONS GROUP

#### DIVISION 20 - COMMON MECHANICAL REQUIREMENTS
- 200500 MECHANICAL GENERAL REQUIREMENTS
- 200510 BASIC MECHANICAL MATERIALS AND METHODS
- 200513 MOTORS
- 200519 METERS AND GAGES
- 200523 VALVES
- 200529 HANGERS AND SUPPORTS
- 200553 MECHANICAL IDENTIFICATION
- 200700 MECHANICAL INSULATION
- 202923 VARIABLE FREQUENCY CONTROLLERS

#### DIVISION 22 - PLUMBING
- 220533 HEAT TRACING FOR PIPING

#### DIVISION 23 - HEATING VENTILATING AND AIR CONDITIONING
- 230500 COMMON WORK RESULTS FOR HVAC
- 230593 TESTING, ADJUSTING, AND BALANCING
- 230933 TEMPERATURE CONTROLS
- 232113 HYDRONIC PIPING
- 233113 METAL DUCTS
- 233300 DUCT ACCESSORIES
- 233500 SPECIAL EXHAUST SYSTEMS
- 233600 AIR TERMINAL UNITS
- 235700 HYDRONIC AND STEAM HEAT EXCHANGERS

#### 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
- 260999 ELECTRICAL TESTING
- 262416 PANELBOARDS
- 262813 FUSES
SECTION 20 0500 - 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 01 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 01 Specification Sections.

1.3 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

1. RELATED DOCUMENTS
5. AMCA - Air Movement and Control Association International, Inc.
7. ASHRAE – American Society of Heating, Refrigeration and Air Conditioning Engineers.
10. CGA – Compressed Gas Association.
12. HI – Hydraulic Institute.
15. NEBB – National Environmental Balancing Bureau.
17. NECA - National Electrical Contractors Association.
18. NEMA – National Electrical Manufacturer’s Association.
21. UL – Underwriter’s Laboratories, Inc.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

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 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.

C. Source Limitations: Obtain equipment and other components of the same or similar systems through one source from a single 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: Perform work to avoid interference with the work of other trades. Remove and relocate 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) (Intertek, 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. Rules of local utility companies shall be complied with. Check with each utility company supplying service to the installation and determine all devices including, but not limited to, all valves, meter boxes, and meters which will be required and include the cost of all such items in proposal.

C. 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. Provide fittings, valves, and accessories as required to meet actual 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.

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.

B. 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 reasonably foreseeable from a site visit or inquiry into local conditions affecting the execution of 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 01 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 01.
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 01 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. Review is only for general conformance with the design concept of the project and general compliance with the information given in the Contract Documents. Any action indicated is subject to the requirement of the plans and specifications.

1. 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.

2. Contractor is responsible for:
   a. Dimensions, which shall be confirmed and correlated at the job site.
   b. Fabrication processes and techniques of construction.
   c. Quantities.
   d. Coordination of Contractor’s work with all other trades.
   e. Satisfactory performance of Contractor’s work.

G. Submit detailed shop drawings of piping systems showing pipe routing and types and locations of all pipe hangers.

H. 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 OPERATION AND MAINTENANCE INSTRUCTIONAL MANUALS

A. Submit project specific Operation and Maintenance Instructional Manuals for review in compliance with Division 01 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. One copy of all manuals shall be furnished for Owner. Maintenance and operating instructional manuals shall be provided when construction is approximately 75 percent complete.

C. Format: Submit operations and maintenance manuals in the following format:

   a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
b. Enable inserted reviewer comments on draft submittals.

D. Operation and maintenance instructional manuals shall be submitted a minimum of four (4) weeks prior to functional testing.

E. 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.

1.13 RECORD DRAWINGS

A. Submit record drawings in compliance with Division 01.

B. Contractor shall submit to the Architect/Engineer, record drawings on electronic media or vellum 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.

1.14 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.

1.15 WARRANTY

A. Warranty: Comply with the requirements in Division 01 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

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 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.

F. Where existing equipment is to be removed, cap piping under floor, behind face of wall, above ceiling or at mains. Cap or plug piping with same or compatible piping material.

G. Cap ductwork and cap piping immediately adjacent to demolition as soon as demolition commences in order to allow existing systems to remain in operation.

1. Cap or plug piping with same or compatible piping material.
2. Cap or plug ducts with same or compatible ductwork material.

3.2 REFRIGERANT HANDLING

A. Refrigerant Installation and Disposal: Perform all work related to refrigerant contained in chillers, cooling coils, air conditioners, and similar equipment, including related piping, in strict accordance with the following requirements:
MECHANICAL GENERAL REQUIREMENTS

2. ASHRAE Standard 34 and Related Revisions: Number Designation and Safety Classification of Refrigerants.
3. United States Environmental Protection Agency (US EPA) requirements of Section 808 (Prohibition of Venting and Regulation of CFC) and applicable State and Local regulations of authorities having jurisdiction.

B. Recovered refrigerant is the property of the Contractor. Dispose of refrigerant legally, in accordance with applicable rules and regulations.

3.3 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.

3.4 TEMPORARY SERVICES

A. Provide temporary service as described in Division 01.

B. The existing building will be occupied during construction. Maintain mechanical services and provide necessary temporary connections and their removal at no additional cost to the Owner.

3.5 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.

3.6 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:

3. Temperature Controls.

F. For systems requiring seasonal operation, demonstrate system performance within six months when weather conditions are suitable.

3.7 PROJECT COMMISSIONING

A. Refer to Division 01 "Project Commissioning" and the Commissioning Manual.

B. Purpose: Training, documentation and verification of the operation and functional performance of mechanical systems for compliance with the "design intent."

END OF SECTION 20 0500
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 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, 21, 22, and 23 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.
5. RTRF: Reinforced thermosetting resin (fiberglass) fittings.
6. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates.

C. Brazing Certificates: As required by ASME Boiler and Pressure Vessel Code, Section IX, or AWS B2.2.

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. 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.
4. 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. 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 interference at Contractor’s expense.

C. 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 21, 22, and 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 21, 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. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

G. Solder Filler Metals: ASTM B32, lead-free, antimony-free, silver-bearing alloys. Include water-flushable flux according to ASTM B813.

H. Brazing Filler Metals: Alloys meeting AWS A5.8.
   1. Use Type BcuP Series, silver-bearing, copper-phosphorus alloys for joining copper or bronze socket fittings with copper pipe. Flux is prohibited unless used with bronze fittings.
   2. Use Type Bag Series, cadmium-free silver alloys for joining copper with steel, stainless steel, or other ferrous alloys.


J. 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.

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. Zum 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: Stainless steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.

2. Design Mix: 5000-psi, 28-day compressive strength.

2.8 PIPE ROOF PENETRATION ENCLOSURES

A. Manufacturers:
   1. Pate Company (The).
   2. Portals Plus, Inc.
   3. Thybar Corporation; Thycurb.

B. Minimum 18 gage welded galvanized steel construction.

C. Integral base plate.

D. Built-in fully mitered cant.

E. Factory installed insect and decay resistant wood nailer.

F. Factory installed 1-1/2 inch thick, 3 pounds per cubic foot density rigid insulation.

G. EPDM compression molded rubber cap for single or multiple pipes as required.

H. Stainless steel draw-band clamps.
3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 21, 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 valves with stems upright or horizontal, not inverted.

R. Provide clearance for installation of insulation and access to valves and fittings.
S. 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.

T. 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.

U. Install piping free of sags and bends.

V. Install fittings for changes in direction and branch connections.

W. 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.

X. Install piping to allow application of insulation.

Y. Select system components with pressure rating equal to or greater than system operating pressure.

Z. After completion, fill, clean, and treat systems. Refer to Division 23 Sections “Hydronic Piping,” “Piping Systems Flushing and Chemical Cleaning,” and “HVAC Water Treatment.”

AA. Pipe Roof Penetration Enclosures:
   1. Coordinate delivery of roof penetration enclosures to jobsite.
   2. Locate and set curbs on roof, provide flashing.
   3. Attach cap to curbs, cut pipe boots to fit pipe, and clamp boots to pipe or conduit.

BB. Verify final equipment locations for roughing-in.

CC. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21, 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."

N. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter.

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 connections 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. Remake joints which fail pressure tests with new materials including pipe, fittings, gaskets and/or a filler.
3.3 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.

3.4 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.

3.5 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. Equipment Rigging Over Roof Areas: Protect building structure against damage during equipment rigging. Make provisions to distribute load of equipment to main roof structure, and to prevent damage to roof decking, roofing, or purlins.

G. 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.

3.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
1. Construct concrete bases as shown on Drawings, but not less than 4 inches larger in both directions than supported unit.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section.

3.7 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.

3.8 JACKING OF PIPE

A. Do not jack pipe in place except upon prior approval of proposed materials and complete details of methods.

3.9 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.
3.10 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.

3.11 FLASHING

A. Provide all flashing required for mechanical work.

3.12 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.

3.13 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. After equipment and HVAC water piping systems have been completed and tested, each entire system shall be cleaned and flushed. Refer to Division 23 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. 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 23 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.

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 0510
SECTION 20 0513 - MOTORS

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 "Mechanical General Requirements."
2. Division 20 Section "Mechanical Vibration Controls" for mounting motors and vibration isolation devices.
3. Division 20 Section “Variable Frequency Controllers”.
4. Division 21, 22, and 23 Sections for application of motors and reference to specific motor requirements for motor-driven equipment.
5. Division 26 Section "Enclosed Switches and Circuit Breakers".
6. Division 26 Section "Enclosed Controllers".
7. Division 26 Section "Fuses".

1.2 SUMMARY

A. This Section includes basic requirements for factory-installed and field-installed motors.

1.3 DEFINITIONS

A. ABMA: American Bearing Manufacturers Association. (Formerly AFBMA: Anti-Friction Bearing Manufacturers Association.)

B. Factory-Installed Motor: A motor installed by motorized-equipment manufacturer as a component of equipment.

C. Field-Installed Motor: A motor installed at Project site and not factory installed as an integral component of motorized equipment.
D. Packaged Self Contained Equipment: Equipment which includes component mechanical and electrical equipment mounted on common bases, skids or frames or in common enclosures with internal control and power wiring factory installed and ready to accept a single electrical service connection. Provide the equipment complete with enclosed controllers, main disconnect switches, control transformers, control devices, wiring and accessories as required.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: A Nationally Recognized Testing Laboratory (NRTL), acceptable to authorities having jurisdiction, with the experience and capability to conduct the testing indicated.

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.

C. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices. Provide motors that are:

1. Compatible with the following:
   a. Magnetic controllers.

2. Matched to torque and horsepower requirements of the load.

3. Matched to ratings and characteristics of supply circuit and required control sequence.

B. Coordinate electrical scope of work to be provided by Division 20, 21, 22, and 23 with this Section, related Division 20, 21, 22, and 23 Specifications, Division 26 Specifications and the Drawings.

C. Electrical work provided under Division 20, 21, 22, and 23: Furnish UL Listed components in accordance with this section, Division 26, and applicable NEMA and NEC (ANSI C 1) requirements. Provide wiring, external to electrical enclosures, in conduit.

D. Furnished and installed under Division 20, 21, 22, and 23 and wired under Division 26 unless otherwise indicated:

1. Motors required for mechanical equipment

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Dayton.
2. Toshiba Intl.
5. Emerson Motor Technologies; U.S. Electrical Motors.
7. Regal Beloit/Leeson.
8. Regal Beloit/Marathon.
2.2 MOTOR REQUIREMENTS

A. Motor requirements apply to factory-installed and field-installed motors except as follows:

1. Different ratings, performance, or characteristics for a motor are specified in another Section.
2. Manufacturer for a factory-installed motor requires ratings, performance, or characteristics, other than those specified in this Section, to meet performance specified.
3. Submersible motors integral to pumps and excluded from NEMA and EISA standards.


D. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide screwed conduit connection in end frame.

2.3 MOTOR CHARACTERISTICS

A. Motors 1/2 HP and Larger: Three phase, unless otherwise indicated.

B. Motors Smaller Than 1/2 HP: Single phase, unless otherwise indicated.

C. Frequency Rating: 60 Hz.

D. Voltage Rating: NEMA standard voltage selected to operate on nominal circuit voltage to which motor is connected.

E. Service Factor: 1.15 for open dripproof motors; 1.0 for totally enclosed motors.

F. Duty: Continuous duty at ambient temperature of 105 deg F and at altitude of 3300 feet above sea level.

G. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

H. Brake Horsepower Input: Shall not exceed 90 percent of the rated motor horsepower.

I. Enclosure: Open dripproof (ODP) for motors installed indoors and out of the airstream. Totally-enclosed fan-cooled (TEFC) for motors installed outdoors or within the airstream.

2.4 POLYPHASE MOTORS

A. Efficiency: Motors 1 horsepower to 200 horsepower shall be premium efficient motors meeting requirements of NEMA Premium Efficiency Motor Program. Efficiency of the motor shall be determined based on the NEMA MG1. The nominal efficiencies shall meet or exceed Table 12-12.
Nominal Efficiencies For "NEMA Premium™" Induction Motors
Rated 600 Volts or Less (Random Wound)

<table>
<thead>
<tr>
<th>HP</th>
<th>6-pole</th>
<th>4-pole</th>
<th>2-pole</th>
<th>6-pole</th>
<th>4-pole</th>
<th>2-pole</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>82.5</td>
<td>85.5</td>
<td>77.0</td>
<td>82.5</td>
<td>85.5</td>
<td>77.0</td>
</tr>
<tr>
<td>1.5</td>
<td>86.5</td>
<td>86.5</td>
<td>84.0</td>
<td>87.5</td>
<td>86.5</td>
<td>84.0</td>
</tr>
<tr>
<td>2</td>
<td>87.5</td>
<td>86.5</td>
<td>85.5</td>
<td>88.5</td>
<td>86.5</td>
<td>85.5</td>
</tr>
<tr>
<td>3</td>
<td>88.5</td>
<td>89.5</td>
<td>85.5</td>
<td>89.5</td>
<td>89.5</td>
<td>86.5</td>
</tr>
<tr>
<td>5</td>
<td>89.5</td>
<td>89.5</td>
<td>86.5</td>
<td>89.5</td>
<td>89.5</td>
<td>88.5</td>
</tr>
<tr>
<td>7.5</td>
<td>90.2</td>
<td>91.0</td>
<td>88.5</td>
<td>91.0</td>
<td>91.7</td>
<td>89.5</td>
</tr>
<tr>
<td>10</td>
<td>91.7</td>
<td>91.7</td>
<td>89.5</td>
<td>91.0</td>
<td>91.7</td>
<td>90.2</td>
</tr>
<tr>
<td>15</td>
<td>91.7</td>
<td>93.0</td>
<td>90.2</td>
<td>91.7</td>
<td>92.4</td>
<td>91.0</td>
</tr>
<tr>
<td>20</td>
<td>92.4</td>
<td>93.0</td>
<td>91.0</td>
<td>91.7</td>
<td>93.0</td>
<td>91.0</td>
</tr>
<tr>
<td>25</td>
<td>93.0</td>
<td>93.6</td>
<td>91.7</td>
<td>93.0</td>
<td>93.6</td>
<td>91.7</td>
</tr>
<tr>
<td>30</td>
<td>93.6</td>
<td>94.1</td>
<td>91.7</td>
<td>93.0</td>
<td>93.6</td>
<td>91.7</td>
</tr>
<tr>
<td>40</td>
<td>94.1</td>
<td>94.1</td>
<td>92.4</td>
<td>94.1</td>
<td>94.1</td>
<td>92.4</td>
</tr>
<tr>
<td>50</td>
<td>94.1</td>
<td>94.5</td>
<td>93.0</td>
<td>94.1</td>
<td>94.5</td>
<td>93.0</td>
</tr>
<tr>
<td>60</td>
<td>94.5</td>
<td>95.0</td>
<td>93.6</td>
<td>94.5</td>
<td>95.0</td>
<td>93.6</td>
</tr>
<tr>
<td>75</td>
<td>94.5</td>
<td>95.0</td>
<td>93.6</td>
<td>94.5</td>
<td>95.4</td>
<td>93.6</td>
</tr>
<tr>
<td>100</td>
<td>95.0</td>
<td>95.4</td>
<td>93.6</td>
<td>95.0</td>
<td>95.4</td>
<td>94.1</td>
</tr>
<tr>
<td>125</td>
<td>95.0</td>
<td>95.4</td>
<td>94.1</td>
<td>95.0</td>
<td>95.4</td>
<td>95.0</td>
</tr>
<tr>
<td>150</td>
<td>95.4</td>
<td>95.8</td>
<td>94.1</td>
<td>95.8</td>
<td>95.8</td>
<td>95.0</td>
</tr>
<tr>
<td>200</td>
<td>95.4</td>
<td>95.8</td>
<td>95.0</td>
<td>95.8</td>
<td>96.2</td>
<td>95.4</td>
</tr>
</tbody>
</table>

B. Stator: Copper windings, unless otherwise indicated.
   1. Multispeed motors shall have separate winding for each speed.

C. Rotor: Squirrel cage, unless otherwise indicated.

D. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 120,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

E. Temperature Rise: Match insulation rating, unless otherwise indicated.

F. Insulation: Class F, unless otherwise indicated.

G. Code Letter Designation:
   1. Motors 10 HP and Larger: NEMA starting Code (KVA Code) F or G.
   2. Motors Smaller Than 10 HP: Manufacturer's standard starting characteristic.

H. Enclosure: Cast iron for motors 7.5 hp and larger; rolled steel for motors smaller than 7.5 hp.
   1. Finish: Gray enamel.

I. Sound Level: Not to exceed NEMA MG-1 12.54.

2.5 SINGLE-PHASE MOTORS

A. Type: One of the following, to suit starting torque and requirements of specific motor application:
1. Permanent-split capacitor.
2. Split-phase start, capacitor run.
3. Capacitor start, capacitor run.

B. Shaded-Pole Motors: For motors 1/20 hp and smaller only.

C. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

D. Bearings: Ball type for belt-connected motors and other motors with high radial forces on motor shaft; sealed, prelubricated-sleeve type for other single-phase motors.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. All three phase motors 1/2 HP and above shall be tested by the Testing Agency.

B. Prepare for acceptance tests as follows:
   1. Check motor nameplates for H.P., speed, phase and voltage.
   2. Check coupling alignment and shaft end play.
   3. Run each motor with its controller. Demonstrate correct rotation, alignment, and speed at motor design load.
   4. Test interlocks and control features for proper operation.
   5. Verify that current in each phase is within nameplate rating.

C. Testing: Perform the following field quality-control testing:
   1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.15.1. Certify compliance with test parameters.
   2. Jog motor as required to verify proper phase and shaft rotation. Immediately after start-up, check bearing temperature and smooth operation. Take current reading at full load using a clamp-on ammeter. If ammeter reading is over the rated full load current, determine reason for discrepancy and take necessary corrective actions. Record all readings, motor nameplate data and overload heater data.
   3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.2 ADJUSTING

A. Align motors, bases, shafts, pulleys and belts. Tension belts according to manufacturer's written instructions.

3.3 CLEANING

A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean motors, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 20 0513
SECTION 20 0519 - METERS AND GAGES

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
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.
B. Shop Drawings: Schedule for thermometers and gages indicating manufacturer’s number, scale range, and location for each.
C. Product Certificates: For each type of thermometer and gage, signed by product manufacturer.
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 PLASTIC-CASE, LIQUID-IN-GLASS THERMOMETERS

A. Manufacturers:

1. AMETEK, Inc.; U.S. Gauge Div.
2. Marsh Bellofram.
3. Miljoco Corp.
4. REOTEMP Instrument Corporation.
5. Trerice, H. O. Co.
6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Case: Plastic, 9 inches long.

C. Tube: Red, blue, or green reading, organic-liquid filled, with magnifying lens.

D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Window: Glass or plastic.

F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

G. Stem: Metal, for thermowell installation and of length to suit installation.

H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.3 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.

2.4 PRESSURE GAGES

A. Manufacturers:

1. AMETEK, Inc.; U.S. Gauge Div.
2. Cambridge.
3. Dwyer Instruments, Inc.
5. Miljoco Corporation.
6. Trerice, H. O. Co.
7. Weiss Instruments, Inc.
8. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.

1. Case: Stainless steel, aluminum, or FRP, 4-1/2-inch diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
6. Pointer: Red or other dark-color metal.
7. Window: Glass or plastic.
8. Ring: Stainless steel or chrome plated metal.
9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
11. Water: 0-100 PSIG (1 psi divisions to 50 psi; 5 psi divisions above 50 psi), liquid filled.
12. Steam (15 psig and less): 30 inches Hg vacuum-30 PSIG (1 inch divisions below 0 psi; 1 psi divisions above 0 psi), silicone dampened.
13. Steam (16 to 60 psig): 30 inches Hg vacuum-100 PSIG, silicone dampened.
14. Range for Fluids under Pressure: 1-1/2 times expected working pressure. If not a standard scale, select next largest scale.

C. Pressure-Gage Fittings:

1. Valves: NPS 1/4 brass ball type.
2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of

2.5 FLOW MEASURING DEVICES

A. Manufacturers:

1. Dietrich Standard Subsidiary of Rosemount Division of Emerson Process Management; Diamond II - Flo-Tap Model.
2. Preso Meters Corporation.
3. Taco, Inc.

B. Flow measuring device shall be used where indicated on the drawings and in sizes NPS 6 and larger and shall be annular primary flow elements. The annular primary flow elements shall be type 316, stainless steel, diamond shape or elliptical shape in cross-section. Pressure rating shall meet or exceed system minimum pressure rating as indicated for each system. Provide permanent, rust-proof metal identification tag on a chain indicating design flow rates, metered fluid and line size. Flow measuring devices shall be weld insert type. Units shall be capable of being inserted without system shut-down.

C. Accuracy shall be plus or minus 1 percent over a flow turndown at least 10 to 1, independent of Reynold's number. Repeatability shall be plus or minus 0.1 percent.

D. Sensors shall be installed in strict accordance with the manufacturer's recommendations with special attention given to alignment and straight run requirements.

E. Flow gages which read in actual GPM shall be provided for all flow measuring devices on pumps 200 GPM or larger. Gage scale shall be linear to flow. Maximum flow rate on scale shall be selected at 120 percent of the pump's scheduled flow rate. Gage scale shall be 2.5 inch x 6 inch minimum, or 4 inch diameter minimum, and shall be mounted at eye level on unistrut support.
PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS
   A. Install liquid-in-glass thermometers where indicated on diagrams.
   B. Provide the following temperature ranges for thermometers:
      1. Chilled Water/Condenser Water: 30 to 130 deg F or 0 to 120 Deg F.

3.2 GAGE APPLICATIONS
   A. Install liquid-filled-case-type pressure gages where indicated on diagrams.
   B. Except where noted otherwise, select range for twice normal operating pressure.

3.3 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 direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.
   C. Install ball valve and snubber fitting in piping for each pressure gage for fluids (except steam).

3.4 CONNECTIONS
   A. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.

3.5 ADJUSTING
   A. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 20 0519
SECTION 20 0523 - 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 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 B31.1 for power piping valves and ASME B31.9 for building services piping valves.

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: Ball or butterfly 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. Valve Grooved Ends: AWWA C606.

K. 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.

L. Threaded: With threads according to ASME B1.20.1.

M. 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, Full-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; 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 77C-140.
   b. Crane Valve Group; Crane Valves.
   c. Milwaukee Valve Company.
   d. NIBCO INC.; Models S-585-70-66 or T-585-70-66.
   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.
   f. SPX Valves and Controls; DeZurik Unit.
   g. Tyco Flow Control; Grinnell Flow Control.
   h. Tyco Flow Control; Keystone.
   i. Watts Water Technologies.

C. Grooved-End Butterfly Valves with EPDM-Encapsulated Ductile-Iron Disc: Bronze body with grooved or shouldered ends, or ductile-iron body with grooved or shouldered ends and polyamide coating inside and outside; Type 416 stainless-steel stem, PTFE bronze sintered on steel bushing, and 300-psig CWP Rating for Valves NPS 2 through NPS 8, 200 psig CWP Rating for Valves NPS 10 through NPS 12.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anvil International, Inc.
   b. NIBCO INC.; Model GD-4765-3/5.
   c. Tyco Fire & Building Products; Grinnell Mechanical Products.
   d. Victaulic Co. of America.

2.4 DRAIN VALVES

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Bronze ball valve as specified in this Section.
2. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

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, 21, 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 chainwheel operators on valves NPS 4 and larger and more than 84 inches above floor. Extend chains to 60 inches above finished floor elevation.

G. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
   3. Lift Check Valves: With stem upright and plumb.

3.3 JOINT CONSTRUCTION

A. Refer to Division 20 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 0523
SECTION 20 0529 - 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 20 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. ERCO 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 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.

2.5 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.

2.6 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.

2.7 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 cold piping larger than NPS 12 with Type 1 attachment with thermal-hanger shield.
      g. 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.
      h. Support insulated hot piping larger than NPS 12 size with double rod roller hangers, Type 41, 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. 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.
   2. Inserts, Concrete: TYPE 18 or 19. When applied to loads equivalent to piping in sizes NPS 2 and larger, and where otherwise required by imposed loads, a one foot length of 1/2 inch NPS 4 reinforcing rod shall be inserted and wired through wing slots. Proprietary type continuous inserts may be proposed and shall be submitted for approval.

M. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

N. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

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. Where necessary, brace piping and supports against reaction, sway and vibration.

I. Do not hang piping from joist pans, floor decks, roof decks, equipment, ductwork, or other piping.

J. Install turnbuckles, swing eyes and clevises to accommodate temperature changes, pipe accessibility, and adjustment for load pitch. Rod couplings are not acceptable.

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. Required hanger spacing.

O. 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.

P. Attach pipe anchors and pipe alignment guides to the building structure where indicated. If not indicated, the method used is optional to the Contractor, subject to approval by the Architect. In the case of structural steel, make attachment by clamping in accordance with the American Institute of Steel Construction Specification for the Design, Fabrication and Erection of Structural Steel for Building.

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. Limit the location of supporting elements for piping and equipment, when supported from roof, to panel points of the bar joists.

T. Building structure shall not be reinforced except as approved by the Architect in writing.

U. 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 A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

V. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

W. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.


Y. 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.

Z. Install lateral bracing with pipe hangers and supports to prevent swaying.

AA. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

BB. 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.

CC. 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.

DD. 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 and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 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. 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.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.
SECTION 20 0553 - 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.

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 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 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. Pumps, compressors, chillers, condensers, and similar motor-driven units.
2. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.

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. Fire department hose valves and hose stations.
c. Meters, gages, thermometers, and similar units.
d. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
e. Pumps, compressors, chillers, condensers, and similar motor-driven units.
f. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
g. Fans, blowers, primary balancing dampers, and mixing boxes.
h. Packaged HVAC central-station and zone-type units.
i. Tanks and pressure vessels.
j. Strainers, filters, humidifiers, water-treatment systems, and similar equipment.

C. Install equipment signs with screws or permanent adhesive on or near each major item of mechanical equipment. Locate signs where accessible and visible.

1. Identify mechanical equipment with equipment markers in the following color codes:
MECHANICAL IDENTIFICATION

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.

3.4 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.5 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.
3.6 CLEANING

A. Clean faces of mechanical identification devices and glass frames of valve schedules.

3.7 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>Pipe System Label</th>
<th>Drawing Abbrev.</th>
<th>Labels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chilled Water Supply</td>
<td>CHWS</td>
<td>White on Green</td>
</tr>
<tr>
<td>Chilled Water Return</td>
<td>CHWR</td>
<td>White on Green</td>
</tr>
<tr>
<td>Condenser Water Supply</td>
<td>CWS</td>
<td>White on Green</td>
</tr>
<tr>
<td>Condenser Water Return</td>
<td>CWR</td>
<td>White on Green</td>
</tr>
</tbody>
</table>

END OF SECTION 20 0553
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 20 Section "Hanger and Supports" for thermal hanger shield inserts.

1.2 SUMMARY

A. This Section includes mechanical insulation for pipe, duct, and equipment.

B. After completion of asbestos abatement, reinsulate all existing systems including piping, fittings, ductwork, equipment, etc. which are remaining in service. Refer to Division 02 Section "Asbestos Remediation."
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 EQUIPMENT INSULATION SYSTEMS DESCRIPTION

A. Acceptable equipment insulation materials and thicknesses are scheduled on the Drawings.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated, identify thermal conductivity, thickness, and jackets (both factory and field applied, if any).

1. ESR Report: For fire-rated grease duct insulation.

1.7 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.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.8 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.
1.9 COORDINATION

A. Coordinate size and location of supports, hangers, and pre-insulated pipe shields/supports specified in Division 20 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.

1.10 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. Adhesives used shall be fire resistant in their dry states and UL listed.

2.2 PIPE INSULATION MATERIALS

A. 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.

B. Mineral-Wool, Preformed Pipe Insulation, Type II:

1. Products: Subject to compliance with requirements, provide one of the products specified.
   a. Fibrex Insulations Inc.; Coreplus 1200.
   b. Rock Wool Manufacturing Company; Delta PC and PF.
   c. Roxul Inc.; 1200 Pipe Insulation.
2. Type II, 1200 deg F Materials: Mineral wool fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ or ASJ-SSL. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

C. Large Diameter Pipe and Tank Insulation: Glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. 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.; CrimpWrap.
   b. Johns Manville; MicroFlex.
   c. Knauf Insulation; Pipe and Tank Insulation.
   d. Manson Insulation Inc.; AK Flex.
   e. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.3 EQUIPMENT INSULATION MATERIALS

A. 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.
   a. Armacell LLC; AP Armaflex.
   b. Nomaco K-Flex; Insul-Sheet and Insul-Tube.

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.

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.
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.


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.

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.
2. **WATER-VAPOUR 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.

5. **COLOR:** White.

### 2.7 SEALANTS

**A. 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.

5. **Color:** White.

### 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.

### 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. Surface Preparation:** Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. **Stainless Steel:** Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating
manufacturer for appropriate coating materials and application methods for operating temperature range.

2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

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 Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Fire-Rated Wall and Partition Penetrations:
   1. 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 chilled water pumps. Installation shall conform to the following:

1. Make removable pump insulation from sectional pipe insulation/sheet insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

E. Install removable and reusable insulation covers in accordance with fabricator's instructions, and at the following locations:

1. At chilled water pumps.

3.6 GLASS-FIBER AND MINERAL WOOL 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.

3.7 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Secure insulation with adhesive and anchor pins and speed washers.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
   2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
   3. Protect exposed corners with secured corner angles.
   4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
      a. Do not weld anchor pins to ASME-labeled pressure vessels.
      b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
      c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
      d. Do not over compress insulation during installation.
      e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
      f. Impale insulation over anchor pins and attach speed washers.
      g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.

6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.

7. Stagger joints between insulation layers at least 3 inches.

8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.

9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.

10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

3.8 FINISHES

A. Equipment and Pipe Insulation with ASJ.

END OF SECTION 20 0700
SECTION 20 2923 - VARIABLE FREQUENCY CONTROLLERS

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 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 REFERENCES

A. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
B. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
C. ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.
D. ANSI/NEMA MG 1 - Motors and Generators.
1.3 DEFINITIONS

A. BAS: Building automation system.

B. EMI: Electromagnetic interference.

C. LED: Light-emitting diode.

D. RFI: Radio-frequency interference.

E. THD: Total harmonic disturbance.

F. VFC: Variable frequency controller. Variable frequency controllers may also be referred to as variable speed drives, variable frequency drives, VSDs, or VFDs in other Specification Sections or on the Drawings.

1.4 SUBMITTALS

A. Submit under provisions of Division 20 Section “Mechanical General Requirements” and as supplemented in this section.

B. Submit for review, drawings indicating power, control and instrument wiring including ladder diagrams for field work as well as factory assembled work. Manufacturer’s drawings are acceptable only when modified and supplemented to reflect project conditions. The drawings shall include:

1. Overall schematic (elementary) diagram in JIC form of the entire system of power and control circuitry. Indicate interfaces with control wiring by temperature controls contractor.
2. Wiring diagrams showing the wiring layout of component assemblies or systems.
3. Interconnection wiring diagrams showing terminations of interconnecting conductors between component assemblies, systems, control devices, and control panels complete with conductor identification, number of conductors, conductor and conduit size.
4. Sequence of operation for components, assemblies or systems.
5. Dimensional data.

C. Shop drawings for motor-driven equipment shall be accompanied by complete information concerning the respective motors including the following.

1. Principal dimensions.
2. Weights.
3. Horsepower.
4. Voltage, phase, frequency.
5. Speed.
6. Class of insulation.
7. Enclosure type.
8. Frame.
9. Bearings including AFBMA Rating Life (L-10 basis).
11. Manufacturer.
12. Service Factor

D. Descriptive data shall include catalogues, guaranteed performance data with efficiency and power factor indicated at 75 percent and 100 percent of rated load and verification of conformance with other requirements of the Contract Documents. The information enumerated under NEMA MG1 Paragraph MG1-10.38, shall be arranged on one sheet for each motor.
1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.7 COORDINATION

A. Coordinate with temperature controls contractor for interfaces with temperature controls wiring.

1.8 WARRANTY

A. Warranty shall be 36 months from date of project acceptance. The warranty shall include all parts, labor, travel time and expenses.

PART 2 - PRODUCTS

2.1 GENERAL

A. For Electrical Work Provided under Division 20, 21, 22, and 23 Specifications: Furnish UL Listed components, in accordance with Division 26 Specifications and applicable NEMA and NEC (ANSI C 1) requirements. Provide wiring, external to electrical enclosures, in conduit.

B. Electrical Power Supply Characteristics: 480 volts, 3 phase, 60 hertz (Hz).

C. Provide Electrical Work required for the operation of components and assemblies provided as part of the Work under Division 20, 21, 22, and 23 Specifications.

D. Mount line voltage (120 VAC) control components specified as part of the Work under Division 20, 21, 22, and 23 Specifications.

E. Refer to ELECTRICAL DRAWINGS and Division 26 Specifications for specified information regarding provisions for the arrangement of electrical circuits and components and for interface with Work specified under Division 20, 21, 22, and 23 Specifications.

F. The controller(s) shall be suitable for use with any standard NEMA-B squirrel-cage induction motor(s) having a 1.15 Service Factor. At any time in the future, it shall be possible to substitute any standard motor (equivalent horsepower, voltage and RPM) in the field.

G. Electrical testing of motors is specified as part of the Work under Division 26 Specifications.
H. The mechanical contractor shall furnish and install the variable frequency controller. Electrical trades shall make power connections to both load and line side of the VFC.

2.2 MOTORS

A. Refer to Division 20 Section "Motors."

2.3 VARIABLE FREQUENCY CONTROLLERS

A. Variable Frequency Controller Manufacturers:

1. Eaton Corp.
2. Siemens.
3. Square D.
4. ABB.

B. Provide variable frequency controllers as scheduled including bypass starter, coasting motor restart, and step over frequency.

1. The ratio of the total impedance to common system impedance shall be greater than or equal to 10.
2. The voltage notch area shall be limited to 16-400 volt microseconds.
3. The total harmonic disturbance (THD) as a result of voltage notching shall be 3 percent or less at the point of common coupling.
4. The THD as a result of current notching shall be 100 percent or less at the point of common coupling.

C. Provide 3 percent AC input line reactors sized appropriate for each current rating variable frequency controller.

D. The variable frequency controller (VFC) shall comply with all applicable provisions of the National Electrical Code.

E. The line side of the VFC shall have a displacement power factor of 0.95 or greater when motor is operating at 50 to 100 percent motor speed.

F. The VFC shall have an efficiency greater than 85 percent when motor is operating at 50 to 100 percent motor speed.

G. Each variable frequency controller shall consist of an adjustable frequency converter which shall convert 460 volt (+10 percent -5 percent), 3-phase, 60 hertz (+2 hertz) input power into an adjustable frequency output in an ambient temperature of zero to 40 deg C. Output power shall be of suitable capacity and waveform to provide stepless speed control of the specified horsepower motor throughout the required speed range under variable torque load not exceeding the motor's full-load rating.

H. Provide fault detection and trip circuits to protect itself and the connected motor against line voltage transients, power line under voltage, output overvoltage and overcurrent. A disconnect with padlockable door interlocked external handle shall be supplied to conveniently disconnect the incoming 460 VAC. Minimum short circuit design shall be 42,000 amperes symmetrical. Criteria in Paragraph B shall be met without the use of isolation transformers. Variable frequency controller will be accepted only if criteria can be met without isolation transformers.

I. The minimum output frequency shall be the lowest frequency at which the connected motor can be operated without overheating.

J. The inverter shall contain current limiting circuitry, adjustable to 100 percent of motor full-load current to provide soft start, acceleration, and running without exceeding motor rated current. The current limit circuit
shall be of the type for variable torque load, which acts to diminish output frequency while limiting, without directly causing shutdown.

K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts. For safety, drive shall shut down and require manual reset and restart if automatic reset/restart function is not successful within three attempts.

L. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.

M. Isolate signal circuits from the power circuits and design to accept a speed signal from a remote process controller in the automatic mode and from the speed control potentiometer in the manual mode. A door-mounted switch shall provide mode selection. The selected signal shall control the motor speed between the adjustable minimum and maximum speed settings. Maximum speed shall be field adjustable to 100 percent of rated speed. The speed signal shall follow a linear time ramp, adjustable from 4-20 seconds to provide acceleration from zero to minimum speed. When minimum speed is reached, the speed signal shall follow the linear time ramp for acceleration and deceleration control.

N. Mount the adjustable frequency inverter and other electrical components that provide the operation specified in a NEMA 1 enclosure. Equipment shall have external heat sinks or air filters on all vents. The enclosure shall have hinged, front access doors with latch. Cabinet to cabinet interconnecting wiring shall be factory dressed, tagged and harnessed, and shipped with one end attached.

O. The controller shall have the ability to step-over certain set frequencies that may cause a system to resonate. The controller shall have at least two manually set points of frequency in which the controller shall step-over during operation.

P. Operating and monitoring devices for the inverter shall be door mounted and shall include the following:

1. Manual Speed Control to set speed in the hand (manual) mode.
2. Speed indicating meter, either in revolutions per minute, proportional to the applied frequency and voltage to indicate speed of the converter-powered motor or frequency (hertz).
3. VFC "fault/reset" pilot light pushbutton combination with dry contact for external alarm. Fault alarm shall not actuate upon normal shutdown.
4. Inverter "control power" indicator.
5. Motor "running" indicator and two (2) dry contacts that close when motor is running.
6. Output current meter calibrated in "AC amps."
7. Operating selector switches and indicating light to perform the following functions:
   a. One hand-off-auto switch for the VFC and bypass starter with indicating lights (red-running, green-energized). In hand position, unit (VFC or bypass starter) shall start. In auto position, unit (VFC or bypass starter) shall start when remote dry contact is closed.
   b. Unit shall be capable of being padlocked in the off position.
   c. Variable frequency bypass selector switch with indicating lights. In bypass position, contactors and interlocks shall be positioned to run unit directly from 460 VAC line voltage when the H-O-A selector switch is in hand or auto position.
8. Output voltmeter (0 - 600 V.A.C) (analog or digital).

Q. The VFC is to be provided with isolated 4-20 mA DC output signals proportional to speed, current and voltage for connection by others.

R. The VFC shall be provided with the ability to communicate (monitoring) through RS485 connector.

S. Remote speed control shall be +4 to 20 mA control signal from a remote controller.

T. Automatic bypass starter shall be as follows:
1. Single-Speed Nonreversing Starter: Consisting of a full voltage magnetic starter with two (2) convertible auxiliary contacts, thermal overloads, control transformer and control devices as indicated and as specified, all mounted and wired in a separate sectioned part of VFC enclosure.

2. Interlocking: Equip switch with an external operating handle. Interlock the operating handle such that the door cannot be opened unless the switch is in the "off" position. Provide means for padlocking the operating handle in the "off" position with three 5/16 inch shackle padlocks such that when the operating handle is padlocked in the "off" position, the cover door cannot be opened and the switch cannot be closed.

3. Starter: Size starters per the horsepower of the motors with which they will be used, except do not furnish starters smaller than NEMA Size 1 for motors of 5 horsepower or less. Provide coils for operation on 120 volts AC unless other requirements are indicated. Equip each starter with a minimum of two convertible auxiliary contacts in addition to the normally-open seal-in contact, unless additional requirements are indicated. Provide additional contacts as indicated.

4. Thermal Overload: One in each phase wire, manual reset type. Select overloads after final installed horsepower of motor is determined. Do not use ratings exceeding 100 percent of motor full load current adjusted for ambient temperatures.

5. Control Transformer: Provide a 480-120 volt control transformer in the starter enclosure. Fuse and ground the secondary winding as indicated. Where indicating lights or other control components are to be energized from the control transformer, increase the capacity of the control transformer to 200 VA.

6. Bypass/VFC starter shall consist of 3 contactors or have a drive disconnect as well as a main disconnect for isolation purposes.

U. Variable frequency controller shall not cause motor to produce noise levels exceeding 80 dBA measured at a distance of 3 feet from the motor. If noise level of motor exceeds this amount, the contractor shall be responsible for correcting the problem.

V. Provide connection points for system safety controls such as smoke detectors, freeze stats, damper end switches, etc. as shown on mechanical temperature control drawings. Opening of a contact on safety controls wired to the drive shall shut down the motor(s) in both the VFC and bypass mode.

W. VFCs specified on the drawings to have contactor motor selection, in order to operate "either one or both" motors connected to the VFC, shall have the separate motors controlled by horse power rated contactors. These contactors shall be capable of being controlled locally (by a switch in the panel door) or remotely. The contactors shall also have two (2) convertible auxiliary contacts in order to sense contactor position.

X. VFCs specified on the drawings to operate "either" motor with contactor motor selection shall have separate horse power rated contactors to control each motor.

Y. The contactors shall be interlocked in order that only one motor may run at a time. These contactors shall be capable of being controlled locally (by a switch in the panel door) or remotely. The contactors shall also have two (2) convertible auxiliary contacts in order to sense contactor position.

Z. Provide in each VFC, a relay that upon loss of the automatic speed control signal, shall automatically switch the unit to bypass mode.

AA. Coordinate with the Temperature Controls Contractor for the interface of control wiring to the drive as required to meet the requirements of the temperature control drawings. Drive shall be furnished with internal control wiring configured in the factory so as to allow single connections of field wiring to terminal blocks in the drive by the Temperature Controls Contractor.

BB. All indicating lights shall be push to test or LED.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: The controller shall be subject to, but not limited to, the following quality assurance controls, procedures and tests:
1. Power transistors, SCRs and diodes shall be tested to ensure correct function and highest reliability.
2. All printed circuit boards shall be tested at 50 deg C for 50 hours. The VFC manufacturer shall provide certification that the tests have been completed.
3. Every controller will be functionally tested with a motor to ensure that if the drive is started up according to the instruction manual provided, the unit will run properly.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.
B. Examine VFC before installation. Reject VFCs that are wet, moisture damaged, or mold damaged.
C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Install and adjust materials and equipment in accordance with the manufacturer's instructions.
B. Obtain the manufacturer's instructions for materials and equipment provided under the Contract in detail necessary to comply with the requirements of the Contract Documents.
C. If unit is free standing, provide a concrete housekeeping pad.

3.3 FIELD QUALITY CONTROL
A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
B. Upon completion of each installation, conduct complete acceptance tests in the presence of duly notified authorities having jurisdiction and the Owner to demonstrate component, assembly or system performance in accordance with the requirements of the Contract Documents.
C. In the event that a test demonstrates that a component assembly or system performance is deficient, the Owner may require additional tests after corrective work.
D. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.
E. Component assembly and systems acceptance is predicated upon completion of specified work and receipt by the Owner of data specified under "Submittals."
3.4 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Adjust the trip settings of instantaneous-only circuit breakers and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to 6 times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed 8 times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Owner before increasing settings.

D. Set the taps on reduced-voltage autotransformer controllers.

E. Set field-adjustable circuit-breaker trip ranges.

F. Set field-adjustable pressure switches.

3.5 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer’s written instructions until controllers are ready to be energized and placed into service.

B. Replace VFCs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.6 DEMONSTRATION

A. The VFC supplier/support group shall provide the following additional services:

1. On-site training of customer personnel in operation and maintenance of variable frequency controllers.
2. Provide four copies of a troubleshooting manual and factory training manuals to help the building operator determine what steps must be taken to correct any problem that may exist in the system.
3. Coordinate enrollment of customer personnel in factory-held service schools.

END OF SECTION 20 2923
SECTION 220533 - HEAT TRACING FOR PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, Standard General and Supplementary General Conditions, Division 1 Specification Sections, and other applicable Specification Sections including the Related Sections listed below, 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 “Mechanical Insulation.”
   4. Division 22 Section "Hydronic Piping."

1.2 SCOPE OF WORK
A. Furnish and install a complete UL listed system of heaters, components, and controls to prevent pipelines from freezing. Refer to drawings for additional scope clarification.

1.3 COORDINATION
A. The heat tracing and all the necessary accessories shall be furnished by the Mechanical Contractor. Electrical Contractor shall install and provide power supply and related wiring by per Division 26, and as shown on electrical drawings.

1.4 MANUFACTURERS
A. Raychem
B. Thermon
C. Delta-Therm
PART 2 - PRODUCTS

2.1 MATERIAL

A. Electric heat tracing shall be self-limiting type suitable for temperature maintenance up to 40 degrees F.

B. The heater shall have a self-regulating factor of at least 90 percent. (the percentage reduction, without thermostatic control, of the heater output going from 40 degrees F pipe temperature operation to 150 degrees F pipe temperature operation).

C. The heater shall operate on line voltages of 120 volts without the use of transformers.

D. The heater shall be sized according to this table. The required heater output rating is in watts per foot at 50 degrees F. (Heater selection is based on 1" fiberglass insulation on metal piping).

<table>
<thead>
<tr>
<th>Pipe Size</th>
<th>Min. Ambient - 10 deg.F</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot; or less</td>
<td>5 watt</td>
</tr>
<tr>
<td>4&quot;</td>
<td>5 watt</td>
</tr>
<tr>
<td>6&quot;</td>
<td>8 watt</td>
</tr>
<tr>
<td>8</td>
<td>2 strips – 5 watt</td>
</tr>
<tr>
<td>12&quot;-14&quot;</td>
<td>2 strips - 8 watt</td>
</tr>
</tbody>
</table>

E. Connectors and fittings, and indicator lights, and other required installation accessories shall be manufacturers standard recommended for the freeze protection application. The heater shall include a tinned copper braided shield, electrically bonded at splice locations, and bonded to the branch circuit ground conductor at the power connection point.

F. All the components and system shall be U. L. listed.

2.2 CONTROL PANEL

A. Provide NEMA 1 enclosure with main contactor controller by hand/off/auto selector switch with owners DDC control in the auto position. Provide 120V 30A GFPE circuits with current sensing relays for monitoring by owners DDC system. Provide power on and heat trace on indicating lights.

B. Provide wiring diagrams with circuit labeled for cooling tower water return piping.

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Self-adhesive labels with legend “ELECTRIC HEAT TRACING.” Refer to Division 20 Section "Mechanical Identification" for additional requirements

C. Warning Tape: Continuously printed ”Electrical Tracing”; vinyl, at least 3 mils thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
PART 3 - EXECUTION

3.1 INSTALLATION

A. The entire installation shall comply with the manufacturer's instructions and all the applicable sections of NEC, latest edition.

B. The electrical and mechanical installation details shall strictly adhere to manufacturer's recommended practices. The manufacturer's representative shall supervise and test the installation and provide a letter to the Owner that the entire installation complies with their requirements, and the installation tested out satisfactorily.

3.2 TESTS

A. After heater installation and before and after installing the thermal insulation, subject heater to testing using a 1000 VDC megger. Minimum insulation resistance shall be 20 megohms regardless of length. Test both heating cable bus wires to verify the connection of any splices or tees.

B. After all megger testing and insulation is complete, manufacturer shall conduct functional performance test to ensure system is fully operational, and submit report.

END OF SECTION 220533
SECTION 23 0500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

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

B. Related Sections include the following:
   1. Division 20 Section "Mechanical General Requirements."
   2. Division 20 Section "Basic Mechanical Materials and Methods."
   3. Division 23 Section "Testing, Adjusting, and Balancing."

1.2 SUMMARY
A. This Section includes common requirements for fans and air moving equipment.

1.3 SUBMITTALS
A. Product Data: For the following:
   1. Fan bearings.
   2. V-belt fan drives.
   3. Direct drive couplings.
1.4 QUALITY ASSURANCE

A. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.


C. Sound Power Level Ratings:
   1. Ducted Fans - Rated per AMCA 301, when tested per AMCA 300.
   2. Nonducted Fans - Rated in Zones at 5 feet from acoustic center of fan rated per AMCA 301, tested per AMCA 300 and converted per AMCA 302.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Do not operate equipment for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

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 FAN SHAFTS

A. Fan Shafts: Ground from solid cold rolled steel, and proportioned to run at least 25 percent below the first critical speed.

2.3 FAN POWER TRANSMISSION


B. A given manufacturer's V-belt drive, as applied to specific equipment provided under the Contract, shall conform to the equipment manufacturer's published recommendations, except as otherwise specified.

C. Base horsepower rating of drive on minimum pitch diameter of small sheave.

D. Locate belt drives outboard of bearings. Align drive and driven shafts by the four-point method.

E. Adjust belt tension in accordance with the manufacturer's recommendations.

F. Perform alignment and final belt tensioning in the presence of the Architect.
2.4 SHEAVES

A. Furnish sheaves of machined cast iron or carbon steel, bushing type of fixed bore, secured to the shaft by key and keyway.

B. For all variable frequency controller (VFC) operated fans, contractor shall provide and install one set of fixed sheaves sized to allow full utilization of fan motor horsepower provided, with VFC at 100 percent of fan motor RPM.

2.5 V-BELT FAN DRIVES

A. Fan Drives: Multiple V-belt style with adjustable pitch driver sheaves for fans up to 2 inches of total static pressure and fixed pitch driver sheaves for fans at or above 2 inches of total static pressure and up. Sheaves shall have split, taper style bushings. Drives shall be selected for a 150 percent service factor and shall provide for adjustment of both belt tension and alignment.

B. Manufacturers:
   1. Emerson Power Transmission; Browning.
   2. Rockwell Automation; Dodge.
   3. T.B. Wood’s Incorporated.

2.6 FAN DRIVE, SHAFT, AND COUPLING GUARDS

A. Safety Provisions: Include guards and screens for power transmission equipment, but do not negate vibration isolation provision.

B. Furnish ANSI and OSHA compliant mechanical power transmission apparatus guards except where superseded by other governing codes, and except as modified and supplemented. Requirements specified apply to all types of fans.

C. Fabricate mechanical power transmission device guards such that the completed structure is capable of withstanding a load of at least 200 pounds applied in any direction.

D. Furnish a guard enclosure for each V-belt drive, coupling, shaft, and rotating component. Secure guards in place, easily removable for maintenance. Guard fasteners used for maintenance access shall be "captive type." Locate holes on each guard for tachometer readings on both the motor and fan shafts. Fabricate guard of minimum 16 gage sheet metal with hemmed edges at openings for shafts. Weld four mounting lugs or feet of 10 gage material to the guard. Fabricate guards for couplings five inches in diameter and larger of 12 gage sheet metal. Furnish holes in mounting feet sized for suitable machine screws.

E. Centrifugal exhaust fans shall be provided with shaft seals.

2.7 BELT DRIVE GUARDS

A. Belt Guards: ANSI and OSHA compliant with provision for readily viewing belt tension and measuring shaft speeds. Guards shall be installed with quick release pins, so that removal of three to five clip pins, will allow the guard to be removed from fan housing.

B. Fabricate guards which completely enclose moving parts of the particular drive. Design and construct guards of such rigidity as to contain a belt which breaks during operation. Minimum material thickness, 16 gage sheet metal. Where ventilation is required, perforated metal shall be used for the sides. Fabricate top of solid sheet metal.
2.8 V-BELTS

A. Notched or cogged style, endless type, of Dacron reinforced elastomer construction, with cross-section to suit sheave grooves. Determine the number of V-belts from the motor horsepower to which apply the service factor to obtain the design horsepower. Determine the corrected horsepower per belt by multiplying the nominal horsepower per belt by an arc of contact factor not greater than 0.85. Divide the design horsepower by the corrected horsepower per belt to obtain the number of belts required. In any case, furnish not less than two belts for each drive.

B. Furnish belts that have been factory or factory-authorized distributor matched and measured on a belt-matching machine. Selection by "code numbers," "sag numbers" or "match numbers" is not acceptable. Bind each belt set with wire and tag with equipment identification.

C. Manufacturers:
   1. Emerson Power Transmission; Browning; AX, BX, and CX Series and 3VX and 5VX Series.
   2. Rockwell Automation; Dodge; Classic Cog and Narrow Cog V-Belts.
   3. T.B. Wood’s Incorporated; Classical Cog and Narrow Cog V-Belts.

2.9 V-BELT DRIVE MOTOR BASES

A. Furnish fan motors with slide or adjustable pivoted bases wherever equipment configuration permits proper installation.

B. Provide for adjustment of both belt tension and alignment.

2.10 AIR HANDLING SYSTEM BALANCING PROVISIONS

A. Provide extra sheaves, sized as recommended by the Balancing Agent, for the adjustment of fan speed for each air handling system during air quantity balancing operations. Furnish sheaves as specified in this Section.

2.11 MOTOR REQUIREMENTS

A. Furnish motors in accordance with Division 20 Section “Motors.”

2.12 FAN BEARINGS

A. Bearings: Anti-friction ball or roller type with provision for self-alignment and thrust load. Made in U.S.A. with ABMA L_10 minimum life of 200,000 hours. Use cast iron housings and dust-tight seals suitable for lubricant pressures.

1. Lubrication Provisions - Use surface ball check type supply fittings. Provide extension tubes to allow safe maintenance while equipment is operating. Provide manual or automatic pressure relief fittings to prevent overheating or seal blow-out due to excess lubricant or pressure. Arrange relief fittings opposite supply but visible for normal maintenance observation.

2. Bearings on Equipment with less than 1/2 horsepower rating or on shafts smaller than 1-3/4 inch in diameter: Permanently sealed, pre-lubricated anti-friction bearings per specified materials and ABMA L_10 life requirements.
2.13 IDENTIFICATION

A. Nameplate: Affix metallic, corrosion-resistant data plate for each fan in a conspicuous location. Include selection point capacity conditions.

2.14 ACCESSORIES

A. Bird Screens: Of material to match adjacent contact construction, 1/2 inch mesh or equal expanded metal. Use on inlet or outlet of each nonducted fan.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Field Rigging: Do not negate balancing. Do not bend shaft. Use lifting eyes.

B. Install sheaves where recommended by Testing, Adjusting, and Balancing agency.

C. Refer to individual Division 23 HVAC equipment Sections for additional requirements.

END OF SECTION 23 0500
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:
      a. Variable-volume exhaust air system.
   2. Hydronic Piping Systems:
      a. Constant-flow systems.

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 sub mains, 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 4 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

C. Strategies and Procedures Plan: Within 60 days from Contractor's Notice to Proceed, submit 4 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.

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. Smoke Control System Testing: Additional Qualifications: The TAB firm shall be a qualified special inspector for the smoke control systems. The TAB firm for the smoke control system shall have expertise in fire protection engineering, mechanical engineering, and certification as air balancers.

C. 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. Airflow Testing Inc.; Lincoln Park, MI.
   d. Barmatic Inspecting Co., Inc.; Lincoln Park, MI.
   e. Ener-Tech Testing; Holly, MI.
   f. Enviro-Aire/Total Balance Co.; St. Clair Shores, MI.
   g. International Test & Balance Inc.; Southfield, MI.
   h. Aireconomics, Inc.; Grand Rapids, MI.
   i. Hi-Tech Test & Balance; Freeland, MI.
   j. Integrity Test & Balance, Inc.; Cedar, MI.

D. 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 representative, HVAC controls installer, 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.

E. 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.

G. 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."

H. 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. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. 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 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 strainers for clean screens and proper perforations.
C. Examine system pumps to ensure absence of entrained air in the suction piping.
D. Examine equipment for installation and for properly operating safety interlocks and controls.
E. 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. Sequence of operation for control modes is according to the Contract Documents.
   6. Interlocked systems are operating.
F. 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. 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. Isolating and balancing valves are open and control valves are operational.

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) inch-pound (IP) units.
3.4 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 makeup-water-station pressure gage for adequate pressure for highest vent.
3. Check flow-control valves for specified sequence of operation and set at indicated flow.
4. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.

3.5 PROCEDURES FOR HEAT EXCHANGERS

A. Measure water flow through all circuits.

B. Adjust water flow to within specified tolerances.

C. Measure inlet and outlet water temperatures.

3.6 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Cooling-Water Flow Rate: 0 to plus 5 percent.

3.7 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.

3.8 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. Pump curves.
2. Manufacturers' test data.
3. Field test reports prepared by system and equipment installers.
4. 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.

3.9 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. Measure sound levels at two locations.
e. Measure space pressure of at least 10 percent of locations.
f. Verify that balancing devices are marked with final balance position.
g. 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.

3.10 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.
SECTION 230933 - 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 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 and dampers (when required). Early submittals of control valves and dampers 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 INPUT/OUTPUT SENSORS

A. Current Sensors:
   1. Split-sore 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. Neilson-Kuljian.
      b. Veris Industries.
      c. Scientific-Columbus

B. Current Switches:
   1. Split-sore 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. Neilson-Kuljian.
      b. Veris Industries.
      c. Scientific-Columbus.

C. 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.
      b. Water flow – Meet or exceed system pressure rating.

D. Flow Meter:
1. Provide a hot tapped insertion turbine flow meter to produce a 4-20mA linear flow output signal to the DDC System.
2. Manufacturer:
   a. Onicon.

2.4 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.
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.

2.5 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.

2.6 CONTROL VALVES AND VALVE OPERATORS

A. 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
B. Butterfly Valves:
   1. Refer to Division 20 Section “Valves” for valve body and trim requirements.
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 20 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.

2.7 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 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.
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 pumps, 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 230933
SECTION 23 2113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections include the following:

1. Division 07 Section "Through-Penetration Firestop Systems" for materials and methods for sealing pipe penetrations through fire and smoke barriers.
2. Division 07 Section "Joint Sealants" for materials and methods for sealing pipe penetrations through exterior walls.
3. Division 20 Section "Mechanical General Requirements."
4. Division 20 Section "Basic Mechanical Materials and Methods" for general piping materials and installation requirements.
5. Division 20 Section "Hangers and Supports" for pipe supports, product descriptions, and installation requirements. Hanger and support spacing is specified in this Section.
6. Division 20 Section "Valves" for general-duty gate, globe, ball, butterfly, and check valves.
7. Division 20 Section "Pipe Flexible Connectors."
8. Division 20 Section "Meters and Gages" for thermometers and pressure gages.
9. Division 20 Section "Mechanical Identification" for labeling and identifying hydronic piping.
10. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.
11. Division 23 Section "Temperature Controls" for temperature-control valves and sensors.

1.2 DEFINITIONS

A. CPVC: Chlorinated polyvinyl chloride.
B. HDPE: High density polyethylene.
C. PP: Polypropylene.
D. PVC: Polyvinyl chloride.
E. PTFE: Polytetrafluoroethylene.
F. RTRF: Reinforced thermosetting resin (fiberglass) fittings.
G. RTRP: Reinforced thermosetting resin (fiberglass) pipe.

1.3 SYSTEMS DESCRIPTIONS
A. Hydronic piping system materials are scheduled on the Drawing.

1.4 SUBMITTALS
A. Product Data: For each type of the following:
   1. Valves. Include flow and pressure drop curves based on manufacturer’s testing for calibrated-orifice balancing valves and automatic flow-control valves.
   2. Air control devices.
   4. Hydronic specialties.
B. Shop Drawings: Detail, at minimum 1/4scale, the piping layout, fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
C. Qualification Data: For Installer.
D. Field quality-control test reports.
E. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in operation and maintenance manuals.
F. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 QUALITY ASSURANCE
A. ASME Compliance: Comply with ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
B. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be as recommended by the manufacturer of the grooved components.

1.6 EXTRA MATERIALS
A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.
B. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
C. DWV Copper Tubing: ASTM B 306, Type DWV.
D. Wrought-Copper Socket Fittings: ASME B16.22.
E. Wrought-Copper Unions: ASME B16.22.
F. Grooved Mechanical-Joint Fittings and Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Tyco Fire & Building Products; Grinnell Mechanical Products; Model 672.
      c. Victaulic Company; Style 606 and Style 607.
   2. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
   3. Grooved-End-Tube Couplings: Rigid pattern, unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.

2.2 STEEL PIPE AND FITTINGS

A. Schedule 40 Steel Pipe: ASTM A 53/A 53M or ASTM A 106, Type E or S, Grade A or B. Include ends matching joining method.
   7. Flanges: Class 300 forged steel welding neck to match pipe wall thickness and valve flanges, ANSI B16.5. Orifice plate flanges shall be raised face welding neck type with ring joint gaskets and flange taps. Coordinate orifice plate flanges with orifice plate flow elements.

B. Grooved Mechanical-Joint Fittings and Couplings:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Tyco Fire & Building Products; Grinnell Mechanical Products; Model 772 Rigid Coupling.
      c. Victaulic Company; Style 07 Rigid Coupling and 107 QuickVic Rigid Coupling.

HYDRONIC PIPING
2. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 234, Grade WPB steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

3. Gaskets: Synthetic rubber gasket of central cavity pressure-responsive design suitable for temperatures from minus 30 deg F to 250 deg F.

4. Couplings: Ductile- or malleable-iron housing with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

   a. Rigid Type: To provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9.

2.3 JOINING MATERIALS

   A. Refer to Division 20 Section "Basic Mechanical Materials and Methods."

2.4 VALVES

   A. General Service Valves: Comply with requirements specified in Division 20 Section "Valves."

2.5 AIR CONTROL DEVICES

   A. Manual Air Vents: Use ball-valve-type hose-end drain valves, refer to Division 20 Section "Valves."

   B. Automatic Air Vents:

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

         a. Amtrol, Inc.
         b. Armstrong Pumps, Inc.
         c. Bell & Gossett; Xylem Inc.
         d. Spirotherm, Inc.
         e. Taco, Inc.

      2. Body: Bronze or cast iron.
      3. Internal Parts: Nonferrous.
      5. Inlet Connection: NPS 1/2.
      7. CWP Rating: 150 psig.
      8. Maximum Operating Temperature: 240 deg F.

2.6 SPECIALTY VALVES

   A. Balance Valves:

      1. Balance Valves NPS 6 and Larger: Lug type butterfly valves with aluminum bronze disc, AISI 300 Series stainless steel stem, resilient replaceable seat for service at not less than 250 deg F (121 deg C) and memory stops. Refer to Division 23 Section "General-Duty Valves for HVAC" for additional requirements.

         a. Provide lubricated enclosed screw or worm gear operator with handwheel for sizes 6 inches and larger.
         b. Pressure rating shall meet or exceed system minimum pressure rating.
3. Balance Valves for Sizes Less than NPS 6: Combination balance valve and flow measuring device as specified in this Section.

B. Combination, Balancing Valves and Flow Measuring Devices NPS 2 and Smaller:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Griswold Controls.
   b. Hydronic Components, Inc. (HCi).
   c. Nexus Valve.
   d. PRO Hydronic Specialties, LLC.
   2. Body: Brass or bronze, ball, or plug type with calibrated orifice or venturi.
   3. Ball: Brass, or stainless steel.
   4. Plug: Resin.
   5. Seat: PTFE.
   6. End Connections: Threaded or socket.
   8. Handle Style: Lever, with memory stop to retain set position.
   10. Maximum Operating Temperature: 250 deg F.

2.7 HYDRONIC PIPING STRAINERS

A. Manufacturers:
   1. Keckley.
   2. Metraflex.
   4. Nibco, Inc.
   5. Spence.
   6. Sure Flow Equipment Inc.
   7. Watts Water Technologies, Inc.
   8. Yarway.
   10. Tyco Fire & Building Products, Grinnell Mechanical Products (for grooved piping)
   11. Victaulic Company; (for grooved piping).

B. Y-Pattern Strainers, Cast and Ductile Iron:

   1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
   2. End Connections: Flanged ends for NPS 2-1/2 and larger.
   3. Strainer Screen: 40-mesh strainer, and perforated stainless-steel basket with 50 percent free area.
   4. CWP: 200 psig minimum, unless otherwise indicated.
   5. Drain:
      a. Factory-installed, hose-end drain valve.

2.8 HYDRONIC PIPING SPECIALTIES

A. Flexible connectors are specified in Division 20 Section “Pipe Flexible Connectors.”
PART 3 - EXECUTION

3.1 PIPING SYSTEMS INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Install piping 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.

C. Install piping to permit valve servicing.

D. Install piping at indicated slopes.

E. Install piping free of sags and bends.

F. Install fittings for changes in direction and branch connections.

G. Install piping to allow application of insulation.

H. Select system components with pressure rating equal to or greater than system operating pressure.

I. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

J. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

K. Install piping, other than drain piping, at a uniform grade of 0.2 percent upward in direction of flow.

L. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

M. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

N. Install valves according to Division 20 Section "Valves."

O. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.

P. Install calibrated balancing valves in the return water line of each heating or cooling element and elsewhere as required to facilitate system balancing.

Q. Install check valves at each pump discharge and elsewhere as required to control flow direction.

R. Install safety valves on hot-water generators and elsewhere as required by the ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to floor. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.

S. Install pressure-reducing valves on hot-water generators and elsewhere as required to regulate system pressure.
T. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

U. Install flanges or grooved mechanical couplings in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

V. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 20 Section "Pipe Flexible Connectors, Expansion Fittings and Loops."

W. Identify piping as specified in Division 20 Section "Mechanical Identification."

3.2 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 20 Section "Hangers and Supports." Comply with the following requirements for maximum spacing of supports.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 7 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
8. NPS 6: Maximum span, 17 feet; minimum rod size, 1/2 inch.
9. NPS 8: Maximum span, 19 feet; minimum rod size, 5/8 inch.
10. NPS 10: Maximum span, 20 feet; minimum rod size, 3/4 inch.
11. NPS 12: Maximum span, 23 feet; minimum rod size, 7/8 inch.
12. NPS 14: Maximum span, 25 feet; minimum rod size, 1 inch.
13. NPS 16: Maximum span, 27 feet; minimum rod size, 1 inch.
14. NPS 18: Maximum span, 28 feet; minimum rod size, 1-1/4 inches.
15. NPS 20: Maximum span, 30 feet; minimum rod size, 1-1/4 inches.

D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
7. NPS 4 to NPS 5: Maximum span, 10 feet; minimum rod size, 1/2-inch.
8. NPS 6: Maximum span, 10 feet; minimum rod size, 5/8-inch.
9. NPS 8: Maximum span, 10 feet; minimum rod size, 3/4-inch.
3.3 PIPE JOINT CONSTRUCTION

A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

3.4 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install bypass chemical feeders in each hydronic system, in upright position with top of funnel not more than 48 inches above the floor. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.

D. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.

   1. Install tank fittings that are shipped loose.
   2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.

E. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

3.5 CHEMICAL TREATMENT

A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:

   1. pH: 9.0 to 10.5.
   2. "P" Alkalinity: 100 to 500 ppm.
   3. Boron: 100 to 200 ppm.
   4. Chemical Oxygen Demand: Maximum 100 ppm. Modify this value if closed system contains glycol.
   5. Corrosion Inhibitor:

      a. Sodium Nitrate: 1000 to 1500 ppm.
      b. Molybdate: 200 to 300 ppm.
      c. Chromate: 200 to 300 ppm.
      d. Sodium Nitrate Plus Molybdate: 100 to 200 ppm each.
      e. Chromate Plus Molybdate: 50 to 100 ppm each.

   6. Soluble Copper: Maximum 0.20 ppm.
   7. Tolyiriazole Copper and Yellow Metal Corrosion Inhibitor: Minimum 10 ppm.
   8. Total Suspended Solids: Maximum 10 ppm.
   10. Free Caustic Alkalinity: Maximum 20 ppm.
   11. Microbiological Limits:

      a. Total Aerobic Plate Count: Maximum 1000 organisms/ml.
      b. Total Anaerobic Plate Count: Maximum 100 organisms/ml.
      c. Nitrate Reducers: 100 organisms/ml.
      d. Sulfate Reducers: Maximum 0 organisms/ml.
3.6 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.
2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
3. Isolate expansion tanks and determine that hydronic system is full of water.
4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 2 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.
2. Inspect pumps for proper rotation.
3. Remove disposal fine-mesh strainers in pump suction diffusers.
4. Set makeup pressure-reducing valves for required system pressure.
5. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
6. Set temperature controls so all coils are calling for full flow.
7. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
8. Verify lubrication of motors and bearings.

END OF SECTION 23 2113
SECTION 23 3113 - 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

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. FRP: Fiberglass-reinforced plastic.

E. 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: 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.

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. Welding Qualifications: Qualify procedures and personnel according to the following:


B. 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 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.

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. Stainless Steel: ASTM A 480/A 480M, Type 316, and having a No. 2D finish for concealed ducts and No. 4 for exposed ducts.

C. Reinforcement Shapes and Plates: Stainless-steel reinforcement where installed on stainless steel ducts.

D. Tie Rods: For rectangular ducts having a side dimension of 48 inches or greater. Stainless 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. Solvent-Based Joint and Seam Sealant:
1. Manufacturers:
   a. Hardcast; Sure-Grip 404.
   b. United McGill.

5. Solids Content: Minimum 60 percent.
7. Water resistant.
8. Mold and mildew resistant.
9. VOC: Maximum 395 g/L.
10. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
11. Service: Indoor or outdoor.

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.

2.4 ROOF MOUNTED DUCT SUPPORTS

A. General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted duct.

B. Support: Assembly of bases, and vertical and horizontal members, for roof installation without membrane penetration.

1. Manufacturer:
   b. Eco Support Products.
   c. ERICO/Michigan Hanger Co.
   d. MIRO Industries.
   e. Portable Pipe Hangers.

2. Bases: Two or more plastic, stainless steel, or recycled rubber.
3. Vertical Members: Two or more protective-coated-steel channels.
4. Horizontal Member: Protective-coated-steel channel.

2.5 RECTANGULAR DUCT FABRICATION

A. Fabracte 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).
   b. LaPine Metal Products.
   c. Lindab Inc.
   e. SEMCO Incorporated.
   f. SET Duct Manufacturing, Inc.
   g. Tangent Air, Inc.
   h. Universal Spiral Air.

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.

4. 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.

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. 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.

PART 3 - EXECUTION

3.1 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. 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.

M. 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."

N. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

3.2 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.

3.3 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. Support ductwork from building structure, not from roof deck, floor slab, pipe, other ducts, or equipment.

D. Install roof mounted duct supports in accordance with manufacturer's instructions. Provide additional membrane layer or walkpads under support bases as required.

3.4 CONNECTIONS

A. Make connections to equipment with flexible connectors according to Division 23 Section "Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.5 FIELD QUALITY CONTROL

A. Duct system will be considered defective if it does not pass tests and inspections.

B. Prepare test and inspection reports.

3.6 START UP

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 23 3113
SECTI0N 23 3300 - 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.

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.
   1. For turning vanes, include data for pressure loss generated sound power levels.
   2. For duct silencers, include pressure drop and dynamic insertion loss data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

2.2 SHEET METAL MATERIALS

2.3 PRESSURE RELIEF DOORS (STAINLESS STEEL)

2.4 MOTORIZED CONTROL DAMPERS

2.5 DUCT-MOUNTING ACCESS DOORS

2.6 FLEXIBLE CONNECTORS

2.7 DUCT ACCESSORY HARDWARE

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

3.2 FIELD QUALITY CONTROL

3.3 ADJUSTING
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. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
   e. Duct security bars.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale and coordinating penetrations and ceiling-mounting items. Show ceiling-mounting access panels and access doors required for access to duct accessories.

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. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
2.3 PRESSURE RELIEF DOORS (STAINLESS STEEL)

A. Manufacturers:
   1. Kees Incorporated.
   2. Pottorf; a division of PCI Industries.
   3. Ruskin Company.

B. Description: Designed to open automatically to prevent exploding or imploding ductwork in the event dampers close while fan is still operating. Doors open outward for positive pressure relief, or inward for negative pressure relief.

C. Frame: 12 gage stainless steel.

D. Door: 12 gage stainless steel.

E. Seal: Polyurethane foam around door perimeter.

F. Pressure Relief Setting: Factory set, field adjustable, minimum 1.0 inch wg (250 Pa) above normal system pressure.

G. Springs: Negator springs for door closure upon pressure relief and system shutdown.

H. Temperature Limits: Minus 40 deg F minimum, and 120 deg F maximum.

2.4 MOTORIZED CONTROL DAMPERS

A. Refer to Division 23 Section “Temperature Controls.”

2.5 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 or Stainless sheet steel to match duct system, 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.

2.6 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: 16 oz./sq. yd.
   2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
   3. Service Temperature: Minus 67 to plus 500 deg F.

2.7 DUCT ACCESSORY HARDWARE

A. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

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 duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
   2. Control devices requiring inspection.
   3. Elsewhere as indicated.

D. Install access doors with swing against duct static pressure.

E. 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.

F. Install pressure relief doors vertically and level in accordance with manufacturer’s instructions, between the fan and first operable damper.

G. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

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. Adjust fire and smoke dampers for proper action.

C. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 23 3300
SECTION 23 3500 – SPECIAL EXHAUST SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 20 Section “Motors.”
   3. Division 23 Section “Common Work Results for HVAC” for common mechanical drive requirements for fans and air moving equipment.

1.2 PERFORMANCE REQUIREMENTS

A. Operating Limits: Classify according to AMCA 99.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated.

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.
2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

3. 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.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a NRTL acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.6 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

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. Belts: One set for each belt-driven unit.

PART 2 - PRODUCTS

2.1 GENERAL

A. Base fan performance at standard conditions (density 0.075 Lb./ft^3).

B. Each fan shall be direct driven in AMCA arrangement 2 according to drawings.
C. Each fan to be equipped with 316 stainless steel lifting lugs for corrosion resistance.

D. Fasteners exposed to corrosive exhaust shall be stainless steel.

E. Curb cap shall be 316 stainless steel.

F. Fan assembly shall be designed for a minimum of 125 mph wind loading, without the use of guy wires.

G. Laboratory Exhaust Fans:
   
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      
      a. Greenheck; Vektor-MH
      b. Loren Cook Company
      c. M.K. Plastics Corporation

2.2 CORROSION RESISTANT COATING

A. All fan and system components (fan, nozzle, windband and plenum) shall be corrosion resistant coated with a two part electrostatically applied and baked, corrosion resistant coating system. Standard finish color to be gray. Coating system shall exceed 4000 hour ASTM B117 Salt Spray Resistance.

2.3 FAN HOUSING AND OUTLET

A. Fan housing to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.

B. Fan housing shall be bifurcated, allowing all drive components, including the motor, to be serviced without contact of the contaminated airstream. Housing shall be manufactured of welded steel and meet specification section 2.15 for corrosion resistant coating. No uncoated metal fan parts will be acceptable.

C. A high velocity discharge nozzle shall be supplied by the fan manufacturer designed to efficiently handle an outlet velocity of up to 7000 FPM.

D. An integral fan housing drain shall be used to drain rainwater when the fan is de-energized.

E. A bolted & gasketed access door shall be supplied for impeller inspection and service.

F. Fan assembly shall be AMCA type B spark resistant construction minimum.

2.4 FAN IMPELLER

A. Fan impeller shall be mixed flow design with non-stall characteristics. The impeller shall be electronically balanced both statically and dynamically exceeding AMCA Standards.

B. Fan impeller shall be manufactured of welded and coated steel. Reference specification section 2.15 for corrosion resistant coating.

2.5 BYPASS AIR PLENUM

A. A bypass air plenum shall be provided. The plenum shall be provided with bypass air damper(s) for introducing outside air at roof level upstream of the fan, complete with bypass air weatherhood and bird screen.
B. The plenum shall be constructed of welded and coated steel and meet specification section 2.15 for corrosion resistant coating.

C. The bypass air plenum shall be mounted on factory fabricated roof curb provided by the fan manufacturer.

D. Bypass air damper(s) shall be opposed-blade design for airflow control, airfoil design, fabricated of 316 stainless steel for structural rigidity as standard. Bypass damper(s) shall have plated steel damper rods, stainless steel sleeved bearings, 301 stainless steel jamb seals and the blades shall have polymer edge seals. Damper model shall be a heavy duty control damper. Damper blade drive linkage shall be set by manufacturer and welded to eliminate linkage slippage. All damper access and service (drive actuators) shall be performed outside of the contaminated airstream.

E. An integral bypass air packed acoustic attenuator fabricated of stainless steel shall be provided by the fan manufacturer.

F. Fan isolation damper(s), shall be parallel-blade design, airfoil design, fabricated of 304 stainless steel for structural rigidity as standard. Damper(s) shall be coated up to 4 mils of chemically resistant polyester resin, electrostatically applied and baked. Isolation damper(s) shall have 304 stainless steel damper rods, stainless steel sleeved bearings, 301 stainless steel jamb seals and the blades shall have polymer edge seals. Damper model shall be a heavy duty control damper. Damper blade drive linkage shall be set by manufacturer and welded to eliminate linkage slippage. All damper access and service (drive actuators) shall be performed outside of the contaminated airstream.

G. Isolation damper actuator shall be factory mounted and shall be wired to a step-down transformer. Actuator and transformer are located in a weatherproof enclosure.

H. Blower / Plenum vibration isolation shall be neoprene / cork vibration pads.

2.6 BYPASS AIR PLENUM CURB

A. Exhaust system manufacturer shall supply a structural support curb for the plenum 18" tall.

B. Curb shall be fabricated of a minimum of 12 gauge corrosion-resistant coated steel and structurally reinforced.

C. Curb shall be insulated.

D. When properly anchored to the roof structure, the standard curb / plenum / blower assembly shall withstand wind loads of up to 125 mph without additional structural support.

2.7 FAN MOTOR AND DRIVE

A. Motors shall be premium efficiency, standard NEMA frame, 1800 or 3600 RPM, TEFC with a 1.15 service factor. A factory-mounted NEMA 3R disconnect switch shall be provided for each fan.

B. Motor maintenance shall be accomplished without fan or fan impeller removal, or requiring maintenance personnel to access the contaminated exhaust components.

C. Motor mounting shall be “C-face” and / or foot mount.

D. Drive arrangement shall be AMCA arrangement #2, utilizing a direct mount coupling connecting the motor shaft and fan impeller shaft. Belt drive arrangement #9 or #10, or direct drive arrangement #4 requiring access and handling of hazardous and contaminated fan components are not acceptable.

E. Fan shaft to be turned and polished 316 stainless steel.
F. Fan shaft bearing shall be Air Handling Quality, ball or roller pillow block type, and sized for an L-10 life of no less than 200,000 hours.

G. All shaft bearings and non-permanently lubricated motors shall have nylon extended lube lines with zerk fittings.

H. Motor, coupling, and bearing shall all be outside the contaminated exhaust, and be capable of replacement without disassembling fan and accessing hazardous and contaminated fan components.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install packaged exhausters and collectors level and plumb.

B. Support units using elastomeric mounts. Vibration-control devices are specified in Division 20 Section "Mechanical Vibration Controls."

C. Secure roof-mounting fans to roof curbs with cadmium-plated hardware.

D. Install units with clearances for service and maintenance.

E. Label units according to requirements specified in Division 20 Section "Mechanical Identification."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories.

B. Install ducts adjacent to packaged exhausters to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 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. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Adjust belt tension.
6. Adjust damper linkages for proper damper operation.
7. Verify lubrication for bearings and other moving parts.
8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
10. Shut unit down and reconnect automatic temperature-control operators.
11. Remove and replace malfunctioning units and retest as specified above.

C. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.
B. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.
C. Lubricate bearings.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain special exhaust systems and equipment.

END OF SECTION 23 3500
SECTION 23 3600 - AIR TERMINAL UNITS

PART 1 - GENERAL

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

B. Related Sections include the following:
   1. Division 20 Section “Mechanical General Requirements.”
   2. Division 23 Section “Metal Ducts.”
   3. Division 23 Section “Temperature Controls.”

1.2 SUBMITTALS
A. Product Data: For each type of product indicated, include rated capacities, furnished specialties, sound-power ratings, and accessories.
   1. Liners and adhesives.
   2. Sealants and gaskets.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Include a schedule showing unique model designation, room location, model number, size, and accessories furnished.
   2. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and Maintenance Data: For air terminal units to include in operation and maintenance manuals. Include the following:
   1. Instructions for resetting minimum and maximum air volumes.
   2. Instructions for adjusting software set points.
1.3 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air terminal units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by NRTL acceptable to authorities having jurisdiction, and marked for intended use.

C. NFPA Compliance: Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

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 SINGLE-DUCT AIR TERMINAL UNITS

A. Manufacturers:

1. Siemens

B. Configuration: Variable volume, medium pressure terminal units with casing, 100 percent tight shutoff volume regulator with pneumatic operator, velocity sensor, and sound attenuating thermal insulation.

C. Casing: Constructed of 0.034-inch mill galvanized steel or 0.032-inch aluminum.


2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.

3. Air Outlet: S-slip and drive connections size matching inlet size.

4. Access: Removable panels for access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket.

D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: AHRI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.


F. Attenuator Section: 0.034-inch mill galvanized steel or 0.032-inch aluminum sheet metal.

1. Lining: 1-inch thick, coated, fibrous-glass duct liner complying with ASTM C 1071; secured with adhesive. Cover liner with nonporous foil.

G. DDC Controls: Single-package unitary controller and actuator specified in Division 23 Section "Temperature Controls."

H. Control Sequence: Refer to Temperature Control Diagrams on Drawings.
2.3 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Steel Cables: Galvanized steel complying with ASTM A 603.

D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

E. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

2.4 SOURCE QUALITY CONTROL

A. Identification: Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and AHRI certification seal.

B. Verification of Performance: Rate air terminal units according to AHRI 880.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.2 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts or structural-steel fasteners appropriate for construction materials to which hangers are being attached. Refer to Division 20 Section "Hangers and Supports" for additional information.

1. Where practical, install concrete inserts before placing concrete.

C. Hangers Exposed to View: Threaded rod and angle or channel supports.

D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
3.3 CONNECTIONS

A. Connect ducts to air terminal units according to Division 23 Section "Metal Ducts."

B. Connect wiring according to Division 26 Section "Conductors and Cables."

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. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP SERVICE

A. Complete installation and startup checks according to manufacturer's written instructions and do the following:

1. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
2. Verify that controls and control enclosure are accessible.
3. Verify that control connections are complete.
4. Verify that nameplate and identification tag are visible.
5. Verify that controls respond to inputs as specified.

END OF SECTION 23 3600
SECTION 23 5700 - HYDRONIC HEAT EXCHANGERS

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 23 Section “Hydronic Piping.”

1.2 PERFORMANCE REQUIREMENTS
A. Pressure and Temperature Ratings: Not less than, and as required for system pressures and temperatures as specified in Division 23 Section “Hydronic Piping.”

1.3 SUBMITTALS
A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
   1. Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.

B. Coordination Drawings: Equipment room, 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. Structural members to which heat exchangers will be attached.

C. Operation and Maintenance Data: For heat exchangers to include in operation and maintenance manuals.
1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, performance, and dimensional requirements of heat exchangers and are based on the specific equipment indicated. Refer to Division 1 Section "Product Requirements."

B. ASME Compliance: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

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 GASKETED PLATE AND FRAME HEAT EXCHANGERS

A. Manufacturers:

1. Alfa Laval Thermal, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett; Xylem Inc.
4. GEA PHE Systems North America, Inc.
6. Tranter, Inc.

B. Configuration: Freestanding assembly consisting of frame support, top and bottom carrying and guide bars, fixed and movable end plates, tie rods, individually removable plates, and one-piece gaskets.

C. Frame:

1. Capacity to accommodate 20 percent additional plates.
2. Painted carbon steel with provisions for anchoring to support.

D. Top and Bottom Carrying and Guide Bars: Painted carbon steel, aluminum, or stainless steel.

E. End-Plate Material: Painted carbon steel.

F. Tie Rods and Nuts: Steel or stainless steel.

G. Plate Material: Minimum 0.016 inch thick; Type 304 or Type 316 stainless steel.

H. Gasket Material: Nitrile rubber or EPDM for operating temperatures below 180 deg F; or EPDM for operating temperatures at or above 180 deg F.

I. Piping Connections:

1. Threaded port for NPS 2 and smaller. For larger sizes, furnish end-plate port with threaded studs suitable for flanged connection.
J. Enclose plates in a solid stainless-steel removable shroud.

K. Capacity and Characteristics: Refer to schedule on Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas for compliance with requirements for installation tolerances and for structural rigidity, strength, anchors, and other conditions affecting performance of heat exchangers.

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

3.2 HEAT-EXCHANGER INSTALLATION

A. Install plate and frame heat exchangers on concrete bases. Concrete base is specified in Division 20 Section "Basic Mechanical Materials and Methods," and concrete materials and installation requirements are specified in Division 03.

B. Concrete Bases: Anchor heat exchanger to concrete base.

1. 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.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Cast-in-place concrete materials and placement requirements are specified in Division 03.

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.

B. Maintain manufacturer's recommended clearances for service and maintenance. Install piping connections to allow service and maintenance of heat exchangers.

C. Install shutoff valves at heat-exchanger inlet and outlet connections.

D. Install relief valves on heat-exchanger heated-fluid connection and install pipe relief valves, full size of valve connection, to floor drain.

3.4 FIELD QUALITY CONTROL

A. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

END OF SECTION 23 5700
ELECTRICAL GENERAL REQUIREMENTS  260010 - 1

PART 1 - GENERAL...................................................................................................................................................... 1
  1.1 RELATED DOCUMENTS........................................................................................................................................ 1
  1.2 SUMMARY......................................................................................................................................................... 1
  1.3 REFERENCES ..................................................................................................................................................... 1
  1.4 QUALITY ASSURANCE ..................................................................................................................................... 2
  1.5 CODES, PERMITS AND FEES ........................................................................................................................ 2
  1.6 DRAWINGS ....................................................................................................................................................... 2
  1.7 MATERIAL AND EQUIPMENT MANUFACTURERS .......................................................................................... 3
  1.8 INSPECTION OF SITE .................................................................................................................................... 3
  1.9 ITEMS REQUIRING PRIOR APPROVAL ......................................................................................................... 3
  1.10 SHOP DRAWINGS/SUBMITTALS .................................................................................................................... 4
  1.11 COORDINATION DRAWINGS ....................................................................................................................... 4
  1.12 OPERATION AND MAINTENANCE INSTRUCTIONAL MANUALS ............................................................. 4
  1.13 RECORD DRAWINGS ................................................................................................................................ 5
  1.14 INSTRUCTION OF OWNER PERSONNEL ..................................................................................................... 5
  1.15 WARRANTY .................................................................................................................................................... 5
  1.16 USE OF EQUIPMENT .................................................................................................................................. 5
  1.17 COORDINATION .......................................................................................................................................... 6

PART 2 - PRODUCTS .................................................................................................................................................. 6

PART 3 - EXECUTION .............................................................................................................................................. 6
  3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION .......................................................... 6
  3.2 DEMOLITION WORK .................................................................................................................................... 6
  3.3 INSTALLATION OF EQUIPMENT ................................................................................................................ 7
  3.4 WORK IN EXISTING BUILDINGS ................................................................................................................. 7
  3.5 CHASES AND RECESSES ........................................................................................................................ 8
  3.6 CUTTING, PATCHING AND DAMAGE TO OTHER WORK ........................................................................... 8
  3.7 EQUIPMENT CONNECTIONS ....................................................................................................................... 8
  3.8 CLEANING .................................................................................................................................................... 8
  3.9 PROTECTION AND HANDLING OF EQUIPMENT AND MATERIALS ....................................................... 8
  3.10 EXTRA WORK .............................................................................................................................................. 8
  3.11 DRAWINGS AND MEASUREMENTS ............................................................................................................. 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 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. **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.

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. **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. **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.

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.

1.7 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. Fuses

1.11 COORDINATION DRAWINGS

A. Submit project specific coordination drawings for review in compliance with Division 1 Specification
Sections.

1.12 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.

1.13 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.

1.14 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.

1.15 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.

1.16 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.

1.17 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 installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. 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.”

D. 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. 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.

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 CHASES AND RECESES

A. Provided by the architectural trades, but the Contractor shall be responsible for their accurate location and size.

3.6 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.

3.7 EQUIPMENT CONNECTIONS

A. Make connections to equipment, motors, 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.

3.8 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 louveres, switchboards, substations, motor control centers, panels, etc. Fixture reflectors and lenses or louveres shall be left with no water marks or cleaning streaks.

3.9 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.

3.10 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, or other devices which may be required for any proposed extra work.
3.11 DRAWINGS AND MEASUREMENTS

A. These Specifications and accompanying Drawings are intended to describe and provide for finished work. They are intended to be cooperative, and what is called for by either shall be as binding as if call for by both. The Contractor understands that the work herein described shall be complete in every detail.

B. 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.
SECTION 26 0519 - 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 1 Specification Sections, apply to this Section.

1.2 SUMMARY
A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

B. Related Sections include the following:
   1. Division 26 Section “Electrical Identification” for conductor and cable color-coding.

1.3 SUBMITTALS
A. Product Data: For each type of product indicated.

B. Qualification Data: For testing agency.

C. Field Quality-Control Test Reports: From a qualified testing and inspecting agency engaged by Contractor.

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.

CONDUCTORS AND CABLES 260519 - 1
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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

B. Manufacturers, Copper:
   1. Triangle.
   2. Rome.

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

D. Refer to Part 3 "Conductor and Insulation Applications" Article for insulation type, cable construction, and ratings.

E. Conductor Material: Copper complying with NEMA WC 70; stranded conductor.

F. Conductor Insulation Types: Type THHN-THWN, complying with NEMA WC 70.

G. 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   2. Approved manufacturers for VFC power cables:
      a. Southwire Armor-x
      b. Draka USA

2.2 CONNECTORS AND SPLICES

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

   1. T & B.
   2. Burndy.
   3. ILSCO.

B. 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 AND INSULATION APPLICATIONS

A. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

B. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspace: Type THHN-THWN, single conductors in raceway.

D. Exposed Branch Circuits, including in Crawlspace: Type THHN-THWN, single conductors in raceway.

E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

F. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN-THWN, single conductors in raceway.

G. Underground Feeders and Branch Circuits: XHHW single conductors in conduit.

H. Class 1 Control Circuits: Type THHN-THWN, in raceway.

I. 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.

3.2 INSTALLATION

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. 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.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Seal around cables penetrating fire-rated elements according to Division 7 Section "Through-Penetration Firestop Systems."

G. Each feeder shall be of the same conductor and insulation material (phase, neutral, and parallel).

H. Identify and color-code conductors and cables according to Division 26 Section "Electrical Identification."

I. All wiring shall be installed in conduit or approved raceway. All raceways shall be provided with a ground conductor unless noted otherwise on the Contract Documents.

J. Use conductor not smaller than 12 AWG for power and lighting circuits. Unless indicated otherwise, all circuits shall be 2#12, 1#12G, ¾"C.
K. Use conductor not smaller than 14 AWG for control circuits, provided by Electrical Contractor.

L. 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.

M. Use suitable cable fittings and connectors.

N. Neatly train and lace wiring inside boxes, equipment, and panelboards.

O. Clean conductor surfaces before installing lugs and connectors.

P. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.

Q. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and larger.

R. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

S. Branch circuits may be combined up to 3 circuits in a homerun conduit.

T. Provide a separate neutral conductor for each circuit.

U. Electrical Contractor shall be responsible for derating of conductors as required by N.E.C.

V. AC/MC cable shall not be used.

W. 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.

3.3 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unsPLICed conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.4 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality control tests in accordance with Division 26 section “Electrical Testing”

1. Description: Test all feeders rated 100 A and above.
2. 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.
3. Electrical Tests
a. Perform insulation resistance test on each conductor with respect to ground and adjacent conductors. Applied potential to be 1000 volts dc for 1 minute.

b. Perform continuity test to insure proper cable connection.

4. Test Values

a. Minimum insulation resistance values shall be not less than fifty mega-ohms.

B. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 26 0519
SECTION 26 0526 - GROUNDING AND BONDING

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.

M. TIA/EIA 607: Commercial Building Grounding and Bonding Requirements Standard.

N. UL 467: Grounding and Bonding Equipment.

O. UL 486 A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Product Data: For the following:
   1. Ground rods.

C. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

D. Field Test Reports: Submit written test reports to include 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.
   4. Indicate overall system resistance to ground.
   5. Indicate overall Telecommunications system resistance to ground.

1.5 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Division 26 “Electrical General Requirements”.

B. Accurately record actual locations of grounding electrodes and connections to building steel.

1.6 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 ANSI/TIA/EIA-607 “Standard for Commercial Building Grounding and Bonding Requirements for Telecommunications”.


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. Grounding Rods:
   a. GB Electrical.
   b. Wilcor Grounding Systems.
   c. Chance/Hubbell.
   d. Copperweld.

3. Exothermic Connections:
   a. Cadweld.

2.2 GROUNDING CONDUCTORS

A. For insulated conductors, comply with Division 26 Section “Conductors and Cables.”

B. Equipment Grounding Conductors: Insulated with green-colored insulation.

C. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.

D. Grounding Electrode Conductors: Stranded cable.

E. Underground Conductors: Bare, stranded, copper unless otherwise indicated.

F. Bare Copper Conductors: Comply with the following:

G. Copper Bonding Conductors: As follows:
   1. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; size per the NEC.
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.

2.4 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel.
   2. Length: 96 inches.

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. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

C. Underground Grounding Conductors: No. 2/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.

D. In raceways, use insulated equipment grounding conductors.

E. Install equipment grounding conductors in all feeders and circuits. Terminate each end on suitable lugs, bus or bushing.

F. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

G. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.

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. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. 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.

D. 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.

E. 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.

F. 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.

G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.3 INSTALLATION

A. Equipotential Ground: Interconnect grounding electrodes to form one, electrically continuous, equipotential grounding electrode system. Grounding electrodes to be interconnected include:
   1. Ground rods.

B. Ground Rods: Install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes.
   1. Verify that final backfill and compaction has been complete before driving ground rods.
   2. Drive ground rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.
   3. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

C. 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.
D. 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.

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.

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.

2. After installing grounding system but before permanent electrical circuitry has been energized, test for compliance with requirements.

   a. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal.
   b. Perform tests, by the fall-of-potential method according to IEEE 81. Instrumentation utilized shall be as defined in Section 12 of IEEE 81 and shall be specifically designed for ground impedance testing. Provide sufficient spacing so that curves flatten in the 62% area of the distance between the item under test and the current electrode.
   c. Equipment Grounds: Utilize two-point method of IEEE 81. Measure between equipment ground being testing and known low-impedance grounding electrode or system.

3. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

   a. Equipment Rated 500 kVA and Less: 10 ohms.
   b. Equipment Rated 500 to 1000 kVA: 5 ohms.
   c. Equipment Rated More Than 1000 kVA: 3 ohms.

4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

3.5 GRADING AND PLANTING

A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Restore disturbed paving as indicated.

END OF SECTION 26 0526
SECTION 26 0529 - 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.
2. Construction requirements for concrete bases.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. IMC: Intermediate metal conduit.
C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

1.5 SUBMITTALS

A. Product Data: For the following:
1. Steel slotted support systems.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.7 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

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. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. 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
   D. Spring-steel clamps are not allowed.

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. Outdoors and interior wet locations: Galvanized Steel
3. 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 using powder-actuated anchors.

I. Obtain permission from Architect/Engineer before drilling or cutting structural members.

J. 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.

K. Install surface-mounted cabinets and panelboards with minimum of four anchors.

L. In wet and damp locations use steel channel supports to stand cabinets and panelboards one inch off wall.

M. Use sheet metal channel to bridge studs above and below cabinets and panelboards recessed in hollow partitions.

N. 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. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
B. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Provide concrete bases for all floor mounted electrical equipment.

B. Provide concrete bases for all exterior, grade level electrical equipment, and where indicated.

C. Base/Pad Construction:
   1. Construct per manufacturer’s recommendations for particular equipment, including suggested piers and dowel rods.
   2. Construct concrete bases for primary and secondary power distribution equipment per requirements of the electrical utility, where submitted for its review.

D. Anchor equipment to base per both supports and equipment manufacturer’s instructions.

E. Coordinate conduit openings and sleeve locations in base with requirements of equipment to be supported.
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of the base.
   2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Division 09 painting Sections 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 0529
SECTION 26 0533 - 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. ENT: Electrical nonmetallic tubing.
C. FMC: Flexible metal conduit.
D. IMC: Intermediate metal conduit.
E. LFMC: Liquidtight flexible metal conduit.
F. LFNC: Liquidtight flexible nonmetallic conduit.
G. RNC: Rigid nonmetallic conduit.
H. PVC: Polyvinyl Chloride.
I. HDPE: High Density Polyethylene.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with NFPA 70.
C. All work in natatoriums, pool areas and fountain structures shall be in accordance with N.E.C. article 680, “Swimming Pools, Fountains, and Similar Installations.”

1.6 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. Allied Tube Triangle Century.
   2. Triangle PWC.
   3. Wheatland.

B. Rigid Steel Conduit: ANSI C80.1.
C. IMC: ANSI C80.6.
D. EMT: ANSI C80.3.
E. FMC: Zinc-coated steel or Aluminum.
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 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cantex Inc.
   2. Lamson and Sessions: Carlon Electrical Products.
   3. Endot Industries.

B. ENT: NEMA TC 13.

C. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.

D. ENT and RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.

E. LFNC: UL 1660.


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: Hinged type.

F. Finish: Manufacturer's standard enamel finish.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. Sheet Metal Outlet and Device Boxes: NEMA OS 1. Shall be used within walls or ceiling.

B. Nonmetallic Outlet and Device Boxes: NEMA OS 2. Shall be used in corrosive areas.

C. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
D. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.5 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."

2.6 SLEEVE SEALS
A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Advance Products & Systems, Inc.
   2. Calpico, Inc.
   3. Metraflex Co.
   4. Pipeline Seal and Insulator, Inc.
B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
   1. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
   2. Pressure Plates: Carbon steel. Include two for each sealing element.
   3. 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 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, Exterior Aboveground: NEMA 250, Type 3R.
C. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

D. Minimum Raceway Size: 3/4-inch trade size.

E. 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. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

3.2 INSTALLATION

A. Install conduit in accordance with NECA “National Electrical Installation Standards”.

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. 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.

I. Raceways Embedded in Slabs is not allowed.

J. 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.

K. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

L. 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.

M. Tighten set screws of threadless fittings with suitable tools.

N. 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.

O. 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.

P. Provide pull string and 25% spare capacity in every branch circuit conduit.

Q. 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.

R. 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.

S. Flexible Connections: 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.

T. 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.

U. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

V. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

W. Do not route feeders across roof.

X. 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.

Y. Route conduits in finished areas with exposed ceilings at underside of structural deck or as high as possible.

Z. Outlet boxes within hazardous locations shall be of the proper class and division as noted in the N.E.C.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Division 2 Section "Earthwork" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Division 2 Section "Earthwork."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Division 2 Section "Earthwork."

4. Install manufactured rigid steel conduit elbows for equipment and at building entrances through the floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.
   b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

3.4 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.5 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."

3.6 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.

3.7 CLEANING

A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 26 0533
SECTION 26 0553 - 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. Equipment identification labels.

1.3 QUALITY ASSURANCE
B. Comply with NFPA 70.

1.4 COORDINATION
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

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. Black letters on a white background. Minimum letter height shall be 3/8 inch (10 mm).

B. Outdoor Equipment Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.4 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
   2. Tensile Strength: 50 lb, minimum.
   3. Temperature Range: Minus 40 to plus 185 deg F.

B. Paint: Paint materials and application requirements are specified in Division 9 painting Sections.

C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

2.5 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 Metal-Clad Cables, 600 V or Less, for Service and Feeders More Than 400 A: Identify with orange self-adhesive vinyl label.

B. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:

1. Control Wiring: Green and red.

C. 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.

D. 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.

E. Branch-Circuit Conductor Identification: Mark junction box covers in indelible ink with the panel and breaker numbers of other circuits contained within.

F. 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.

H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.

I. 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.
   b. Outdoor Equipment: Stenciled.
   c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled: If included on project. All items may not be on project.
a. Disconnect switches.
b. Motor starters.

J. 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. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
I. 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.

J. 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>

K. Fusible Enclosed Switches and Distribution Equipment: Install self-adhesive vinyl label indicating fuse rating and type on the outside of door on each fused switch.

L. Painted Identification: Prepare surface and apply paint according to Division 9 painting Sections.

M. Degrease and clean surface to receive nameplates.

N. Install nameplate and labels parallel to equipment lines.

O. Secure nameplate to equipment front using screws.

P. Secure nameplate to inside surface of door on panelboard that is recessed in finished locations.

Q. Identify conduit using field painting where required.

END OF SECTION 26 0553
SECTION 26 0999 - 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 "Conductors and Cables."
   3. Division 26 Section "Grounding and Bonding."

1.2 SECTION INCLUDES

A. The Electrical Contractor shall engage the services of a recognized corporately independent N.E.T.A. certified testing firm for the purpose of performing inspections and tests as herein specified.

B. The testing firm shall provide all material, equipment, labor, and technical supervision to perform such tests and inspections.

C. 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.

D. The test and inspections shall determine suitability for energization.

E. 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

Not Applicable

END OF SECTION 26 0999
SECTION 26 2416 - 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 ....................................................................................................................................... 2
1.6 PROJECT CONDITIONS ......................................................................................................................................... 3
1.7 COORDINATION .................................................................................................................................................... 3
1.8 EXTRA MATERIALS ............................................................................................................................................... 3

PART 2 - PRODUCTS ....................................................................................................................................................... 3
2.1 MANUFACTURERS ................................................................................................................................................... 3
2.2 MANUFACTURED UNITS ..................................................................................................................................... 4
2.3 PANELBOARD SHORT-CIRCUIT RATING .......................................................................................................... 4
2.4 DISTRIBUTION PANELBOARDS ........................................................................................................................ 4
2.5 OVERCURRENT PROTECTIVE DEVICES ......................................................................................................... 4
2.6 ACCESSORY COMPONENTS AND FEATURES ................................................................................................ 5

PART 3 - EXECUTION ..................................................................................................................................................... 5
3.1 INSTALLATION ...................................................................................................................................................... 5
3.2 IDENTIFICATION ................................................................................................................................................ 5
3.3 CONNECTIONS ................................................................................................................................................... 5
3.4 FIELD QUALITY CONTROL ................................................................................................................................ 5
3.5 CLEANING ........................................................................................................................................................... 6

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.
3. Isolation power panelboards.

1.3 DEFINITIONS

A. EMI: Electromagnetic interference.
B. GFCI: Ground-fault circuit interrupter.
C. RFI: Radio-frequency interference.
D. RMS: Root mean square.
E. 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. Phase and Ground Buses:
   2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.

B. Conductor Connectors: Suitable for use with conductor material.
   1. Main and Neutral Lugs: Mechanical type.
   2. Ground Lugs and Bus Configured Terminators: Compression type.

C. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of 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 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.

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. Do not use tandem circuit breakers.
2.6 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.

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 26 2416
SECTION 26 2813 - FUSES

PART 1 - GENERAL ...................................................................................................................................................... 1
  1.1 RELATED DOCUMENTS ........................................................................................................................................... 1
  1.2 SUMMARY............................................................................................................................................................... 1
  1.3 SUBMITTALS ......................................................................................................................................................... 1
  1.4 QUALITY ASSURANCE ........................................................................................................................................ 2
  1.5 PROJECT CONDITIONS ........................................................................................................................................... 2
  1.6 COORDINATION ..................................................................................................................................................... 2

PART 2 - PRODUCTS ......................................................................................................................................................... 2
  2.1 MANUFACTURERS ................................................................................................................................................. 2
  2.2 CARTRIDGE FUSES .............................................................................................................................................. 2

PART 3 - EXECUTION ....................................................................................................................................................... 3
  3.1 EXAMINATION ....................................................................................................................................................... 3
  3.2 INSTALLATION ....................................................................................................................................................... 3
  3.3 IDENTIFICATION ................................................................................................................................................... 3

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 controllers.

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.
2. Let-through current curves for fuses with current-limiting characteristics.
3. Time-current curves, coordination charts and tables, and related data.

B. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

1. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
2. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

C. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals.

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 Bussman, 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. Feeders: Class L, time delay.
   2. Motor Branch Circuits: Class RK5, time delay.
   3. Other Branch Circuits: Class RK5, 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.

3.3 IDENTIFICATION

A. Install labels indicating fuse rating and type on outside of the door on each fused switch.

END OF SECTION 26 2813