



Division of Finance and Business Operations

Wayne State University

Harwell Field Building

WSU Project Number 080-232104

Prevailing Wage Work

FOR:

Board of Governors
Wayne State University
Detroit, Michigan

Owner's Agent:

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

Owner's Representative:

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

Consultant:

Silveri Architects
650 Livernois
Ferndale, MI 48220

May 19, 2016

TABLE OF CONTENTS

Title Page	00001-1
Table of Contents	00002-1

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

00005	Information for Bidders	00005-1 thru 00005-2
00100	Instructions to Bidders	00100-1 thru 00100-5
00250	Notice of Pre-Bid Conference	00250-1 thru 00250-2
00300	Form of Proposal & Qualification Statement	00300-1 thru 00300-7
00410	Prevailing Wage Rate Schedule Information	00410-1 thru 00410-3
00420	KPI Reporting	00420-1 thru 00420-3
00430	Payment Package Document Requirements	00430-1 thru 00430-2
00440	Contractor's Performance Evaluation	00440-1 thru 00440-3
00500	Agreement between Contractor and Owner for Construction	00500-1 thru 00500-8
00510	Form of Guarantee	00510-1
00700	General Conditions (A.I.A. A-201)	00700-1
00800	WSU Supplementary General Conditions of the Contract for Construction	00800-1 thru 00800-11
00850	Drawings	00850-1

Division 1 - General Requirements

01000	General Requirements	01000-1 thru 01000-8
01010	Summary of Work (Includes Scope of Work)	01010-1

Appendix A

Project Specific Prevailing Wage Schedule (posted separately)

INFORMATION FOR BIDDERS

OWNER: Board of Governors
Wayne State University

PROJECT: Harwell Field Building
Project No. 080-232104

LOCATION: Wayne State University
Detroit, Michigan 48202

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

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

Architect: Silveri Architects
650 Livernois
Ferndale, MI 48220

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: May 19, 2016

BIDDING: Bidding documents may be obtained by vendors from the University Purchasing Web Site at http://www.forms.procurement.wayne.edu/Adv_bid/Adv_bid.html beginning May 19, 2016. When visiting the Web Site, click on the "Construction" link in green. Copies of the RFP will not be available at the pre-proposal meeting.

MANDATORY Pre-Bid Conference: 2:00 p.m., local time, June 1, 2016 to be held at Wayne State University – 5101 John C. Lodge, Room 128, Detroit, MI, 48202. Late Arrivals may not be permitted to submit bids.

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

DUE DATE FOR QUESTIONS: Due Date for questions shall be June 6, 2016 at 12:00 Noon. All questions must be reduced to writing and emailed to the attention of Valerie Kreher, Senior Buyer at rfpteam2@wayne.edu, copy to Leiann Day, Procurement Analyst at: Leiann.day@wayne.edu.

Bids Due: Sealed proposals for lump-sum General Contract will be received at the office of the Procurement & Strategic Sourcing located at 5700 Cass Avenue, Suite 4200, Detroit, MI 48202 on June 9, 2016, until 2:00 p.m. (local time).

No public bid opening will be held.

Bid Qualification Meeting: Bidders must be available for bid prequalification meeting as soon as the day following the bid opening. The lowest qualified bidder will be contacted and requested to meet with Facilities Planning & Management at their office located at 5454 Cass Avenue, Detroit, MI 48202. During the prequalification, the Vendor

must provide a Project Schedule and a Schedule of Values, including a list of Contractor's suppliers, subcontractors and other qualifications.

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

All available information pertaining to this project will be posted to the Purchasing web site at

http://www.forms.procurement.wayne.edu/Adv_bid/Adv_bid.html.

Information that is not posted to the website is not available/not known

INSTRUCTIONS TO BIDDERS

OWNER: Board of Governors
Wayne State University

PROJECT: Harwell Field Building
Project No. 080-232104

LOCATION: Wayne State University
Detroit, Michigan 48202

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

1. PROPOSALS

- A. The Purchasing Agent will receive sealed Proposals for the work as herein set forth at the place and until the time as stated in the "Information for Bidders", a copy of which is bound herewith in 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.

13. NOTICE OF AWARD/ACCEPTANCE OF BID PROPOSAL (revised 12-15-2009)

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

14. TIME OF STARTING AND COMPLETION

- A. It is understood that the work is to be carried through to substantial completion with the utmost speed consistent with good workmanship and to meet the established start and completion dates.
- B. The Contractor shall begin work under the Contract without delay, upon receipt of a fully-executed contract from the Owner, and shall substantially complete the project ready for unobstructed occupancy and use of the Owner for the purposes intended within the completion time stated in the Contract.
- C. The Contractor shall, immediately upon receipt of fully-executed contract, schedule his work and expedite deliveries of materials and performance of the subcontractors to maintain the necessary pace for start and completion on the aforementioned dates.

15. CONTRACTOR'S PERFORMANCE EVALUATION (2-2015)

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

16. BIDDING DOCUMENTS

- A. Bid specifications are not available at the University, but are available beginning **May 19, 2016** through Wayne State University Procurement & Strategic Sourcing's Website for Advertised Bids: http://www.forms.procurement.wayne.edu/Adv_bid/Adv_bid.html. The plans for this project can be viewed in advance and/or printed from the above website. Copies of the RFP will not be available at the pre-proposal meeting.
- B. **DOCUMENTS ON FILE (revised 12-2007)**

- (1) *Wayne State University Procurement & Strategic Sourcing's Website.*
All available information pertaining to this project will be posted to the Purchasing web site at http://www.forms.procurement.wayne.edu/Adv_bid/Adv_bid.html.
Information that is not posted to the website is not available/not known.
- (2) Notification of this Bid Opportunity has been sent to *DUNN BLUE (for purchase of Bid Documents only), DODGE REPORTS, REED CONSTRUCTION, CONSTRUCTION NEWS and the CONSTRUCTION ASSOCIATION OF MICHIGAN (CAM).*
- (3) Please note: Effective December 1, 2007, bid notices will be sent only to those Vendors registered to receive them via our Bid Opportunities list serve. To register, to http://www.forms.procurement.wayne.edu/Adv_bid/Adv_bid.html, and click on the "Join our Listserve" link at the top of the page.

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

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

NOTICE OF MANDATORY PRE-BID CONFERENCE

PROJECT: **Harwell Field Building**

PROJECT NOS.: **WSU PROJECT NO. 080-232104**

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
5101 John C. Lodge, Room 128
Detroit MI 48202

2:00 p.m., local time, June 1, 2016

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

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

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

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

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

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

AGENDA

- I. Welcome and Introductions
 - A. Wayne State University Representatives
 - B. Vendor Representatives
 - C. Sign in Sheet- be sure to include your fax number and email address (LEGIBLY) on the sign in sheet.
- II. Brief Overview of Wayne State University
 - A. Purpose and Intent of RFP.
 - B. Detailed review of the RFP and the requirements for a qualified response.
 - C. Review of all pertinent dates and forms that are REQUIRED for a qualified response.
- III. Vendor Questions/Concerns/Issues
 - A. Questions that can be answered directly by the appropriate person in this meeting will be answered and both question and answer will be recorded in the minutes of the meeting.
 - B. Questions that need to be researched will be answered and a nature of clarification will be emailed to the appropriate ListServ. See http://www.forms.purchasing.wayne.edu/Adv_bid/Adv_Bid_Listserve.html for a list of ListServ Bid Lists.
 - C. Minutes will be emailed to all participants of the meeting within a reasonable amount of time. (be sure to include your email address/addresses on the sign in sheet)
 - D. Questions and concerns that come up after this meeting are to be addressed to **Valerie Kreher**, Procurement & Strategic Sourcing. Discussion with other University members is seriously discouraged and could lead to disqualification from further consideration. All questions and answers will be recorded and emailed to all participants of the RFP.
 - E. Due date for questions is **June 6, 2016, 12:00 noon**.
- IV. Minimum Participation
 - A. Pre-registration for the Pre-Bid meeting is required. In the event that we do not have four (4) or more eligible bidders pre-registered, the University reserves the right to postpone the Pre-bid meeting with up to 4 business hour notice.
 - B. If less than 4 individual contractor firms attend the mandatory pre-bid meeting, the University reserves the right, at its sole discretion, to either reschedule the pre-bid conference or proceed and offer a second pre-bid conference date. (Attendance at only one pre-bid conference will be required).
 - C. On the day of the bid opening, if less than 3 sealed bids are received, the University reserves the right, at its sole discretion, to rebid the project in an effort to obtain greater competition. If the specifications are unchanged during the rebid effort, any contractor who submitted a bid will be given the option of keeping its bid on file for opening after the second bid effort, or of having the bids returned to them unopened.
- V. Proposal Due Date- **June 9, 2016, 2:00 p.m.**
- VI. Final Comments
- VII. Adjourn

VENDOR NAME _____

GENERAL CONTRACT - PROPOSAL FORM (revised 1 - 2011)

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

OWNER: Board of Governors
Wayne State University

PROJECT: Harwell Field Building

PROJECT NO.: WSU PROJECT NO. 080-232104

PROJECT TYPE: General Construction, Construction Management Work

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

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

TO: Board of Governors
Wayne State University
Detroit, Michigan

BASE PROPOSAL:

The undersigned agrees to enter into an Agreement to complete the entire work of the **Harwell Field Building** project (WSU Project No. **080-232104**) in accordance with the Bidding Documents for the following amounts:

_____ \$ _____ Dollars

ALTERNATES: The following alternates to the base proposal(s) are required to be offered by the respective bidder. The undersigned agrees that the following amounts will be added to or deducted from the base bid as indicated, for each alternate which is accepted.

ALTERNATE NO. 1:

The undersigned agrees to enter into an agreement to complete the Alternate # 1 work of the Harwell Field Building project and to provide all labor and material associated with the work in accordance with the Bidding Documents for the following amounts:

(select one) ADD _____ \$ _____ Dollars

or
DEDUCT _____ \$ _____ Dollars**ALTERNATE NO. 2:**

The undersigned agrees to enter into an agreement to complete all site work and exterior envelope of the Harwell Field Building project by October 1, 2016 and to provide all labor and material associated with the work in accordance with the Bidding Documents for the following amounts:

(select one) ADD _____ \$ _____ Dollars

or
DEDUCT _____ \$ _____ Dollars**LAWN REPLACEMENT:**

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

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

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

1. For subcontract work, Contractor's markup for handling, overhead, profit and bonding on subcontractors sell price, shall not exceed **5%**.

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

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

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

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

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

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

TIME OF COMPLETION:***(revised 4-01-2011)***

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

Substantial Completion will be completed no later than **December 23, 2016**.

LIQUIDATED DAMAGES:

It is understood and agreed that, if project is not completed within the time specified in the contract plus any extension of time allowed pursuant thereto, the actual damages sustained by the Owner because of any such delay, will be uncertain and difficult to ascertain, and it is agreed that the reasonable foreseeable value of the use of said project by Owner would be the sum of **\$500.00, Five Hundred Dollars per day**, and therefore the contractor shall pay as liquidated damages to the Owner the sum of **\$500.00, Five Hundred Dollars per day** for each day's delay in substantially completing said project beyond the time specified in the Contract and any extensions of time allowed thereunder.

TAXES:

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

ADDENDA:

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

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

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

WSU considers this project: **General Construction, Construction Management Work.**

Criteria	Small Project bid less than \$50,000	Medium Project bid between \$50,001 and \$250,000	Large Project bid between \$250,001 and \$2 million	Very Large Project bid greater than \$2 million
EMR Rating (Experience Modification Rating)	1.0 or Less	1.0 or Less	1.0 or Less	1.0 or Less
Bondable Vendor	N.A.	Required	Required	Required
Length of Time in Construction Business	2 Years	3 Years	5 Years	5 Years
Demonstrated Experience in Projects Similar in Scope and Price in the last 3 years	1 or more	1 or more	2 or more	3 or more

Unsuccessful Projects on Campus in last 3 years	None Allowed	None Allowed	None Allowed	None Allowed
Failure to comply with Prevailing Wage and/or Project Labor requirements	None Allowed	None Allowed	None Allowed	None Allowed
Withdrawn University Bid (with or without Bond forfeiture) within the last 3 years **	1 or less	1 or less	1 or less	1 or less
Company currently not in Chapter 11 of the US Bankruptcy Code	1 Year	2 Years	3 Years	3 Years

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

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

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

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

_____ Corporation

_____ Individual

_____ Partnership

_____ Joint Venture

_____ Other (Explain below):

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

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

1. How many years has your organization been in business as a contractor? _____

2. How many years has your organization been in business under its present business name? _____

3. List states in which your organization is legally qualified to do business. _____

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

5. What is your current EMR Rating? _____
The minimum requirement is an EMR Rating of 1.0 or less for all projects. Bidders with a rating higher than 1.0 understand that their bid may be disqualified, at the sole discretion of the University.
6. What percentage of work performed on projects are by company employees; excluding any hired subcontracting and outsourced relationships, for the bid submitted? _____ %
7. What percentage of work performed on your companies behalf are by subcontracted business relationships; disallowing 1099 contracting work forces, for the bid submitted? _____ %
8. Have you ever failed to complete any work awarded to you? If so, attach a separate sheet of explanation. Include the name of the Project, the customer, the dates of the work, and the amount of the contract?
9. Have you withdrawn a bid after a University bid opening and/or refused to enter into a contract with the University upon notification of award within the last 3 years? If so, state the Project Name and Number, and the date of bid submission below.
10. Has any officer or partner of your organization ever been an officer or partner of another organization that failed to complete a construction contract? If so, attach a separate sheet of explanation.

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

Name: _____ Title: _____

Name: _____ Title: _____

Name: _____ Title: _____

12. List the construction Projects, and approximate dates, when you performed work similar in Scope to this project.

Project: _____ Owner: _____

Contract Amount: _____ Date Completed: _____

Project: _____ Owner: _____

Contract Amount: _____ Date Completed: _____

Project: _____ Owner: _____

Contract Amount: _____ Date Completed: _____

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

Project: _____ Owner: _____

Contract Amount: _____ Date Completed: _____

Project: _____ Owner: _____

Contract Amount: _____ Date Completed: _____

Project: _____ Owner: _____

Contract Amount: _____ Date Completed: _____

14. Is your Company "bondable"? Yes _____ No _____

15. What is your present bonding capacity? \$ _____

16. Who is your bonding agent?

NAME: _____

ADDRESS: _____

PHONE: (_____) _____

CONTACT: _____

17. Does your company agree to provide financial reports to the University upon request? Failure to agree may result in disqualification of your bid. Yes _____ No _____
18. Does your company agree that all of the Terms and Conditions of this RFP and Vendor's Response Proposal become part of any ensuing agreement? Yes _____ No _____
19. Does your company agree to execute a contract containing the clauses shown in Section 00500 "Agreement Between Contractor and Owner for Construction"? Yes _____ No _____

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

20. Did your company quote based upon **Prevailing Wage Rates**? Yes _____ No _____
21. Does your company agree to comply with the University **Smoke and Tobacco Free Policies**? Yes _____ No _____

Note: Contractors submitting proposals for this project may, at the discretion of the University, be required to submit references including contact information to be used to assist in the post bid evaluation process for the subject project

**ACKNOWLEDGEMENT OF
MINIMUM QUALIFICATIONS:**

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

ACCEPTANCE OF PROPOSAL:

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

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

NAME OF COMPANY: _____

OFFICE ADDRESS: _____

PHONE NUMBER: _____ DATE _____

FAX NUMBER: _____

SIGNED BY: _____
Signature

(Please print or type name here)

TITLE _____

EMAIL ADDRESS: _____ @ _____

PREVAILING WAGE RATE SCHEDULE (revised 4-05-2010)

- A. See also Page 00100-4 Section 12.B
- B. Wayne State University requires all project contractors, including subcontractors, who provide labor on University projects to compensate at a rate no less than prevailing wage rates.
- C. The rates of wages and fringe benefits to be paid to each class of laborers and mechanics by each VENDOR and subcontractor(s) (if any) shall be not less than the wage and fringe benefit rates prevailing in Wayne County, Michigan, as determined by the United States Secretary of Labor. Individually contracted labor commonly referred to as "1099 Workers" and subcontractors using 1099 workers are not acceptable for work related to this project.
- D. To maintain compliance with State of Michigan Ordinances, Certified Payroll must be provided for each of the contractor's or subcontractor's payroll periods for work performed on this project. Certified Payroll should accompany all Pay Applications. Failure to provide certified payroll will constitute breach of contract, and pay applications will be returned unpaid, and remain so until satisfactory supporting documents are provided.

A Prevailing Wage Rate Schedule has been issued from the State of Michigan that is enclosed in this section

Additional information can be found on the University Procurement & Strategic Sourcing's web site at the following URL address:

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

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

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

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

E. Wayne State University's Prevailing Wage Requirements:

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

- A. The contractor shall obtain and keep posted on the work site, in a conspicuous place, a copy of all current prevailing wage and fringe benefit rates.
- B. The contractor shall obtain and keep an accurate record showing the name and occupation of and the actual wages and benefits paid to each laborer and mechanic employed in connection with this contract.
- C. The contractor shall submit a completed certified payroll document [U.S. Department of Labor Form WH 347] verifying and confirming the prevailing wage and benefits rates for all employees and subcontractors for each payroll period for work performed on this project. The contractor shall include copies of pay stubs for all employee or contract labor payments related to Wayne State University work. The certified payroll form can be downloaded from the Department of Labor website at <http://www.dol.gov/whd/forms/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.

APPENDIX A FOR THE STATE PREVAILING WAGE SCHEDULE FOR THIS PROJECT

See web site:
http://www.forms.procurement.wayne.edu/Adv_bid/Adv_bid.html

**APPENDIX A FOR THE
STATE PREVAILING WAGE SCHEDULE FOR THIS PROJECT**

See web site:

http://www.forms.procurement.wayne.edu/Adv_bid/Adv_bid.html

Key Performance Indicator Tracking Sworn Statement Requirements

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

Submission of Bid

1. **Diverse or disadvantaged prime contractor:** Please specify in your bid whether ownership of your company is a certified diverse or disadvantaged business, according to the categories listed previously in section 00300. In accordance with guidelines from the MMSDC and GL-WBC, the University considers a business to be diverse when it is at least 51% owned, operated, and controlled by one or more members of a diverse classification. Section 00300 has a place for this information on page 00300-3.
2. **Detroit based and Michigan Based contractor:** It is presumed that the contractor is headquartered at the location we submit our Purchase Orders to, and that it should be the same address as listed in Section 00300 at the signature line. If a supplier is headquartered elsewhere, please make note of this information, so we do not inaccurately include or exclude spend.

Pay Applications and Sworn Statements

1. **Applicability:** The University requires Sworn Statements with Pay Applications for all construction projects that use
 - Subcontractors greater than \$1,000.00
 - Significant suppliers (those with a purchase value of \$1,000 or more).
2. **Sworn Statements:** The Supplier must submit applicable monthly sworn statements to the Project Manager and the Buyer of Record, in the format shown on page 2 of Section 00420. Sworn Statements are "always required" for this project, and are to be submitted to **Jason R. Davis**, the project manager, and to **Valerie Kreher, Senior Buyer**
3. **Inclusion:** Sworn Statements are to detail the inclusion of recognized diverse and disadvantaged groups in the following 2 categories; Subcontracts or Suppliers. The University recognizes the following groups as diverse or disadvantaged:
 - Minority Business Enterprises (MBE)
 - Women Business Enterprises (WBE)
 - Disabled Veteran Enterprises (DVBE)
 - Disabled Person Enterprises (DBE)
 - Veteran Owned Businesses (VBE)
 - Small Businesses per the US Small Business Administration (SBE)
4. A complete set of the University's Supplier Diversity Program, which includes complete definitions of each of the above, can be downloaded from our web site at <http://policies.wayne.edu/administrative/04-02-supplier-diversity.php>.

STATE OF MICHIGAN				Sworn Statement						
COUNTY OF _____ } §										
_____, being duly sworn, deposes and says that (s)he makes the Sworn Statement on behalf of _____, who is the Contractor for an improvement to the following described real property situated in _____ County, Michigan, and described as follows:										
That the following is a statement of each subcontractor and supplier and laborer, for which laborer the payment of wages or fringe benefits and withholdings is due but unpaid, with whom _____ has subcontracted for performance under the contract with the Owner or lessee thereof, and that the amounts due to the persons as of the date thereof are correctly and fully set forth opposite their names, as follows. (Subcontracts or suppliers of values of less than \$1,000 are omitted.)										
NO.	SUBCONTRACTOR (Name, Address, Telephone Number) SUPPLIER OR LABORER	S=Supplier C=Contractor	Type of Entity *see below	TYPE OF IMPROVEMENT FURNISHED	TOTAL CONTRACT PRICE	CONTRACT CHANGE +/-	ADJUSTED CONTRACT AMOUNT	AMOUNT PAID TO DATE	AMOUNT CURRENTLY OWING	BALANCE TO COMPLETE
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
TOTALS										
* Type of Entity: MBE=Minority Business Enterprises; WBE=Women Business Enterprises; DVBE=Disabled Veteran Enterprises; DBE=Disabled Person Enterprises; VBE=Veteran Owned Businesses; SBE=Small Businesses per the US Small Business Administration Please attach additional sheets if the number of items exceeds the page limit.										

00420 - 3

WAYNE STATE UNIVERSITY
PAYMENT PACKAGE DOCUMENT REQUIREMENTS (Revised 7-23-2015):

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

PAYMENT APPLICATION - AIA document G702 & G703 (or equivalent) –Checklist:

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

SWORN STATEMENT – Checklist:

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

CERTIFIED PAYROLL - Dept. of Labor Form WH-347 – Checklist: (Union and Non-Union)

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

APPLICATION PACKAGE SUPPORTING DOCUMENTATION –

- o Copies of **Pay Stubs** for each Certified Payroll period reported may be required– (Social Security Numbers MUST be blackened out or listed in XXX-XX-1234 format. Pay stubs need to reflect claimed participation of fringes like Medical, Dental, Retirement or 1099 classification.)
- o **Proof of Ownership** for any 'Owner Operator' contractors not wishing to claim their time on prevailing wage. – (Must list their hours and dates worked on the WH-347 Form and enter EXEMPT on the income

brackets.) The Owner must provide copies of "DBA" registration form confirming status as exempt from prevailing wage requirements.

- o **Proof of Stored Materials** – Bill of Lading, Delivery Receipts, Pictures, Certificate of Insurance or endorsement page specifically insuring stored material at location, and pictures with materials clearly separated and labeled for WSU. The University reserves the right to on site verification of stored materials.
- o **Partial Conditional Waivers** – The contractor shall provide covering the entire amount of the application. For non-bonded projects all sub-contractors must provide for all applications which they have a draw.
- o **Partial Unconditional Waivers** – Must release amount paid for work and be delivered starting with application #2 and in no case after payment application #3, through all sequential applications for contractors, sub-contractors, and suppliers listed on the Sworn Statements.
- o **Full Unconditional Waivers** – Must be delivered with final payment application, releasing all contractors, sub-contractors, suppliers listed on the sworn statements and any legitimate notice of furnishings reconciled.

FINAL PAYMENT APPLICATION – Checklist:

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

o

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

Revised 7-23-2015

Contractor Performance Evaluation

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

Contractor Evaluation Sheet												
Contractor Name : _____						Project Name: _____						
Contractor's PM: _____						PM Name: _____						
Superintendent: _____						Project Number: _____			PO#: _____			
Designer: _____												
EVALUATION SCORING: 1 = Unacceptable, 2 = Less than Satisfactory, 3 = Satisfactory or Neutral, 4 = Good, 5 = Excellent Note: Comments are REQUIRED if any score is less than 3. Write comments on the back of the evaluation.												
Field Management						Score			Weight		Total	
1) Work Planning / Schedule:						1	2	3	4	5	8	
2) Compliance with Construction Documents:						1	2	3	4	5	8	
3) Safety Plan & Compliance:						1	2	3	4	5	5	
4) Compliance with WSU procedures:						1	2	3	4	5	7	
5) Effectiveness of Project Supervision:						1	2	3	4	5	8	
6) Project Cleanliness:						1	2	3	4	5	3	
7) Punch List Performance:						1	2	3	4	5	5	
8) Contractor Coordination with WSU Vendors:						1	2	3	4	5	3	
9) Construction Quality:						1	2	3	4	5	8	
Administrative Management												
10) Responsiveness:						1	2	3	4	5	4	
11) Contractor communication:						1	2	3	4	5	4	
12) Contractor Professionalism:						1	2	3	4	5	3	
13) Subcontractor Professionalism:						1	2	3	4	5	3	
14) Compliance with Contract Requirements:						1	2	3	4	5	3	
15) Submittal\RFI Process:						1	2	3	4	5	4	
16) Close-out - Accuracy of Documents						1	2	3	4	5	7	
Invoice and Change Management												
17) Change Management						1	2	3	4	5	7	
18) Applications for Payment						1	2	3	4	5	6	
19) Timely payment of Subs/Suppliers:						1	2	3	4	5	4	
									Total 100		Total	
20) Level of Self-Performance:						Low	Med		High			
21) Would you work with this Contractor again?								Yes		No		
22) Would you work with this team again?								Yes		No		
One year follow up												
23) Warranty Support:						1	2	3	4	5		
Evaluator												
Signature _____						Date: _____						
Title: _____												
Name: _____												
Please Print						Rev. 2-17-2015 RGP						

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

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

Contractors engaged in work are encouraged to maintain an open and regular dialog with the Design and Construction Department over the course of the construction project to ensure that the final evaluation is an accurate representation of the Contractor's performance.

WAYNE STATE UNIVERSITY

AGREEMENT BETWEEN THE UNIVERSITY AND CONTRACTOR FOR CONSTRUCTION SERVICES

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

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

and

CONTRACTOR'S_NAME
CONTRACTOR'S_ADDRESS

regarding

PROJECT_NAME
PROJECT_LOCATION
CONTRACT_NUMBER

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

Article 1 - Scope of Work

- 1.1 This Agreement provides for "(Enter a one or two-sentence description of the project)". The documents listed in Article 4 fully define the scope of work.
- 1.2 The Contractor shall furnish all the labor, materials, equipment, services, and supervision to perform all the work shown on the drawings and specifications listed in Article 18, including any addenda issued during the bid phase, and approved change orders issued during the construction phase.
- 1.3 The Contractor shall notify the University in writing within five (5) calendar days when the Contractor discovers any condition that will affect the contract amount or the completion date.

Article 2 - Time of Completion

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

Article 3 - The Contract Sum

- 3.1 The University shall pay the Contractor a "lump sum/not-to-exceed (pick one)" amount of \$\$\$\$\$\$ ("Amount in words 00" /100 dollars) for the performance of all work associated with the Contractor's Base Bid "and Alternates (List)".
- 3.2 The University may, at its sole discretion, during the life of the contract, award the following alternates at the amounts indicated:
"(If section 3.2 is not used, delete all text and enter _ Deleted"

<u>Description</u>		<u>Amount</u>
Alternate ☐		
Alternate ☐		
Alternate ☐		
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"		
<u>Work Item</u>	<u>Unit Price</u>	
1.		
2.		
3.		

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)"

Architect's/Engineer's Firm Name
Street Number and Street Name
Suite or PO Box
City, State, Zip
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 superceded by this Article.

- 8.2 In any claim or dispute by the Contractor against the University, which cannot be resolved by negotiation, the Contractor shall submit the dispute in writing for an administrative decision by the University's Vice President for Finance and Administration, within 30 days of the end of negotiations. Any decision of the Vice President shall be made within 45 days of receipt from the Contractor and is final unless it is challenged by the Contractor by filing a lawsuit in the Court of Claims of the State of Michigan within one year of the issuance of the decision. The Contractor agrees that appeal to the Vice President is a condition precedent to filing suit in the Michigan Court of Claims.
- 8.3 For purposes of this section, the "end of negotiations" shall be deemed to have occurred when:
- 8.3.1 Either party informs the other that pursuant to this section, negotiations are at an impasse; or
- 8.3.2 The Contractor submits the dispute in writing to the Vice President.
- 8.4 Unless otherwise agreed by the University in writing, and notwithstanding any other rights or obligations of either of the parties under any Contract Documents or Agreement, the Contractor shall continue with the performance of its services and duties during the pendency of any negotiations or proceedings to resolve any claim or dispute, and the University shall continue to make payments in accordance with the Contract Documents; however, the University shall not be required or obligated to make payments on or against any such claims or disputes during the pendency of any proceeding to resolve such claims or disputes.

Article 9 - Termination for Convenience

- 9.1 Upon thirty days written notice to the Contractor, the University may, without cause and without prejudice to any other right or remedy of the University, elect to terminate the contract. In such case, the Contractor shall only be paid (without duplication of any items), using a Close out Change Order, for the following:
- 9.1.1 For completed and acceptable work executed in accordance with the Contract Documents prior to the effective date of termination, including fair and reasonable sums for overhead and profit on such Work;
- 9.1.2 For expenses sustained prior to the effective date of termination in performing services and furnishing labor, materials, or equipment as required by the Contract Documents in connection with uncompleted work, including fair and reasonable sums for overhead and profit on such expenses.
- 9.2 The Contractor shall not be paid on account of loss of anticipated profits or revenue, delay or disruption, or other economic loss arising out of or resulting from such termination. For purposes

of this section, "fair and reasonable sums for overhead and profit" shall be determined by reference to Michigan law, without reference to principles used for such determinations in arbitration.

Article 10 - Progress Payments

- 10.1 On or before the 20th day of each month, the Contractor shall submit a written application for payment, using form AIA G702, to the Architect/Engineer and the University's Project Manager for review. The Architect/Engineer shall have ten (10) calendar days to accept or reject the Contractor's application for payment. Acceptable applications for payment shall then be submitted to the University for Payment of authorized amount(s) within thirty (30) calendar days of receipt by the University's Project Manager.
- 10.2 The application for payment shall contain a full schedule of values organized and sorted by subcontractor, by Construction Specifications Institute standard work categories, or in another format acceptable to the University.
- 10.3 Monthly progress payments shall show the percentage of work installed as of the date of the application, less amount previously installed and the amount due for the application period. The Contractor shall deduct a 10% retainage from the balance due for each progress payment and indicate the net amount due on each application.
- 10.4 When 50% of the work associated with this Agreement is installed, the Contractor shall not deduct additional retainage from the balance due from the University. When substantial completion is achieved and acknowledged by the Architect/Engineer, the Contractor and the University in writing, the University shall remit to the Contractor all but 2% of the retainage. The remaining 2% shall be retained by the University until the final payment is authorized and remitted to the Contractor.

Article 11 - Acceptance and Final Payments

- 11.1 Final payment shall be due thirty (30) days after the completion of the work, including all punch list items, provided the work is fully completed and the Agreement fully performed.
- 11.2 Upon receipt of written notice that the work is ready for final inspection and acceptance, the Architect/Engineer shall promptly inspect the work. When the Architect/Engineer concludes that the work is acceptable and the Agreement to be fully performed, the Architect/Engineer shall promptly issue a final certificate with an original signature, stating that the work provided is complete and acceptable and that the entire remaining balance found to be due the Contractor shall be remitted by the University once the final application for payment is received.
- 11.3 If, after the work has been substantially completed, full completion thereof is materially delayed through no fault of the Contractor, and the Architect/Engineer so certifies, the University shall, upon certificate of the Architect/Engineer, and without terminating the Contract, make payments of the balance due for that portion of the work fully completed and accepted. Such payments shall be made under the terms and conditions governing final payment, except that it shall not constitute a waiver of claims.

Article 12 - Non-Discrimination

- 12.1 The Contractor agrees that it will not discriminate against any employee or applicant for employment, to be employed in the performance of this Agreement, with respect to hire, tenure,

terms, conditions or privileges of employment or any matter directly or indirectly related to employment, because of race, color, religion, sex, age, national origin, or ancestry. Breach of this covenant may be regarded as material breach of this Agreement.

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

Article 13 – Laborers and Mechanics

- 13.1 All laborers and mechanics must be covered by Worker's Compensation and Employer's Liability Insurance as required by Federal and Michigan law. The Contractor shall also require all of its Subcontractors to maintain this insurance coverage.
- 13.2 The Contractor acknowledges and shall abide by the University's prohibition on use of 1099 independent contractors and owner / operator business entities. The Contractor shall ensure that all classifications of laborers and construction mechanics performing Work on the Project job site are employees of the Contractor or any Trade Contractor for any tier thereof, and that each worker is covered by workers compensation insurance

Article 14 - Prevailing Wages

- 14.1 The Contractor and each subcontractor shall pay to each class of mechanics and laborers not less than the wage and fringe benefit rates prevailing in the Detroit Metropolitan Area, as determined by the Michigan Department of Licensing and Regulatory Affairs, Department of Wage and Hour.. The Contractor shall post on site, in a conspicuous place, a copy of all applicable wage and benefit rates, and shall provide the University with a copy of the applicable wage and benefit rates.
- 14.2 The Contractor and each subcontractor shall keep an accurate record showing the name and occupation of and the actual benefits and wages paid to each laborer and mechanic employed in connection with this contract. The Contractor and each subcontractor shall make certified payroll records available to the University's representatives upon request.
- 14.3 If a Contractor or subcontractor fails to pay the prevailing rates of wages and fringe benefits and does not cure such failure within ten (10) days after notice to do so by the University, the University shall have the right, at its option, to do any or all of the following:
- 14.3.1 Withhold all or any portion of payments due the Contractor as may be considered necessary by the University to pay laborers and mechanics the difference between the rates of wages and fringe benefits required by this Agreement and the actual wage and fringe benefits paid.
- 14.3.2 Terminate part or all of this Agreement or any subagreement and proceed to complete the Agreement or subagreement by separate agreement with another Contractor or otherwise, in which case the Contractor and its sureties shall be liable to the University for any excess costs incurred by the University.
- 14.4 The Contractor shall include terms identical or substantially similar to this section in any

Agreement or subagreement pertaining to the project.

Article 15 - Save Harmless

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

Article 16 - Liquidated Damages

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

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

Article 17 - Interpretation

- 17.1 This Agreement shall be interpreted and construed according to the laws of the State of Michigan.
- 17.2 If one part of this Agreement is found to be void by legal or legislative action, the remainder of the contract remains in full effect.

Article 18 - Drawings and Specifications

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

<u>Drawing No.</u>	<u>Description</u>	<u>Dated</u>

IN WITNESS WHEREOF the parties to these presents have hereunto set their hands as of the day and year first written above.

Signed, sealed and delivered
In the presence of:

CONTRACTOR'S NAME GOES HERE

By _____
Signature

Please print name here

Date signed

Title

Witness

**THE BOARD OF GOVERNORS of
WAYNE STATE UNIVERSITY**

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

Date signed

Form Contract Approved by OGC 06/13 - LG
Rev. 5-6-30-2014 formatting only RGP
Rev. 6-1-15-2015 date changes only SS
Rev. 7-7-1-2015 formatting, signatory only RGP

FORM OF GUARANTEE

PROJECT: Harwell Field Building

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:

Harwell Field Building (080-232104)

For: **Board of Governors, Wayne State University**

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

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

WITNESS:

signed: _____
Subcontractor

by: _____

address: _____

city/state/zip: _____

signed: _____
General Contractor

by: _____

(THIS FORM TO BE FILED IN DUPLICATE.)

GENERAL CONDITIONS (Revised 10-2009)

- A. Although AIA Document A201 - Twelfth Edition (April 1970) - "General Conditions of the Contract for Construction" is not bound herein, it forms a part of these construction documents.
- B. A reference copy of AIA Document A201 - Twelfth Edition (April 1970) - "General Conditions of the Contract for Construction" is on file at the following location:

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

SUPPLEMENTARY GENERAL CONDITIONS
OF
THE CONTRACT FOR CONSTRUCTION

Facilities Planning & Management - Design & Construction Services
Wayne State University

WSU SUPPLEMENTARY GENERAL CONDITIONS
OF THE
CONTRACT FOR CONSTRUCTION

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

ARTICLE 1 - CONTRACT DOCUMENTS

1.1 DEFINITIONS

1.1.5 The Agreement

The Agreement executed by the Contractor and the Owner.

1.2 EXECUTION, CORRELATION, INTENT, AND INTERPRETATIONS

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

1.2.7 Precedence of Drawings and Specifications.
The Agreement has precedence over WSU Supplementary General Conditions.

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

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

ARTICLE 2 - ARCHITECT

2.1 DEFINITION

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

2.2 ADMINISTRATION OF THE CONTRACT

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

- a. Explain Contract Documents: Assist the Contractor via the Contractor's Superintendent to understand the intent of the Contract Documents.
- b. Observations: Conduct on-site observations and spot checks of the work in progress as a basis for determining conformance of the work, material, and equipment with the Contract Documents.
- c. Additional Information: Obtain from the Architect, additional details or information, if and when required, at the job site for proper execution of the work.
- d. Modifications: Consider and evaluate suggestions or modifications that may be submitted by the Contractor and report them with recommendations to the Architect for final decision.
- e. Construction Schedule and Completion: Be alert to the completion, and report same to the Architect. When the construction work has been completed in accordance with the Contract

Documents, advise the Architect that the work is ready for general inspection and acceptance.

- f. Job Conferences: Attend and report to the Architect on all required conferences held at the job site.
- g. Observe Tests: See that tests which are required by the Contract Documents are actually conducted; observe, record and report to the Architect all details relative to the test procedures; and advise the architect's office in advance of the schedules of tests.
- h. Inspection by Others: If inspectors, representing local, state or federal agencies having jurisdiction over the project, visit the job site, accompany such inspectors during their trips through the project, record the outcome of these inspections, and report same to the Architect's office.
- i. Shop Drawings: Do not permit the installation of any materials and equipment for which shop drawings are required unless such drawings have been duly approved and issued by the Architect.
- j. Contractor's Requisitions for Payment: Review and make recommendations to the Architect for disposition.
- k. List of Items for Correction: After substantial completion, make a list of items for correction before final inspection and check each item as it is corrected.
- l. Owner's Occupancy of the Building: If the Owner occupies (to any degree) the building prior to actual completion of the work by the Contractor, be especially alert to possibilities of claims for damage to completed work prior to the acceptance of the building.
- m. Owner Existing Operation: In the case of additions to or Demolitions of an existing facility, which must be maintained as an operational unit, be alert to conditions on the job site which may have an effect on the Owner's existing operation.
- n. Limitations of Authority: Do not become involved in any of the following areas of responsibility unless specific exceptions are established by written instructions issued by the Architect.
 - aa. Do not authorize deviations from the Contract Documents.
 - bb. Avoid conducting any test personally.
 - cc. Do not enter into the area of responsibility of the Contractor's field superintendent.
 - dd. Do not expedite job for Contractor unless so instructed by the Architect.
 - ee. Do not advise on or issue directions relative to any aspect of the building technique or sequence unless a specific technique or sequence is called for in the Specifications or by written instructions from the Architect.
 - ff. Do not approve shop drawings or samples.
 - gg. Do not authorize or advise the Owner to occupy the Project, in whole or in part, prior to the final acceptance of the building.
 - hh. Do not issue a Certificate for Payment.

ARTICLE 3 - OWNER

3.5 OWNER'S RIGHT TO DO WORK

- 3.5.1 The Owner may exercise his right, which is hereby acknowledged by the Contractor, to let independent of the Contract for the work herein specified, any other work on the premises even if of like character and trades, and the Owner shall not be liable for any damage, loss or expense incurred by the Contractor through the fault of any other Contractor so employed by the Owner. The Contractor acknowledges the

necessity of work by others, to be performed at approximately the same time as the work hereunder, and agrees to perform his work in full cooperation with the work of such other trades and/or Contractors, partially or entirely completed, by such other trades and/or Contractors, or by the Owner, when, in the opinion of the Architect, such access or use is necessary for the performance and completion of any portion or all of the work of others or of any work on the site.

3.6 OWNER'S ACCESS AND PARTIAL OCCUPANCY

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

- a. Such occupancy shall not constitute an acceptance of work not performed in accordance with the Contract nor shall such occupancy relieve the Contractor of liability to perform any work by the Contract by not complete at the time of occupancy.
- b. Except as otherwise provided by an agreement at the time of such partial occupancy, the Contractor shall be relieved of all maintenance costs on units or parts so occupied.
- c. The Contractor shall not be responsible for wear and tear or damage resulting from partial occupancy.
- d. The Owner shall assume risk of loss with respect to any unit or part so occupied.
- e. The Contractor shall, if required by the Owner, furnish heat, light, water, or other such services to the units or parts occupied and the Owner shall make proper remuneration therefore to the Contractor.

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

ARTICLE 4 - CONTRACTOR

4.4 LABOR AND MATERIALS

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

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

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

4.6 TAXES

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

4.7 PERMITS, FEES AND NOTICES

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

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

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

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

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

4.9 SUPERINTENDENT

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

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

4.12 DRAWINGS AND SPECIFICATIONS AT THE SITE

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

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

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

4.13 SHOP DRAWINGS AND SAMPLES

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

The "Informational Package" shall include:

1. One (1) set of transparency (sepia) of the approved shop drawings and descriptive material submitted during construction. Any shop documents unobtainable in sepia shall be supplied in three (3) sets.
2. One (1) set of transparency (sepia) of constructional shop drawings with all installation revisions incorporated to reflect the as-built condition. Examples of constructional shop drawings are dimensioned conduit, piping and ductwork layout drawings.
3. Three (3) sets of instructional manuals on the installation, operation, maintenance and service of equipment and systems, including parts lists.

Examples of Specific Information Required:

1. Electrical
 - a. Conduit layout of light, power, and special systems, indicating dimensionally the locations and size of runs; circuit grouping and conductor size and number in conduit runs.
 - b. System description and elementary diagrams, connection and interconnection diagrams, and device internal diagrams.
2. Mechanical
 - a. Piping and ductwork layout indicating dimensionally the location and size of the runs.
 - b. Description and diagrams of control systems.

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

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

ARTICLE 5 - SUBCONTRACTORS

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

5.2.3 Delete Article 5.2.3 in its entirety.

5.2.4 Delete Article 5.2.4 in its entirety.

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

7.5 PERFORMANCE BOND AND LABOR AND MATERIAL PAYMENT BOND

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

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

- (1) A Labor and Material Payment bond for 100% of the contract award amount to the Board of Governors of Wayne State University, and guaranteeing the payment of all subcontractors and all

indebtedness incurred for labor, materials, or any cause whatsoever on account of the Contractor in accordance with the laws of the State of Michigan relating to such bonds.

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

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

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

7.7 ROYALTIES AND PATENTS

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

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

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

7.9 INTEREST

- 7.9.1 Delete Article 7.9 in its entirety.

ARTICLE 8 - TIME

8.1 DEFINITIONS

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

8.3.5 LIQUIDATED DAMAGES

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

ARTICLE 9 - PAYMENT AND COMPLETION

9.3 PROGRESS PAYMENTS

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

amount as approved by the Architect shall be due and payable to the Contractor on or about the 15th day of the succeeding month.

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

9.6 FAILURE OF PAYMENT

9.6.1 Delete Article 9.6 in its entirety.

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

11.1 CONTRACTOR'S LIABILITY INSURANCE

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

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

A. General Requirements

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

B. Maximum Acceptable Deductibles

<u>Type of Insurance</u>	<u>Maximum Deductible</u>
Comprehensive General Liability	\$5,000
Fire Legal Liability	\$5,000
Comprehensive Automobile Liability	-0-
Workers' Compensation	-0-
Property - All Risk	\$ 500

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

11.1.3.1 The Contractor shall 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 WORK12.1 **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 CONTRACT14.1 **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.

DRAWINGS

The Technical Specifications dated **May 19, 2016** and the following List of Drawings represent the scope of work as defined in the Contract Documents from Article 4.

DRAWINGS

Drawing No.:	Description
A.00	Title Sheet – Index
C101	Demolition Plan
C102	Utility Plan
C103	Grading and Layout Plan
L.01	Site Plan
A.01	Mounting Heights, Clearances
A.02	Code Data
A.03	Schedules
A.11	Plan
A.12	High Bay Plan
A.13	Reflected Ceiling Plan
A.14	Roof Plan, Section
A.21	Exterior Elevations
A.22	Interior Elevations
A.31	Wall Sections
A.32	Wall Sections, Details
A.34	Details
S101	Foundation Plan
S102	Roof Framing Plan
S201	General Notes
S202	Special Inspection Notes
S203	Typical Details
S301	Details and Sections
M0.1	Mechanical Standards and Drawing Index
M2.0	Underground Plumbing Plan
M2.1	Plumbing Plan
M4.1	Sheet Metal Plan
M6.1	Mechanical Details
M6.2	Mechanical Details
M7.1	Mechanical Schedules
M7.2	Mechanical Schedules
M7.3	Mechanical Schedules
M8.1	Temperature Control Standards
M8.2	Temperature Controls
M8.3	Temperature Controls
E0.1	Electrical Standards and Drawing Index
E0.2	Electrical Standard Schedules
E0.3	Electrical Site Plan
E0.4	Fiber Routing Site Plan
E2.1	Lighting Plan
E3.1	Power Auxiliary Systems Plan
E5.1	One Line Diagram
E7.1	Electrical Details
E7.2	Electrical Details
SC-F1	Security Floor Plan
SC-R1	Security Riser Detail
1	Overall Survey

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.

Include Test-Adjust-Balance Report in the Manual.

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

SUMMARY OF WORK

PROJECT: Harwell Field Building

WSU PROJECT NO.: 080-232104

PROJECT MANAGER: Jason Davis

1. EXAMINATION

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

- 2. Description of Work – Harwell Field will provide physical structure and utility relocation. Grandstands and press box not included in this scope. The foyer will house some of Harwell's baseball artifacts and memorabilia he collected over his distinguished career. The outer façade of the field will mirror Ebbets Field, where Harwell once worked calling games for the Brooklyn Dodgers. The new construction will be located adjacent to Brooklyn Street..**

- 3. The building is located at**

Wayne State University
Detroit, Michigan 48202

WAYNE STATE UNIVERSITY

Harwell Field Building
WSU Project No. 080-232104
May 19, 2016

Harwell Field Building

080-232104

Project Manual

General Requirements and Specifications



Wayne State University
Facilities Planning and Management
5454 Cass Avenue
Detroit, Michigan 48209

BIDS 04-29-16

Division 1 - General Requirements

010100 Summary of Work

013300 Submittal Procedures

017000 Execution Requirements

017700 Closeout Procedures

Division 3 – Concrete

033000 Cast in Place Concrete

033600 Integrally Colored Concrete

Division 4 – Masonry

042000 Unit Masonry

044300 Stone Masonry

Division 5 – Metals

051200 Structural Steel Framing

053100 Steel Decking

054000 Cold-Formed Metal Framing

055200 Metal Railings

Division 6 – Wood, Plastics and Composites

066110 Solid Surfacing

Division 7 – Thermal and Moisture Protection

071113 Bituminous Dampproofing

072100 Thermal Insulation

075000 TPO Membrane Roofing

076200 Sheet Metal Flashing and Trim

077100 Roof Specialties

077200 Roof Accessories

078413 Penetration Firestopping

079200 Joint Sealants

Division 8 – Openings

081113 Hollow Metal Doors and Frames

081416 Flush Wood Doors

084113 Aluminum Framed Entrances

085113 Aluminum Windows

087100 Door Hardware

088000 Glazing

Division 9 – Finishes

092900 Gypsum Board

093000 Tiling

095123 Acoustical Tile Ceilings

096513 Resilient Base and Accessories

099100 Painting

Division 10 – Specialties

101400 Signage

102800 Toilet and Custodial Accessories

107313 Awnings

Division 20 – Common Mechanical Requirements

200500 Mechanical General Requirements

200510 Basic Mechanical Materials and Methods

200529 Hangers and Supports

200553 Mechanical Identification

200700 Mechanical Insulation

Division 22 – Plumbing

- 220523 General Duty Valves for Plumbing
- 221113 Water Main
- 221116 Domestic Water Piping
- 221119 Domestic Water Piping Specialties
- 221313 Sanitary Sewers
- 221316 Sanitary Waste and Vent Piping
- 221319 Drainage Piping Specialties
- 221413 Storm Drainage Piping
- 223410 Condensing Fuel-Fired Domestic Water Heaters
- 224200 Plumbing Fixtures
- 224700 Drinking Fountains and Water Coolers

Division 23 – Heating Ventilation and Air Conditioning

- 230500 Common Work Results for HVAC
- 230593 Testing Adjusting and Balancing
- 230933 Temperature Controls
- 231123 Fuel Gas Piping
- 233113 Metal Ducts
- 233300 Duct Accessories
- 233423 Power Ventilators
- 233713 Diffusers Registers and Grilles
- 238120 Unitary Rooftop Air Conditioners
- 238244 Centrifugal Fan Cabinet Unit Heaters (Electric)

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
- 260533 Electrical Identification
- 260573 Overcurrent Device Coordination Study/Arc Flash Hazard analysis
- 260923 Lighting Control Devices
- 260999 Electrical Testing
- 262200 Dry-Type Transformers
- 262413 Switchboards
- 262416 Panelboards
- 262726 Wiring Devices
- 262816 Enclosed Switches and Circuit Breakers
- 262913 Enclosed Controllers
- 264313 Surge Protective Devices
- 265919 LED Interior Lighting
- 265100 Lighting Fixture Product Sheets

Division 27 – Communications

- 270010 Telecommunicatios General Requirements
- 270110 Telecommunications Interior Pathways
- 270130 Communications Equipment Spaces Support Hardware
- 270150 Telecommunications Cabling
- 270170 Cable Plant Administration and Testing

Division 28 – Electronic Safety and Security

281000 Electronic Access Control and Intrusion Detection

282300 Video Surveillance System

283100 Fire Alarm

Division 31 – Earthwork

311000 Site Clearing

311012 Fine Grading

311018 Soil erosion Control

311200 Earth Moving

Division 32 – Exterior Improvements

321313 Cement Concrete Pavements, Curbs and Gutters

321373 Concrete Paving Joint Sealants

329200 Turf and Grasses

329220 Topsoil

329400 Landscape Maintenance and Warranty Standards

Division 33 – Utilities

334100 Storm Sewers – Underdrainage – Drainage System

SECTION 010100 - SUMMARY

PART 1 - GENERAL

1.1 PROJECT INFORMATION

- A. Project: Harwell Field Building
 - 1. Project Location: Athletics Campus, Wayne State University
WSU Project Number: 080-232104
- B. Owner:
Wayne state University
Facilities Planning and Management
5454 Cass Avenue
Detroit, Michigan 48209
- C. Architect:
Silveri Architects
650 Livernois
Ferndale, Michigan 48220
silveri@silveri.com
- D. Structural Engineer:
JCA Engineering
Plymouth, Michigan
- E. Mechanical and Electrical Engineer:
Peter Basso Associates
Troy, Michigan
- F. Civil Engineer:
Spallding DeDecker Associates
Detroit, Michigan
- G. Security Consultant;
Electronic Security Systems
Warren, Michigan

1.2 WORK RESTRICTIONS

- A. Contractor's Use of Premises: During construction, Contractor will have full use of site. Contractor's use of premises is limited only by Owner's right to perform work or employ other contractors on portions of Project:

1.3 DRAWINGS

ISSUED: BIDS 04-29-16

A.00	TITLE SHEET, INDEX
C101	DEMOLITION PLAN
C102	UTILITY PLAN
C103	GRADING AND LAYOUT PLAN
L.01	SITE PLAN
A.01	MOUNTING HEIGHTS AND CLEARANCES
A.02	CODE DATA
A.03	SCHEDULES
A.11	PLAN
A.12	HIGH BAY PLAN
A.13	REFLECTED CEILING PLAN
A.14	ROOF PLAN, SECTION
A.21	EXTERIOR ELEVATIONS
A.22	INTERIOR ELEVATIONS
A.31	WALL SECTIONS
A.32	WALL SECTIONS, DETAILS
A.33	WALL DETAILS
A.34	DETAILS
S101	FOUNDATION PLAN
S102	ROOF FRAMING PLAN
S201	GENERAL NOTES
S202	SPECIAL INSPECTION NOTES
S203	TYPICAL DETAILS
S301	DETAILS AND SECTIONS
M0.1	MECHANICAL STANDARDS AND DRAWING INDEX
M2.0	UNDERGROUND PLUMBING PLAN
M2.1	PLUMBING PLAN
M4.1	SHEET METAL PLAN
M6.1	MECHANICAL DETAILS
M6.2	MECHANICAL DETAILS
M7.1	MECHANICAL SCHEDULES
M7.2	MECHANICAL SCHEDULES
M7.3	MECHANICAL SCHEDULES
M8.1	TEMPERATURE CONTROL STANDARDS
M8.2	TEMPERATURE CONTROLS
M8.3	TEMPERATURE CONTROLS
E0.1	ELECTRICAL STANDARDS AND DRAWING INDEX
E0.2	ELECTRICAL STANDARDS SCHEDULES
E0.3	ELECTRICAL SITE PLAN
E2.1	LIGHTING PLAN
E3.1	POWER AUXILIARY SYSTEMS PLAN
E5.1	ONE LINE DIAGRAM
E7.1	ELECTRICAL DETAILS

Harwell Field Building
Wayne State University
080-232104

Silveri Architects
BIDS 04-29-16

E7.2	ELECTRICAL DETAILS
SC-F1	SECURITY FLOOR PLAN
SC-R1	SECURITY RISER DETAIL
1	SURVEY
R.01	SITE INFRASTRUCUTRE PATHWAY
B.01	FUTURE SEATING LAYOUT
B.02	FUTURE SEATING LAYOUT

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 001010

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other miscellaneous submittals.

1.2 DEFINITIONS

- A. Action Submittals: Written and graphic information that requires Architect's responsive action.
- B. Informational Submittals: Written information that does not require Architect's approval. Submittals may be rejected for not complying with requirements.

1.3 SUBMITTAL PROCEDURES

- A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
- B. Processing Time: Allow enough time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Architect's receipt of submittal.
 - 1. Initial Review: Allow 10 days for initial review of each submittal.
 - 2. If intermediate submittal is necessary, process it in same manner as initial submittal.
 - 3. Allow 5 days for processing each resubmittal.
 - 4. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing.
- C. Deviations: Highlight, encircle, or otherwise identify deviations from the Contract Documents on submittals.
- D. Transmittal: Package each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. Architect will return submittals, without review received from sources other than Contractor.
- E. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- F. Use for Construction: Use only final submittals with mark indicating action taken by Architect in connection with construction.

PART 2 - PRODUCTS

2.1 ACTION SUBMITTALS

- A. General: Prepare and submit Action Submittals required by individual Specification Sections.
 - 1. Submit PDF of each submittal, unless otherwise indicated. Architect will return submittals in PDF format.
- B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
- C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale.
- D. Samples: Prepare physical units of materials or products, including the following:
 - 1. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
 - 2. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from the same material to be used for the Work, cured and finished in manner specified, and physically identical with the product proposed for use, and that show full range of color and texture variations expected.
 - a. Submit three sets of Samples. Architect will retain two Sample sets; remainder will be returned.
- E. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design.

2.2 INFORMATIONAL SUBMITTALS

- A. General: Prepare and submit Informational Submittals required by other Specification Sections.
 - 1. Number of Copies: Submit two PDF copies of each submittal.

PART 3 - EXECUTION

3.1 CONTRACTOR'S REVIEW

- A. Review each submittal and check for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Architect.

3.2 ARCHITECT'S ACTION

- A. General: Architect will not review submittals that do not bear Contractor's approval stamp and will return them without action.
- B. Action Submittals: Architect will review each submittal, make marks to indicate corrections or modifications required, and return it. Architect will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken as follows:
 - 1. Final Unrestricted Release: When the Architect or his designated reviewer marks a submittal "APPROVED," the Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents. Final payment depends on that compliance.
 - 2. Final-But-Restricted Release: When the Architect or his designated reviewer marks a submittal "NOTE MARKINGS," the Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents. Final payment depends on that compliance.
 - 3. Final-But-Restricted Release Requiring Resubmittal: When the Architect or his designated reviewer marks a submittal "RESUBMIT," the Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents. Final payment depends on that compliance. Revise or prepare a new submittal according to the notations; resubmit for record purposes without delay. Generally used in conjunction with "NOTE MARKINGS".
 - 4. Returned for Resubmittal: When the Architect or his designated reviewer marks a submittal "REJECTED," do not proceed with Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal according to the notations; resubmit without delay. Repeat if necessary to obtain different action mark.
 - a. Do not use, or allow others to use submittals marked "Not Approved, Revise and Resubmit" at the Project Site or elsewhere where Work is in progress.
- C. Informational Submittals: Architect will review each submittal and will not return it, or will reject and return it if it does not comply with requirements. Architect will forward each submittal to appropriate party.
- D. Submittals not required by the Contract Documents will not be reviewed and may be discarded.

END OF SECTION 013300

SECTION 017000 - EXECUTION REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:
 - 1. General installation of products
 - 2. Progress cleaning.
 - 3. Starting and adjusting.
 - 4. Protection of installed construction.
 - 5. Correction of the Work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Existing Conditions: The existence and location of site improvements, utilities, and other construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the Work.
 - 1. Before construction, verify the location and points of connection of utility services.
- B. Existing Utilities: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities and other construction affecting the Work.
- C. Acceptance of Conditions: Examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
 - 1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
 - 2. Examine roughing-in for electrical systems to verify actual locations of connections before equipment and fixture installation.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect. Include a

detailed description of problem encountered, together with recommendations for changing the Contract Documents. Submit requests on AIA Form "Request for Information."

3.3 INSTALLATION

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
 - 1. Make vertical work plumb and make horizontal work level.
 - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
- B. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- C. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- D. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
 - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
 - 2. Allow for substrate movement, including thermal expansion and contraction.
- E. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

3.4 CORRECTION OF THE WORK

- A. Repair or remove and replace defective construction. Restore damaged substrates and finishes.
 - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.

END OF SECTION 017000

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
 - 1. Inspection procedures.
 - 2. Final cleaning.

1.2 SUBSTANTIAL COMPLETION

- A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.
 - 1. Prepare a list of items to be completed and corrected (punch list).
 - 2. Terminate and remove temporary facilities from Project site, along with construction tools, and similar elements.
 - 3. Complete final cleaning requirements.
 - 4. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

1.3 FINAL COMPLETION

- A. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
 - 1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.4 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

- A. Preparation: Submit PDF of list. Include name and identification of each area affected by construction operations for incomplete items and items needing correction. Use standard CSI Form .

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

PART 3 - EXECUTION

3.1 FINAL CLEANING

- A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
 - 1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
 - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
 - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
 - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
 - e. Leave Project clean and ready for occupancy.
- C. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

END OF SECTION 017700

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: concrete mix designs and submittals required by ACI 301.
- B. Ready-Mixed Concrete Producer Qualifications: ASTM C 94/C 94M.
- C. Comply with ACI 301, "Specification for Structural Concrete"; ACI 117, "Specifications for Tolerances for Concrete Construction and Materials"; and CRSI's "Manual of Standard Practice."

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Plain Steel Wire: ASTM A 82, as drawn.
- C. Plain-Steel Welded Wire Reinforcement: ASTM A 185, as drawn, flat sheet.
- D. Deformed-Steel Welded Wire Reinforcement: ASTM A 497, flat sheet.
- E. Portland Cement: ASTM C 150, Type I or II.
- F. Fly Ash: ASTM C 618, Type C or F.
- G. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- H. Silica Fume: ASTM C 1240, amorphous silica.
- I. Aggregates: ASTM C 33, uniformly graded.
 - 1. Maximum Aggregate Size for Concrete in Insulating Concrete Forms: 3/4 inch.
- J. Air-Entraining Admixture: ASTM C 260.
- K. Chemical Admixtures: ASTM C 494, water reducing. Do not use calcium chloride or admixtures containing calcium chloride.

- L. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures.
- M. Vapor Retarder: Reinforced sheet, ASTM E 1745, Class A.
- N. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork.
- O. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- P. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.
- Q. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.
- R. Clear, Waterborne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

2.2 MIXES

- A. Comply with ACI 301 requirements for concrete mixtures.
- B. Normal-Weight Concrete: Prepare design mixes, proportioned according to ACI 301, as follows:
 - 1. Minimum Compressive Strength: See design drawings
 - 2. Maximum Water-Cementitious Materials Ratio: 0.45.
 - 3. Slump Limit: 3 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
 - 4. Air Content: Maintain within range permitted by ACI 301. Do not allow air content of floor slabs to receive troweled finishes to exceed 3 percent.
 - 5. Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
 - 6. For concrete exposed to deicing chemicals, limit use of fly ash to 25 percent replacement of portland cement by weight and granulated blast-furnace slag to 40 percent of portland cement by weight; silica fume to 10 percent of portland cement by weight.
- C. Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116.
 - 1. When air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 CONCRETING

- A. Construct formwork according to ACI 301 and maintain tolerances and surface irregularities within ACI 347R limits of Class A, 1/8 inch for concrete exposed to view and Class C, 1/2 inch for other concrete surfaces.
- B. Place vapor retarder on prepared subgrade, with joints lapped 6 inches and sealed.
- C. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- D. Install construction, isolation, and contraction joints where indicated. Install full-depth joint-filler strips at isolation joints.
- E. Place concrete in a continuous operation and consolidate using mechanical vibrating equipment.
- F. Protect concrete from physical damage, premature drying, and reduced strength due to hot or cold weather during mixing, placing, and curing.
- G. Formed Surface Finish: Smooth-formed finish for concrete exposed to view, coated, or covered by waterproofing or other direct-applied material; rough-formed finish elsewhere.
- H. Slab Finishes: Comply with ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces. Provide the following finishes:
 - 1. Scratch finish for surfaces to receive mortar setting beds.
 - 2. Float finish for interior steps and ramps and surfaces to receive waterproofing, roofing, or other direct-applied material.
 - 3. Troweled finish for floor surfaces and floors to receive floor coverings, paint, or other thin film-finish coatings.
 - 4. Trowel and fine-broom finish for surfaces to receive thin-set tile.
 - 5. Nonslip-broom finish to exterior concrete platforms, steps, and ramps.
- I. Cure formed surfaces by moist curing for at least seven days.
- J. Begin curing concrete slabs after finishing. Keep concrete continuously moist for at least seven days
- K. Owner will engage a testing agency to perform field tests and to submit test reports.
- L. Protect concrete from damage. Repair surface defects in formed concrete and slabs.

END OF SECTION 033000

SECTION 033600

INTEGRALLY COLORED CONCRETE

PART 1 – GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Integrally colored concrete interior floor slabs.
 - 2. Curing of integrally colored concrete.
- B. Related Sections:
 - 1. Division 7 Section "Joint Sealants" for colored sealant for joints.

1.2 REFERENCES

- A. American Concrete Institute (ACI):
 - 1. ACI 301 "Specification for Structural Concrete for Buildings."
 - 2. ACI 302 IR "Recommended Practice for Concrete Floor and Slab Construction."
 - 3. ACI 303.1 "Standard Specification for Cast-In-Place Architectural Concrete."
 - 4. ACI 304 "Recommended Practice for Measuring, Mixing, Transporting and Placing of Concrete."
 - 5. ACI 305R "Recommended Practice for Hot Weather Concreting."
 - 6. ACI 306R "Recommended Practice for Cold Weather Concreting."
- B. American Society for Testing and Materials (ASTM):
 - 1. ASTM C309 "Liquid Membrane-Forming Compounds for Curing Concrete."
 - 2. ASTM C494 "Standard Specification for Chemical Admixtures for Concrete."
 - 3. ASTM C979 "Standard Specification for Pigments for Integrally Colored Concrete."
- C. American Association of State Highway and Transportation Officials (AASHTO):
 - 1. AASHTO M194 "Chemical Admixtures."

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's complete technical data sheets for the following:

1. Colored admixture.
2. Curing compound.
3. Liquid Lithium Silicate Densifiers
4. Concrete Guard
5. Floor Protection

- B. Design Mixes: For each type of integrally colored concrete.
- C. Samples for Initial Selection: Manufacturer's color charts showing full range of colors available.
- D. Qualification Data: For firms indicated in "Quality Assurance" Article, including list of completed projects.
- E. Applicators qualification data.
- F. Polished concrete samples 8x8 for each Polished Concrete finish required.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer with 10-years experience in the production of specified products.
- B. Installer Qualifications: An installer with five years experience with work of similar scope and quality.
- C. Comply with the requirements of ACI 301.
- D. Obtain each specified material from same source and maintain high degree of consistency in workmanship throughout Project.
- E. Provide project names, addresses, contact names, phone numbers of at least three projects of similar scope completed by the installer.
- F. Installer/Applicator shall be certified by concrete finish equipment and chemical manufacturer and shall provide adequate number of skilled workmen who are thoroughly trained and experienced in the necessary craft.
- G. Manufacturer's Certification: Provide a letter of certification from both the equipment and chemical manufacturer stating that the installer is a certified applicator and is familiar with proper procedures and installation requirements recommended by the manufacturer.

H. Integrally Colored Ground and Polished Concrete Field Sample:

1. At location on Project selected by Architect, place and finish 8 feet by 8 feet area.
3. For accurate color, the quantity of concrete mixed to produce the sample should not be less than 3 cubic yards and should always be in full cubic yard increments. Excess material shall be discarded according to local regulations.
4. Construct field sample using processes and techniques intended for use on permanent work, including curing procedures. Include samples of control, and expansion joints in sample panels. Field sample shall be produced by the individual workers who will perform the work for the Project.
5. Retain samples of cements, sands, aggregates and color additives used in mockup for comparison with materials used in remaining work.
6. Aggregate selected must be tested to ensure it will accept polish.
7. Select from Part 4 – Schedules cut and shine level and finish coat.
9. Accepted field sample provides visual standard for work of Section.
10. Remove field sample when directed.

I. Environmental Limitations:

1. Comply with manufacturer's written instructions for substrate temperature and moisture content, ambient temperature and humidity, ventilation and other conditions affecting chemical performance.
2. Flatness and levelness
 - a. Finish concrete shall have a minimum Floor Flatness rating of at least 40.
 - b. Finish concrete shall have a minimum Floor Levelness rating of at least 30.
 - c. Finish concrete shall be cured a minimum of 28 days or at which point equipment can be put on the slab and does not displace aggregate.
3. Application of finish system shall take place a minimum of 21 days prior to fixture and trim installation and/or substantial completion.
4. Finish concrete area shall be closed to traffic during finish floor application and after application for the time as recommended by the manufacturer.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Colored Admixture: Comply with manufacturer's instructions. Deliver colored admixtures in original, unopened packaging. Store in dry conditions.

1.6 PROJECT CONDITIONS

- A. Integrally Colored Concrete Environmental Requirements:

1. Schedule placement to minimize exposure to wind and hot sun before curing materials are applied.
 2. Avoid placing concrete if rain, snow, or frost is forecast within 24-hours. Protect fresh concrete from moisture and freezing.
 3. Comply with professional practices described in ACI 305R and ACI 306R.
- B. Schedule delivery of concrete to provide consistent mix times from batching until discharge. Mix times shall meet manufacturer's written recommendations.

1.7 PRE-JOB CONFERENCE

- A. One week prior to placement of integrally colored concrete a meeting will be held to discuss the Project and application materials.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

- A. L.M. SCOFIELD COMPANY, Douglasville, Georgia and Los Angeles, California (800) 800-9900 or the appropriate local contact: Eastern Division – 201-672-9050; Western Division – 323-720-3055; Central Division Office – 630-377-5959.

2.2 MATERIALS

- A. Colored Admixture for Integrally Colored Concrete: CHROMIX P[®] Admixture and CHROMIX ML[®]; L.M. SCOFIELD COMPANY.
1. Admixture shall be a colored, water-reducing, admixture containing no calcium chloride with coloring agents that are limeproof and ultra-violet resistant.
 2. Colored admixture shall conform to the requirements of ACI 303.1, ASTM C979, ASTM C494 and ASSHTO M194.
- B. Chemical Hardener/Densifiers Manufactured by L.M. SCOFIELD COMPANY:
1. Materials:
 - a. SCOFIELD[®] Formula One™-LD is a high performing hardening and dust proofing compound that is chemically reactive and permanently bonds to concrete formulated to be used in conjunction with integrally colored concrete. (No substitutes)
 - b. SCOFIELD[®] Guard-W

2. 3 head or 4 head counter rotating variable speed floor grinding machine with at least 600 pounds down pressure.
 3. Dust extraction system, pre-separator, and squeegee attachments with minimum flow rating of 322 cubic feet per minute.
 4. Grinding heads:
 - a. Metal bonded 16, 25, 40, 60, 80, 150 and 300 grits.
 - b. Resin bonded, phenolic diamonds, 100, 200, 400, 800, 1500 and 3000 grits.
 5. Grinding pads for edges:
 - a. 40, 60, 100 and 120 grits.
 - b. 200, 400, 800, 1500 and 3000 grits.
 6. Hand grinder with dust extraction equipment and pads.
- C. Curing Compound for Polished, Hardened Concrete: LITHOCHROME® COLORWAX™; L.M. SCOFIELD COMPANY. Use to cure in the same color as the concrete directly after finishing process.

2.3 COLORS

- A. Concrete Color: Provide cement, sand, aggregate and colored admixture as required to match Architect's sample. Scofield Sun Baked Clay
- B. Curing Compound: Colorwax tinted with Sunbaked Clay

2.4 CONCRETE MIX DESIGN

- A. Minimum Cement Content: 5 sacks per cubic yard of concrete.
- B. Slump of concrete shall be consistent throughout Project at 4-inches or less. At no time shall slump exceed 5-inches.
- C. Do not add calcium chloride to mix as it causes mottling and surface discoloration.
- D. Supplemental admixtures shall not be used unless approved by manufacturer.
- E. Do not add water to the mix in the field.
- F. Add colored admixture to concrete mix according to manufacturer's written instructions.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install concrete according to requirements of Division 3 Section "Cast-In-Place Concrete."
- B. Do not add water to concrete mix in the field.
- C. Surfaces shall be finished uniformly with the following finish:
 - 2. Ground and Polished Concrete Surface: Precautions should be taken to insure the surface is in tolerances to perform this function.
- D. Protect floor with Scofield "Duracover" 72 hours after applying Colorwax curing compound. Remove for grinding process and then use to protect floor during move in process.

3.1.1 POLISHED CONCRETE APPLICATION

- A. Applicator shall examine the areas and conditions under which work of this section will be provided and the General Contractor shall correct conditions detrimental to the timely and proper completion of the work and the Applicator shall not proceed until unsatisfactory conditions are resolved.
- B. Grind the concrete floor to within 2 – 3 inches of walls with 16, 25, 40, 60, 80 and/or 150 grit removing construction debris, floor slab imperfections and until there is a uniform scratch pattern and desired concrete aggregate exposure.
- C. Apply material approved by architect for color effects in accordance with the architectural drawings and the manufacturer's recommended guidelines.
- D. Fill construction joints and cracks with filler products as specified in accordance with manufacturer's instructions colored to match (or contrast) with concrete color as specified by architect.
- E. Apply densifying impregnator undiluted at approximately 200 square feet per gallon using a stiff, long bristled broom. Cover the entire area liberally. Using a broom, work the densifier into the substrate for 30 minutes. During this 30-minute period, continually keep the substrate wet with densifier. Squeegee excess material off the floor. Allow 12 to 24 hours for full cure.

- F. Grind the floor to within 2 – 3 inches of walls with metal bonded diamond grits of 150 and 300—grinding 90 degrees from each previous grind and removing all the scratches from the previous grit. Vacuum the floor thoroughly after each grind using a squeegee vacuum attachment.
- G. (If specified) Grind the edges with 40, 60, 120 and 220 grit grinding pads removing all of the scratches from the previous grit. Vacuum the floor thoroughly after each grind using a squeegee vacuum attachment.
- H. Polish the floor, to desired sheen level, with phenolic resin bonded diamond grits of 100, 400, 800, 1500 and 3000—first polishing the edges (if specified) with pads of the same grit and then the field of the floor removing all scratches from the previous grit. After each polish, clean the floor thoroughly using clean water and an auto scrubber or a mop and a wet vacuum.
- I. After the floor has dried, apply densifier at a rate of 300 square feet per gallon. Using a broom, work the material into the floor for a minimum of 10 minutes. Tight squeegee the remaining material from the floor without leaving squeegee marks or puddles. Allow to cure for 12 – 24 hours.
- J. Using a high speed burnishing machine and hogs hair burnishing pad, buff the surface to a high shine.
- K. Upon completion, the work shall be ready for final inspection and acceptance by the customer.

3.2 CURING

- A. Integrally Colored Concrete: Apply curing compound for integrally colored concrete according to manufacturer's instructions using manufacturer's recommended application techniques. Apply curing compound at consistent time for each pour to maintain close color consistency.
- B. Curing compound shall be same color as the colored concrete and supplied by same manufacturer of the colored admixture.
- C. Precautions shall be taken in hot weather to prevent plastic cracking resulting from excessively rapid drying at surface as described in CIP 5 *Plastic Shrinkage Cracking* published by the National Ready Mixed Concrete Association.
- D. Do not cover concrete with plastic sheeting.

3.7 CLEANING

- A. The work area shall be kept clean and free of debris at all times.
- B. Remove slurry and dust from adjoining surfaces as necessary.
- C. Dispose of material containers in accordance with local regulations.
- D. Protect finished work until fully cured per manufacturer's recommendations.

PART 4 – SCHEDULES

4.1 CUT AND SHINE LEVELS

- A. Cut Level (Depth of cut)
 - 1. Grade 1 – cream finish
 - 2. Grade 2 – light exposure of course aggregate
 - 3. Grade 3 – heavy exposure of course aggregate
- B. Shine Level
 - 1. Class 1 – 400 grit polish
 - 2. Class 2 – 800 grit polish
 - 3. Class 3 – 1500 grit polish
- C. Polished concrete finish coat
 - 1. At a distance of 100 feet, the floor will reflect images from side lighting.
 - 2. Apply two applications of Guard-W.
- D. Specified for project
 - Grade: 2
 - Class: 1
 - Guard-W applications: 2

END OF SECTION

SECTION 042000 - UNIT MASONRY

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. See Division 05 Section "Metal Fabrications" for furnishing steel lintels and shelf angles for unit masonry.
- B. Submittals:
 - 1. Samples for decorative concrete masonry units, face brick and colored mortar.
 - 2. Material Certificates: For each type of product indicated. Include statements of material properties indicating compliance with requirements.
- C. Comply with ACI 530.1/ASCE 6/TMS 602.
- D. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections required by authorities having jurisdiction.
- E. Sample Panels: Construct a sample wall panel approximately 48 inches long by 48 inches high to demonstrate aesthetic effects and set quality standards for materials and execution.

PART 2 - PRODUCTS

2.1 MASONRY UNITS

- A. Concrete Masonry Units: ASTM C 90; Density Classification, Normal Weight.
 - 1. Integral Water Repellent: ACM Chemistries; RainBloc BASF Aktiengesellschaft; Rheopel Plus or Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block.
 - 2. Special shapes for lintels, corners, jambs, sash, control joints, and other special conditions.
 - 3. Bullnose units for outside corners unless otherwise indicated.
- B. Interior decorative Concrete Masonry Units: ASTM C 90; Density Classification, Normal Weight.
 - 1. Products: Refer to masonry schedule in drawings - Sheet A.03.
 - 2. Post Water Repellent: Prosoco Gloss N' Guard WB.
 - 3. Special shapes for lintels, corners, jambs, sash, control joints, and other special conditions.

- C. Exterior decorative Concrete Masonry Units: ASTM C 90; Density Classification, Normal Weight.
 - 1. Textured Finish: Exposed faces with Sti-Face finish.
 - 2. Integral Water Repellent: ACM Chemistries; RainBloc BASF Aktiengesellschaft; Rheopel Plus or [Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block.
 - 3. Special shapes for lintels, corners, jambs, sash, control joints, and other special conditions.
- D. Concrete Lintels: Precast units matching concrete masonry units and with reinforcing bars indicated or required to support loads indicated.
- E. Face Brick: ASTM C 216, Type FBS. No- efflorescence.
 - 1. Products:
 - a. Refer to masonry schedule in drawings - Sheet A.03.
 - 2. Size: 3-1/2 inches wide by 2-1/4 inches high by 7-1/2 inches long or 3-5/8 inches wide by 2-1/4 inches high by 7-5/8 inches long.
 - 3. Solid brick with exposed surfaces finished for ends of sills and caps.
 - 4. Special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

2.2 MORTAR AND GROUT

- A. Mortar: ASTM C 270, proportion specification.
 - 1. Use portland cement-lime mortar.
 - 2. Do not use calcium chloride in mortar.
 - 3. For masonry below grade or in contact with earth, use Type M.
 - 4. For reinforced masonry, use Type S.
 - 5. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions, and for other applications where another type is not indicated, use Type N.
 - 6. Colored Mortar: For decorative concrete masonry units and face brick use colored cement or cement-lime mix of color selected.
 - 7. Water-Repellent Additive: For mortar used with concrete masonry units made with integral water repellent, use product recommended by manufacturer of units.
- B. Grout: ASTM C 476 with a slump of 8 to 11 inches.

2.3 REINFORCEMENT, TIES, AND ANCHORS

- A. Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

- B. Joint Reinforcement: ASTM A 951.
 - 1. Coating: Hot-dip galvanized at both interior and exterior walls.
 - 2. Wire Size for Side Rods: 0.187-inch diameter.
 - 3. Wire Size for Cross Rods: 0.187-inch diameter.
 - 4. Wire Size for Veneer Ties: 0.187-inch diameter.
 - 5. For single-wythe masonry, provide either ladder design or truss design.
- C. Corrugated-Metal Veneer Anchors: 7/8 inch wide and made from 0.060-inch thick stainless-steel sheet.
- D. Veneer Anchors: Stainless-steel, two-piece adjustable masonry veneer anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to studs, and acceptable to authorities having jurisdiction.

2.4 EMBEDDED FLASHING MATERIALS

- A. Sheet Metal Flashing: Stainless steel, 0.0156 inch (0.4 mm) thick.
- B. Rubberized Asphalt Sheet Flashing: Pliable, adhesive rubberized-asphalt compound, bonded to a polyethylene film to produce an overall thickness of 0.040 inch (1.02 mm). Use only where flashing is fully concealed.
- C. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy, 0.025 inch (0.64 mm) thick, with a 0.015-inch- (0.38-mm-) thick coating of adhesive. Use only where flashing is fully concealed.

2.5 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded strips complying with ASTM D 1056, Grade 2A1.
- B. Preformed Control-Joint Gaskets: Designed to fit standard sash block and to maintain lateral stability in masonry wall; made from styrene-butadiene rubber or PVC.
- C. Weep Holes: Cellular-plastic extrusion, full height and width of head joint or Free-draining polyethylene mesh, full height and width of head joint.
- D. Cavity Drainage Material: Free-draining polymer mesh, full depth of cavity with dovetail shaped notches that prevent mortar clogging.
- E. Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV or X.
- F. Polyisocyanurate Board Insulation: ASTM C 1289, Type I, Class 2; aluminum-foil faced.

- G. Proprietary Acidic Masonry Cleaner: Product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Cut masonry units with saw. Install with cut surfaces and, where possible, cut edges concealed.
- B. Mix units for exposed unit masonry from several pallets or cubes as they are placed to produce uniform blend of colors and textures.
- C. Stopping and Resuming Work: Rack back units; do not tooth.
- D. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.
- E. Build non-load-bearing interior partitions full height and install compressible filler in joint between top of partition and underside of structure above.
- F. Tool exposed joints slightly concave when thumbprint hard unless otherwise indicated.
- G. Keep cavities clean of mortar droppings and other materials during construction.

3.2 LINTELS

- A. Install lintels where indicated.
- B. Minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.3 FLASHING AND WEEP HOLES

- A. Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to the downward flow of water in the wall, and where indicated.
- B. Place through-wall flashing on sloping bed of mortar and cover with mortar. Seal penetrations in flashing before covering with mortar.
 - 1. Extend flashing 4 inches (100 mm) into masonry at each end and turn up 2 inches (50 mm) to form a pan.
- C. Trim wicking material used in weep holes flush with outside face of wall after mortar has set.

3.4 CLEANING

- A. Clean masonry as work progresses. Remove mortar fins and smears before tooling joints.
- B. Final Cleaning: After mortar is thoroughly cured, clean exposed masonry.
 - 1. Wet wall surfaces with water before applying acidic cleaner, then remove cleaner promptly by rinsing thoroughly with clear water.
 - 2. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.

END OF SECTION 042000

SECTION 044300 - STONE MASONRY

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Samples for stone.
- B. Submit qualification data for masonry contractor, including a list of completed projects.
- C. Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
- D. Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

- A. Limestone: ASTM C 568, Classification II Medium-Density or Classification III High-Density.

2.2 MORTAR

- A. Mortar for Stone Masonry: ASTM C 270, Proportion Specification, Type N for setting stone, Type N for pointing.
 - 1. Use portland cement-lime or masonry cement mortar.
 - 2. Colored Mortar: Use colored cement product of color selected. Refer to unit masonry specification
- B. Latex-Modified Portland Cement Setting Mortar: Proportion and mix portland cement, aggregate, and latex additive to comply with latex-additive manufacturer's written instructions.

2.3 STONE MASONRY-VENEER ANCHORS

- A. Adjustable Veneer Anchors: Stainless-steel, two-piece adjustable masonry veneer anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to studs, and acceptable to authorities having jurisdiction.

2.4 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Stainless steel, 0.016 inch (0.4 mm) thick.
- B. Rubberized-Asphalt Flashing: Adhesive rubberized-asphalt compound, bonded to polyethylene film, with an overall thickness of 0.030 inch (0.8 mm). Use only where flashing is fully concealed.
- C. Elastomeric Thermoplastic Flashing: Composite flashing product consisting of a polyester-reinforced ethylene interpolymer alloy, 0.025 inch (0.64 mm) thick, with a 0.015-inch- (0.38-mm-) thick coating of adhesive. Use only where flashing is fully concealed.

2.5 MISCELLANEOUS MATERIALS

- A. Acidic Cleaner: Cleaner designed for removing mortar stains from stone masonry surfaces; expressly approved for intended use by cleaner manufacturer and stone producer.

2.6 STONE FABRICATION

- A. Thickness of Stone Masonry Veneer: 3 inches (100 mm) plus or minus 1/4 inch (6 mm).
 - 1. Thickness does not include projection of pitched faces.
- B. Finish: As indicated.

PART 3 - EXECUTION

3.1 SETTING STONE MASONRY, GENERAL

- A. Execute stone masonry by skilled masons experienced with the kind and form of stone and installation method indicated. Arrange stones for good fit, in pattern indicated.
- B. Maintain uniform joint widths except for variations due to different stone sizes and minor variations required to maintain bond alignment. Lay walls with joints not less than 3/8 inch (10 mm).
- C. Install embedded flashing at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
 - 1. Extend flashing 4 inches (100 mm) into masonry at each end and turn up 2 inches (50 mm) to form a pan.

3.2 INSTALLING ANCHORED STONE MASONRY

- A. Set stone in full bed of mortar with full head joints. Build veneer anchors into mortar joints as stone is set.
 - 1. Embed veneer anchors in mortar joints of stone masonry at least halfway, but not less than 1-1/2 inches (38 mm), through stone masonry and with at least 5/8-inch (16-mm) cover on outside face.
 - 2. Space anchors to provide not less than one anchor per 2 sq. ft. (0.2 sq. m) of wall area. Install additional anchors within 12 inches (300 mm) of openings, sealant joints, and perimeter at intervals not exceeding 12 inches (300 mm).
- B. Keep cavity between stone masonry and backup construction free of mortar droppings and debris.

3.3 CLEANING

- A. In-Progress Cleaning: Clean masonry as work progresses. Remove mortar fins and smears before tooling joints.
- B. Final Cleaning: After mortar is thoroughly cured, remove large mortar particles, scrub, and rinse stone masonry veneer.
 - 1. Wet wall surfaces with water before applying cleaner; remove cleaner promptly by rinsing thoroughly with clear water.

END OF SECTION 044300

SECTION 051200 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Shop Drawings
- B. Comply with applicable provisions of the following:
 - 1. AISC 303.
 - 2. AISC 341 and AISC 341s1.
 - 3. AISC 360.
 - 4. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

PART 2 - PRODUCTS

2.1 STRUCTURAL STEEL

- A. W-Shapes: ASTM A 99, Grade 50.
- B. Channels, Angles: ASTM A 36, Grade 36.
- C. Plate and Bar: ASTM A 36, Grade 36.
- D. Cold-Formed Hollow Structural Sections: ASTM A 500, Grade B, structural tubing.
- E. Steel Pipe: ASTM A 53, Type E or S, Grade B.

2.2 ACCESSORIES

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade C, heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers.
- B. Anchor Rods: ASTM F 1554, Grade 36.
 - 1. Configuration: Straight.
 - 2. Nuts: ASTM A 563 hex carbon steel.
 - 3. Plate Washers: ASTM A 36/A 36M carbon steel.
 - 4. Washers: ASTM F 436, Type 1, hardened carbon steel.
- C. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer.

- D. Grout: ASTM C 1107, nonmetallic, shrinkage resistant, factory packaged.

2.3 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC 360.
- B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
- C. Shop Priming: Prepare surfaces according to SSPC-SP 2, "Hand Tool Cleaning"; or SSPC-SP 3, "Power Tool Cleaning." Shop prime steel to a dry film thickness of at least 1.5 mils. Do not prime surfaces to be embedded in concrete or mortar or to be field welded.

PART 3 - EXECUTION

3.1 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
- B. Bearing and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
 - 1. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure.
- C. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
- D. Do not use thermal cutting during erection.
- E. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 for type of bolt and type of joint specified.
- F. Weld Connections: Comply with AWS D1.1 and AWS D1.8 for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

END OF SECTION 051200

SECTION 053100 - STEEL DECKING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Shop Drawings.
- B. Comply with SDI Publication No. 30.
- C. Comply with AWS D1.3, "Structural Welding Code - Sheet Steel."

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Galvanized Steel Sheet: ASTM A 653, Structural Steel (SS), Grade 33 , G90 zinc coating.

2.2 DECKING

- A. Roof Deck: Fabricate panels from galvanized steel sheet, without top-flange stiffening grooves, to comply with the following:
 - 1. Deck Profile: Type WR wide rib.
 - 2. Profile Depth: 1-1/2 inches.
 - 3. Design Uncoated-Steel Thickness: 0.0295 inch.

2.3 MISCELLANEOUS

- A. Accessories: Manufacturer's recommended roof deck accessory materials. Sheet metal accessories of same material and finish as deck.

PART 3 - EXECUTION

3.1 DECK INSTALLATION

- A. Place, adjust, align, and bear deck panels on structure. Do not stretch or contract side-lap interlocks.

- B. Place deck panels flat and square and weld or mechanically fasten to structure without warp or deflection.
- C. Cut, reinforce, and fit deck panels and accessories around openings and projections.
- D. Roof Deck Accessories: Install sump pans, sump plates, ridge and valley plates, finish strips, cover plates, end closures, and reinforcing channels. Weld to substrate.
- E. Prepare and repair damaged galvanized coatings on both surfaces with galvanized repair paint according to ASTM A 780.
- F. Wire brush, clean, and paint scarred areas, welds, and rust spots on both surfaces of painted deck panels.

END OF SECTION 053100

SECTION 054000 - COLD-FORMED METAL FRAMING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Comply with AISI's "Specification for the Design of Cold-Formed Steel Structural Members" for calculating structural characteristics of cold-formed metal framing.
- C. Comply with HUD's "Prescriptive Method for Residential Cold-Formed Metal Framing."
- D. Comply with AWS D1.3, "Structural Welding Code - Sheet Steel."
- E. Protect cold-formed metal framing from corrosion, deformation, and other damage during delivery, storage, and handling.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Steel Studs: C-shaped, with flange width of not less than 1-5/8 inches (41 mm), minimum uncoated steel thickness of 0.0538 inch (1.37 mm), and of depths indicated.
- B. Steel Joists: C-shaped, with flange width of not less than 1-5/8 inches (41 mm), minimum uncoated steel design thickness of 0.0677 inch (1.72 mm), and of depths indicated.
- C. Steel Track: U-shaped, minimum uncoated metal thickness same as studs or joists used with track, with flange widths of 1-1/4 inches (32 mm) for studs and 1-5/8 inches (41 mm) for joists, of web depths indicated.

2.2 ACCESSORIES

- A. Accessories: Fabricate from the same material and finish used for framing members, of manufacturer's standard thickness and configuration, unless otherwise indicated.
- B. Cast-in-Place Anchor Bolts: ASTM F 1554, Grade 36, threaded carbon-steel hex-headed bolts and carbon-steel nuts; and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A 153/A 153M, Class C.
- C. Mechanical Fasteners: Corrosion-resistant coated, self-drilling, self-threading steel drill screws.

PART 3 - EXECUTION

3.1 FRAMING

- A. Install framing and accessories level, plumb, square, and true to line, and securely fastened, according to ASTM C 1007. Temporarily brace framing until entire integrated supporting structure has been completed and permanent connections are secured.
 - 1. Cut framing members by sawing or shearing; do not torch cut.
 - 2. Fasten framing members by welding or screw fastening.
 - 3. Install insulation in built-up exterior framing members.
 - 4. Fasten reinforcement plates over web penetrations larger than standard punched openings.
- B. Erection Tolerances: Install cold-formed metal framing with a maximum variation of 1/8 inch in 10 feet (1:960) and with individual framing members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
- C. Studs: Install continuous top and bottom tracks securely anchored at corners and ends. Squarely seat studs against webs of top and bottom tracks. Space studs as indicated, set plumb, align, and fasten both flanges of studs to top and bottom tracks.
 - 1. Install and fasten horizontal bridging in stud system, spaced in rows not more than 48 inches (1219 mm) apart.
 - 2. Install steel-sheet diagonal bracing straps to both stud flanges, terminate at and fasten to reinforced top and bottom track and anchor to structure.
 - 3. Install miscellaneous framing and connections to provide a complete and stable wall-framing system.
 - 4. Isolate non-load-bearing, curtain-wall framing from building structure using vertical slide clips or deflection track to prevent transfer of vertical loads while providing lateral support.
- D. Joists: Install and securely anchor perimeter joist track sized to match joists. Install joists bearing on supporting framing, brace and reinforce, and fasten to both flanges of joist track.
 - 1. Install bridging and fasten bridging at each joist intersection.
 - 2. Install miscellaneous joist framing and connections, including web stiffeners, closure pieces, clip angles, continuous angles, hold-down angles, anchors, and fasteners.

END OF SECTION 054000

SECTION 055200 - METAL RAILINGS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Shop drawings and color sample.

PART 2 - PRODUCTS

2.1 RAILING SYSTEMS

- A. Provide railings capable of withstanding a uniform load of 50 lbf/ ft. (0.73 kN/m) and a concentrated load of 200 lbf (0.89 kN) applied to handrails and top rails of guards in any direction. Uniform and concentrated loads need not be assumed to act concurrently.

2.2 METALS

- A. Steel Tubing: ASTM A 500 (cold formed) or ASTM A 513.
- B. Screen Panel: 14 ga. perforated steel sheet.
- C. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

2.3 FABRICATION

- A. Assemble railing systems in shop to the greatest extent possible. Use connections that maintain structural value of joined pieces.
- B. Form changes in direction of railing members by mitering at elbow bends.
- C. Fabricate railing systems and handrails for connecting members by welding.
- D. Provide manufacturer's standard wall brackets, flanges, miscellaneous fittings, and anchors to connect handrail and railing members to other construction.

2.4 FINISHES

- A. Steel Railings and Screen Panels: Hot-dip galvanized after fabrication, ASTM A 123; cleaned and shop primed and painted after galvanizing. Refer to Section 099100 for painting of galvanized metal substrates. Media blast railings no more than 12 hours prior to finishing.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fit exposed connections accurately together to form tight, hairline joints.
- B. Set railings accurately in location, alignment, and elevation and free of rack.
- C. Coat concealed surfaces of aluminum that will be in contact with cementitious materials or dissimilar metals, with a heavy coat of bituminous paint.
- D. Anchor posts in concrete by forming or core-drilling holes 5 inches (125 mm) deep and 3/4 inch (20 mm) greater than OD of post. Fill annular space between post and concrete with nonshrink, nonmetallic grout.
- E. Attach handrails to wall with wall brackets.

END OF SECTION 055200

SECTION 066110 – SOLID SURFACING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data, Shop Drawings, and material Samples.

PART 2 - PRODUCTS

2.1 CULTURED MARBLE FABRICATIONS

- A. Solid surfacing material tops: DuPont Corian or owner approved equal. Not less than 1/2 inch (12.7 mm) thick.
 - 1. Front Style: Eased edge, with applied apron.
 - 2. Backsplash: none.
 - 3. End Splash: none.
 - 4. Coordinate cutouts for self-rimming sink per mechanical specifications.
 - 5. Seams shall not be visible.
 - 6. Color: As selected from manufacturer's full range.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install solid surfacing products according to manufacturer's written directions. Fasten to substrates with adhesive. Align adjacent surfaces. Seal seams and perimeter with mildew-resistant elastomeric sealant.
- B. Install level and plumb to a tolerance of 1/8 inch in 8 feet (3.2 mm in 2.4 m).

END OF SECTION 066113

SECTION 071113 - BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 BITUMINOUS DAMPPROOFING

- A. Cold-Applied, Emulsified-Asphalt Dampproofing:
 - 1. Available Manufacturers:
 - a. Sonneborn Systems – BASF
 - b. Owner Representative approved alternate
 - 2. Trowel Coats: ASTM D 1227, Type II, Class 1.
 - 3. Fibered Brush and Spray Coats: ASTM D 1227, Type II, Class 1.
 - 4. Brush and Spray Coats: ASTM D 1227, Type III, Class 1.
- B. Emulsified-Asphalt Primer: ASTM D 1227, Type III, Class 1, except diluted with water as recommended by manufacturer.
- C. Asphalt-Coated Glass Fabric: ASTM D 1668, Type I.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Clean substrates of projections and substances detrimental to work; fill voids, seal joints, and apply bond breakers if any, as recommended by prime material manufacturer.
- B. Comply with manufacturer's written recommendations unless more stringent requirements are indicated or required by Project conditions to ensure satisfactory performance of dampproofing.
- C. Apply dampproofing to footings and foundation walls where opposite side of wall faces building interior

1. Apply from finished-grade line to top of footing, extend over top of footing, and down a minimum of 6 inches (150 mm) over outside face of footing.
 2. Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, cracks, and where shown as "reinforced," by embedding an 8-inch- (200-mm-) wide strip of asphalt-coated glass fabric in a heavy coat of dampproofing. Dampproofing coat for embedding fabric is in addition to other coats required.
- D. Apply dampproofing to provide continuous plane of protection on exterior face of inner wythe of exterior masonry cavity walls.
1. Lap dampproofing at least 1/4 inch (6 mm) onto flashing and items that penetrate inner wythe.
 2. Extend dampproofing over outer face of structural members and concrete slabs.
- E. Apply dampproofing to provide continuous plane of protection on interior face of above-grade, exterior single-wythe masonry walls unless walls are indicated to receive direct application of paint.
- F. Cold-Applied Emulsified-Asphalt Dampproofing:
1. On concrete foundation walls, apply two brush or spray coats, one fibered brush or spray coat, or one trowel coat.
 2. On Masonry Backup for Stone Veneer Assemblies and Dimension Stone Cladding: Apply primer and one brush or spray coat.
 3. On Exterior Face of Inner Wythe of Cavity Walls: Apply primer and one brush or spray coat.
 4. On Interior Face of Single-Wythe Exterior Masonry Walls: Where above grade and indicated to be furred and finished, apply primer and one brush or spray coat.

END OF SECTION 071113

SECTION 072100 - THERMAL INSULATION

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 INSULATION PRODUCTS

- A. Surface-Burning Characteristics: ASTM E 84, and as follows:
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoked-Developed Index: 450 or less.
- B. 2" Rigid Insulation: Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 2" thickness (R10).
- C. Polyisocyanurate Board Insulation: Refer to Section 07.
- D. Tapered insulation: Refer to Section 07.

2.2 ACCESSORIES

- A. Vapor Retarder: ASTM E 1745, Class C Reinforced polyethylene, 7.8 mils (0.18 mm) thick.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install insulation in areas and in thicknesses indicated or required to produce R-values indicated. Cut and fit tightly around obstructions and fill voids with insulation.
- B. Bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
- C. Fire-Rated Locations: Install fire-containment systems at top of partitions to fill gaps between wall and the deck above

- D. Sound Attenuation Insulation: Install 3" blanket over suspended ceilings at partition locations in a width that extends insulation to 48" on either side of partition.
- E. Extend vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with adhesives or other anchorage. Locate seams at framing members, overlap, and seal with tape.

END OF SECTION 072100

SECTION 075000 – TPO MEMBRANE ROOFING

PART 1 - GENERAL

1.1 Section INCLUDES

- A. TPO Adhered membrane roofing system.
- B. Cover board.
- C. Roof insulation.
- D. Substrate board.

1.2 REFERENCES

- A. Roofing Terminology: Refer to the following publications for definitions of roofing work related terms in this Section:
 - 1. ASTM D 1079 "Terminology Relating to Roofing and Waterproofing."
 - 2. Glossary of NRCA's "The NRCA Roofing and Waterproofing Manual."
 - 3. Roof Consultants Institute "Glossary of Roofing Terms."
- B. Sheet Metal Terminology and Techniques: SMACNA Architectural Sheet Metal Manual.

1.3 DESIGN CRITERIA

- A. General: Installed roofing membrane system shall remain watertight; and resist specified wind uplift pressures, thermally induced movement, and exposure to weather without failure.
- B. Material Compatibility: Roofing materials shall be compatible with one another under conditions of service and application required, as demonstrated by roofing system manufacturer based on testing and field experience.
- C. Wind Uplift Performance: Roofing system shall be identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist wind uplift pressure calculated in accordance with ASCE 7.
- D. FM Listing: Roofing membrane, base flashings, and component materials shall comply with requirements in FM 4450 and FM 4470 as part of a roofing system and that are listed in FM's "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM markings. Fire Windstorm Classification: Class 1A-90. Hail Resistance: SH.
- E. EPA Energy Star:
 - 1. Roofing membrane shall achieve an initial reflectance of greater than 0.65 and a three year aged reflectance of greater than 0.50.

1.4 SUBMITTALS

- A. Product Data: Manufacturer's data sheets for each product to be provided.
- B. Detail Drawings: Provide roofing system plans, elevations, sections, details, and details of attachment to other Work, including:
 - 1. Base flashings, cants, and membrane terminations.
 - 2. Tapered insulation, including slopes.
 - 3. Crickets, saddles, and tapered edge strips, including slopes.
 - 4. Insulation fastening patterns.
- C. Verification Samples: Provide for each product specified.
- D. Qualification Data: For Installer and manufacturer.
- E. Maintenance Data: Refer to Johns Manville's latest published documents on www.specJM.com.
- F. Guarantees: Special guarantees specified in this Section.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive the specified manufacturer's guarantee.
- B. Source Limitations: Obtain all components from the single source roofing manufacturer guaranteeing the roofing system. All products used in the system must be labeled by the single source roofing manufacturer issuing the guarantee.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storage.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

1.7 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when current and forecasted weather conditions permit roofing system to be installed in accordance with manufacturer's written instructions and guarantee requirements.

1.8 Guarantee

- A. Provide manufacturer's system guarantee equal to Johns Manville's Peak Advantage No Dollar Limit Roofing System Guarantee.
 - 1. Single-Source special guarantee includes roofing plies, base flashings, liquid applied flashing, roofing membrane accessories, roof insulation, fasteners, cover board, and other single-source components of roofing system marketed by the manufacturer.
 - 2. Guarantee Period: 15 years from date of Substantial Completion.
 - 3. Wind Rider: Guarantee shall not exclude coverage for wind events up to 100 mph.
 - 4. Hail Rider: Guarantee shall have no exclusions for hail events up to 1.5 inches
 - 5. Accidental Puncture Rider: Guarantee shall provide coverage for accidental puncture for up to 8 billed repair hours per year for the life of the guarantee.
- B. Installer's Guarantee: Submit roofing Installer's guarantee, including all components of roofing system for the following guarantee period:
 - 1. Guarantee Period: Five Years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 THERMOPLASTIC POLYOLEFIN ROOFING MEMBRANE - TPO

- A. Fabric-Reinforced Thermoplastic Polyolefin Sheet: ASTM D 6878, uniform, flexible sheet formed from a thermoplastic polyolefin, internally fabric or scrim reinforced.
 - 1. Thickness: 60 mils
 - 2. Accelerated Weathering: Minimum of 24,000 hours without cracking or crazing as tested using ASTM G155.
 - 3. Breaking Strength: Minimum of 300 lbf as tested using ASTM D751
 - 4. Tearing Strength: Minimum of 85 lbs as tested using ASTM D751
- B. Available Manufacturers:
 - Carlisle SynTec Inc.
 - Firestone Building Products
 - Versico
 - Johns Manville

2.2 AUXILIARY ROOFING MATERIALS – SINGLE PLY

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.
 - 1. Liquid-type auxiliary materials shall meet VOC limits of authorities having jurisdiction.
- B. Sheet Flashing: Manufacturer's 60 mil sheet flashing of same material, type, reinforcement, thickness, and color as sheet membrane.

- A. Bonding Adhesive: Manufacturer's standard solvent based bonding adhesive for membrane, and solvent-based bonding adhesive for base flashings.
- B. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.
- C. Metal Termination Bars: Manufacturer's standard predrilled stainless-steel or aluminum bars, with anchors.
- D. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.

2.3 COVER BOARD

- A. Cover Board: ASTM C 1177/C 1177M, glass mat water resistant gypsum substrate, 1/4" thick, factory primed and fully adhered to insulation

Manufacturer's standard recommended cover board.
Georgia Pacific Dens Deck.

2.4 ROOF INSULATION

- A. General: Preformed roof insulation boards that comply with requirements and referenced standards, selected from manufacturer's standard sizes and of thicknesses indicated.
- B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II.
 - 1. Provide insulation package with minimum thickness per drawings.

2.5 TAPERED INSULATION

- A. Tapered Insulation: ASTM C 1289, provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches minimum, unless otherwise indicated.

2.6 INSULATION ACCESSORIES

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatible with membrane roofing.

2.7 SUBSTRATE BOARD

- A. Substrate Board: ASTM C 1177/C 1177M, glass mat water resistant gypsum substrate, Type X, 5/8" thick.
Georgia Pacific Dens Deck
- B. Fasteners: Factory coated steel fasteners and metal or plastic plates complying with corrosion resistance provisions in FM Approvals 4470.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions for compliance with requirements affecting performance of roofing system:
 - 1. Verify that roof openings and penetrations are in place and set and braced.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean and remove from substrate sharp projections, dust, debris, moisture, and other substances detrimental to roofing installation in accordance with roofing system manufacturer's written instructions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 SUBSTRATE BOARD INSTALLATION

- A. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
 - 1. Fasten substrate board to top flanges of steel deck according to recommendations in FMG's "Approval Guide" for specified Windstorm Resistance Classification.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.4 INSULATION INSTALLATION

- A. Coordinate installation of roof system components so insulation and cover board is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with roofing system manufacturer's written instructions for installation of roof insulation and cover board.
- C. Install tapered insulation under area of roofing to conform to slopes indicated.
- D. Install insulation boards with long joints in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards.
- E. Install tapered edge strips at perimeter edges of roof that do not terminate at vertical surfaces.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.5 COVER BOARD INSTALLATION

- A. Coordinate installing membrane roofing system components so cover board is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with membrane roofing system manufacturer's written instructions for installing roof cover board.
- C. Install cover board with long joints of cover board in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with cover board.
- D. Adhere cover boards according to requirements in FMG's "Approval Guide" for specified Windstorm Resistance Classification.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.6 ROOFING MEMBRANE INSTALLATION, GENERAL

- A. Install roofing membrane in accordance with roofing system manufacturer's written instructions, applicable recommendations of the roofing manufacturer and requirements in this Section.
- B. Cooperate with testing and inspecting agencies engaged or required to perform services for installing roofing system.
- C. Coordinate installing roofing system so insulation and other components of the roofing membrane system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is imminent.
 - 1. Provide tie-offs at end of each day's work to cover exposed roofing membrane sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt with joints and edges sealed.
 - 2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system.
 - 3. Remove and discard temporary seals before beginning work on adjoining roofing.

3.7 ADHERED ROOFING MEMBRANE INSTALLATION

- A. Install roofing membrane over area to receive roofing in accordance with membrane roofing system manufacturer's written instructions. Unroll roofing membrane and allow to relax before installing.
- B. Accurately align roofing membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- C. Bonding Adhesive: Apply solvent-based bonding adhesive to substrate and underside of roofing membrane at rate required by manufacturer and allow to partially dry before installing roofing membrane. Do not apply bonding adhesive to splice area of roofing membrane.

- D. Mechanically fasten roofing membrane securely at terminations, penetrations, and perimeter of roofing.
- E. Apply roofing membrane with side laps shingled with slope of roof deck where possible.
- F. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping roofing membranes according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of roofing membrane terminations.
 - 1. Apply a continuous bead of in-seam sealant before closing splice if required by membrane roofing system manufacturer.
- G. Seams: Clean seam areas, overlap roofing membrane, and hot-air weld side and end laps of roofing membrane according to manufacturer's written instructions to ensure a watertight seam installation.
 - 1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roofing membrane.
 - 2. Verify field strength of seams a minimum of twice daily and repair seam sample areas.
 - 3. Repair tears, voids, and lapped seams in roofing membrane that do not meet requirements.
- H. Spread sealant or mastic bed over deck drain flange at deck drains and securely seal roofing membrane in place with clamping ring.
- I. Proceed with installation only after unsatisfactory conditions have been corrected.

3.8 BASE FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.
- B. Apply solvent-based bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply bonding adhesive to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with sheet flashing.
- D. Clean seam areas and overlap and firmly roll sheet flashings into the adhesive. Weld side and end laps to ensure a watertight seam installation.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform roof tests and inspections and to prepare test reports.

- B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Owner's Representative.
 - 1. Notify Owner 48 hours in advance of date and time of inspection.
- C. Repair or remove and replace components of roofing system where test results or inspections indicate that they do not comply with specified requirements.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.10 PROTECTION AND CLEANING

- A. Protect roofing system from damage and wear during remainder of construction period.
- B. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 075423

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.
- B. Comply with SMACNA's "Architectural Sheet Metal Manual." Conform to dimensions and profiles shown unless more stringent requirements are indicated.
- C. Coordinate installation of sheet metal flashing and trim with interfacing and adjoining construction to provide a leakproof, secure, and noncorrosive installation.

PART 2 - PRODUCTS

2.1 SHEET METAL

- A. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, with No. 2D finish; not less than 0.016 inch (0.4 mm) thick.
- B. Metallic-Coated Steel Sheet: Galvanized structural-steel sheet, ASTM A 653/A 653M, G90 (Z275), or aluminum-zinc alloy-coated structural-steel sheet, ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40 (Class AZM150 coating designation, Grade 275); 0.028-inch (0.71-mm) nominal thickness.
 - 1. Finish: Manufacturer's standard two-coat fluoropolymer system with color coat containing not less than 70 percent PVDF resin by weight or three-coat fluoropolymer system with color coat and clear coat containing not less than 70 percent PVDF resin by weight.
 - 2. Concealed Finish: Manufacturer's standard white or light-colored acrylic or polyester backer finish.

2.2 ACCESSORIES

- A. Felt Underlayment: ASTM D 226, Type II (No. 30), asphalt-saturated organic felts.
- B. Self-Adhering Sheet Underlayment, High Temperature: Butyl or SBS-modified asphalt; slip-resisting-polyethylene surfaced; with release paper backing; cold applied. Stable after testing at 240 deg F (116 deg C) and passes after testing at minus 20 deg F (29 deg C); ASTM D 1970.
- C. Slip Sheet: Building paper, 3-lb/100 sq. ft. (0.16-kg/sq. m) minimum, rosin sized.

- D. Fasteners: Wood screws, annular-threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners.
 - 1. Exposed Fasteners: Heads matching color of sheet metal roofing using plastic caps or factory-applied coating.
 - 2. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
 - 3. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
 - 4. Fasteners for Metallic-Coated Steel Sheet: Hot-dip galvanized steel or Series 300 stainless steel.
- E. Solder for Copper: ASTM B 32, Grade Sn50.
- F. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
- G. Solder for Zinc-Tin Alloy-Coated Stainless Steel: ASTM B 32, 100 percent tin.
- H. Butyl Sealant: ASTM C 1311, solvent-release butyl rubber sealant.
- I. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.3 FABRICATION

- A. Fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of the item indicated.
- B. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.
- C. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with SMACNA's "Architectural Sheet Metal Manual." Allow for thermal expansion; set true to line and level. Install Work with laps, joints, and seams permanently watertight and weatherproof; conceal fasteners where possible.
- B. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.

- C. Fabricate nonmoving seams in sheet metal with flat-lock seams.
- D. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pretin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm), except where pretinned surface would show in finished Work.
 - 1. Do not solder metallic-coated steel sheet.
- E. Separate dissimilar metals with a bituminous coating or polymer-modified, bituminous sheet underlayment.

END OF SECTION 076200

SECTION 077100 - ROOF SPECIALTIES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data and Color Samples.
- B. Warranties: Provide manufacturer's standard written warranty, signed by manufacturer agreeing to promptly repair or replace roof specialties that show evidence of deterioration of factory-applied finishes within 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required.
- B. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy and temper as recommended by manufacturer for use and finish indicated.
- C. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.
- D. Prepainted, Zinc-Coated Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation, structural quality.
 - 1. Finish: Manufacturer's standard two-coat fluoropolymer system with color coat containing not less than 70 percent PVDF resin by weight; complying with AAMA 621.
- E. Slip Sheet: Rosin-sized paper, minimum 3 lb/100 sq. ft. (0.16 kg/sq. m).
- F. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements.
 - 1. Exposed Penetrating Fasteners: Gasketed screws with heads matching color of metal.
 - 2. Fasteners for Copper Sheet: Copper, hardware bronze, or Series 300 stainless steel.
 - 3. Fasteners for Aluminum: Aluminum or Series 300 stainless steel.
 - 4. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
 - 5. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel.
- G. Butyl Sealant: ASTM C 1311, solvent-release butyl rubber sealant.

- H. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.2 ROOF SPECIALTIES

- A. SPRI Wind Design Standard: Provide copings and roof-edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressures:
1. Design Pressure: shall exceed horizontal and vertical design wind pressure as calculated in accord with the ANSI/SPRI ES-1 Test RE-3.
- B. Copings: Manufactured coping system consisting of formed-metal coping cap, concealed anchorage; corner units, end cap units, and concealed splice plates.
1. Available Products:
 - a. Hickman Engineered Systems Permasnap 2.
 - b. Perma-Tite Gold Coping.
 - c. Owner Representative approved equivalent product.
 2. Prepainted, Zinc-Coated Steel: 0.034 inch (0.86 mm) thick.
- C. Gutters and Downspouts:
1. Available Products:
 - a. Dow Roofing Systems.
 - b. Owner Representative approved equivalent product.
 2. Gutters: Manufactured in uniform section lengths, with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least 1 inch (25 mm) above front edge. Furnish expansion joints, and expansion-joint covers.
 - a. Gutter Style: Rectangular.
 - b. Prepainted, Zinc-Coated Steel: 0.034 inch (0.86 mm) thick.
 - c. Gutter Supports: Manufacturer's standard supports as selected by Architect with finish matching the gutters.
 3. Downspouts: Plain rectangular with mitered elbows. Furnish wall brackets of same material and finish as downspouts, with anchors.
 - a. Prepainted, Zinc-Coated Steel: 0.034 inch (0.86 mm).
- D. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces. Provide reglets with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
1. Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness.

- E. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches (100 mm) designed to snap into reglets or through-wall-flashing receiver and compress against base flashings with joints lapped.

- 1. Zinc-Coated Steel: Nominal 0.028-inch (0.71-mm) thickness.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement.
- B. Coat back side of aluminum roof specialties with bituminous coating where they will contact wood, ferrous metal, or cementitious construction.
- C. Separate dissimilar metals with a bituminous coating or polymer-modified, bituminous sheet underlayment.
- D. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.
- E. Space movement joints at a maximum of 12 feet (3.6 m) with no joints within 18 inches (450 mm) of corners or intersections unless indicated.
 - 1. Install gutter with expansion joints at locations indicated but not exceeding 50 feet (15.2 m) apart. Install expansion joint caps.
- F. Fastener Sizes: Use fasteners of sizes that will penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- G. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than 24 inches (610 mm) apart. Attach ends with rivets and seal with sealant to make watertight. Slope to downspouts.
- H. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1500 mm)] o.c.
- I. Reglets: Install reglets to receive flashings where flashing without embedded reglets is indicated on Drawings. Install at height so that inserted counterflashings overlap 4 inches (100 mm) over top edge of base flashings.

END OF SECTION 077100

SECTION 077200 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data and color Samples.
- B. Sheet Metal Standard: Comply with SMACNA's "Architectural Sheet Metal Manual."

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Metallic-Coated Steel Sheet: Galvanized steel, ASTM A 653/A 653M, G90 (Z275), or aluminum-zinc alloy-coated steel, ASTM A 792/A 792M, AZ50 (AZM150).
 - 1. Prepainted, Metallic-Coated Steel Sheet: Coil-coated with manufacturer's standard two-coat, thermocured system consisting of inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
- B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy and temper recommended by manufacturer for type of use and finish.

2.2 ROOF ACCESSORIES

- A. Roof Curbs and Equipment Supports: Fabricate from 0.079-inch- (2.0-mm-) thick, metallic-coated steel with welded or sealed mechanical corner joints.
 - 1. Available Products:
 - a. LM Curbs.
 - b. Owner Representative approved equivalent product.
 - 2. Provide units with cant strips and base profile coordinated with roof insulation thickness and roof deck slope.
 - 3. Provide preservative-treated wood nailers at tops of curbs.
 - 4. Provide manufacturer's standard rigid or semirigid insulation.
 - 5. Finish: Baked enamel or High-performance organic coating].
- B. Roof Hatches: Fabricate from metallic-coated steel with 9-inch- (225-mm-) high, integral-curb, double-wall construction with 1-1/2-inch (38-mm) insulation, formed cants and cap flashing, with welded or sealed mechanical corner joints. Provide double-wall cover (lid) construction

with 1-inch- (25-mm-) thick insulation core. Provide gasketing and corrosion-resistant hardware including pintle hinges, hold-open devices, interior padlock hasps, and both interior and exterior latch handles.

1. Available Products:
 - a. Bilco Type S.
 - b. Owner Representative approved equivalent product.
2. Fabricate units to withstand 40-lbf/sq. ft. (1.9-kPa) external and 20-lbf/sq. ft. (0.95-kPa) internal loading pressure.
3. Finish: Baked enamel or High-performance organic coating.
4. Options: cylinder lock, safety pole, thermally enhanced.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Installation: Unless otherwise indicated, install roof accessory items according to construction details of NRCA's "Roofing and Waterproofing Manual." Coordinate with installation of roof deck, vapor barriers, roof insulation, roofing, and flashing to ensure combined elements are secure, waterproof, and weathertight.

END OF SECTION 077200

SECTION 078413 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data and Installer certificates signed by Installer certifying that products have been installed in compliance with requirements.

PART 2 - PRODUCTS

2.1 PENETRATION FIRESTOPPING

- A. Provide penetration firestopping materials that are compatible with one another, substrates, and penetrating items if any.
- B. Penetrations in Fire-Resistance-Rated Walls and Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).
 - 1. F-Rating at Fire-Resistance-Rated Walls: Not less than that of construction penetrated.
 - 2. F-Rating at Horizontal Assemblies: At least 1 hour, but not less than that of construction penetrated.
 - 3. T-Rating at Horizontal Assemblies: At least 1 hour, but not less than the fire-resistance rating of construction penetrated except for penetrations within the cavity of a wall.
- C. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- D. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

- B. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Include the following information on labels:
 - 1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Designation of applicable testing and inspecting agency.
 - 3. Manufacturer's name.
 - 4. Installer's name.
- C. Owner will engage a qualified testing agency to perform tests and inspections.

END OF SECTION 078413

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data and Color Samples.
- B. Environmental Limitations: Do not proceed with installation of joint sealants when ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (4.4 deg C).

PART 2 - PRODUCTS

2.1 JOINT SEALANTS

- A. Compatibility: Provide joint sealants, joint fillers, and other related materials that are compatible with one another and with joint substrates under service and application conditions.
- B. Sealant for Use in Building Expansion Joints:
 - 1. Single-component, neutral-curing silicone sealant, ASTM C 920, Type S; Grade NS; Class 50; for Use NT.
- C. Sealant for General Exterior Use Where Another Type Is Not Specified, One of the Following:
 - 1. Single-component, nonsag polysulfide sealant, ASTM C 920, Type S; Grade NS; Class 25; for Use NT.
 - 2. Single-component, neutral-curing silicone sealant, ASTM C 920, Type S; Grade NS; Class 25; for Use NT.
 - 3. Single-component, nonsag urethane sealant, ASTM C 920, Type S; Grade NS; Class 25; and for Use NT.
- D. Sealant for Exterior Traffic-Bearing Joints, Where Slope Precludes Use of Pourable Sealant:
 - 1. Single-component, nonsag urethane sealant, ASTM C 920, Type S; Grade NS; Class 25; for Use T.
- E. Sealant for Masonry Joints:
 - 1. Single-component, nonsag urethane sealant, ASTM C 920, Type S; Grade NS; Class 25; and for Use NT.

- F. Sealant for Use in Interior Joints in Ceramic Tile and Other Hard Surfaces in Toilet Rooms and Around Plumbing Fixtures:
 - 1. Single-component, mildew-resistant silicone sealant, ASTM C 920, Type S; Grade NS; Class 25; for Use NT; formulated with fungicide.
- G. Sealant for Interior Use at Perimeters of Door and Window Frames:
 - 1. Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.

2.2 MISCELLANEOUS MATERIALS

- A. Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.
- D. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with ASTM C 1193.
- B. Install sealant backings to support sealants during application and to produce cross-sectional shapes and depths of installed sealants that allow optimum sealant movement capability.
- C. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- D. Acoustical Sealant Installation: At sound-rated assemblies and elsewhere as indicated, seal perimeters, control joints, openings, and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions. Comply with ASTM C 919.

END OF SECTION 079200

SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Samples for factory-finished doors. Shop Drawings indicating location, size, hand and elevation of each door. Dimensions and locations of mortises and holes.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Cold-Rolled Steel Sheets: ASTM A 1008/A 1008M, suitable for exposed applications.
- B. Hot-Rolled Steel Sheets: ASTM A 1011/A 1011M, free of scale, pitting, or surface defects.
- C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, G60 (Z180) or A60 (ZF180).
- D. Frame Anchors: ASTM A 591/A 591M, 40Z (12G) coating designation; mill phosphatized.
 - 1. For anchors built into exterior walls, sheet steel complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.
- E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

2.2 HOLLOW METAL DOORS AND FRAMES

- A. Provide products by one of the following:
 - 1. Amweld Building Products, Inc.
 - 2. Ceco Door Products
 - 3. Detroit Door
 - 4. Pioneer Industries, Inc.
 - 5. Republic Builder Products
 - 6. Steelcraft
 - 7. Mesko Door Inc.
- B. Fire-Rated Doors and Frames: Labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, based on testing according to NFPA 252.
 - 1. At vertical exit enclosures and exit passageways, provide doors that have a temperature rise rating of 450 deg F (250 deg C).
- C. Doors: Complying with ANSI 250.8 for level and model and ANSI A250.4 for physical-endurance level indicated, 1-3/4 inches (44 mm) thick unless otherwise indicated.
 - 1. Interior Doors: Level 2 and Physical Performance Level B (Heavy Duty), Model 2 (Seamless).

2. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as door face sheets.
- D. Frames: ANSI A250.8; conceal fastenings unless otherwise indicated.
 1. Steel Sheet Thickness for Interior Doors: .053 inch.
 2. Fabricate interior frames with mitered or coped and corners knocked down for field assembly.
 3. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.
 4. Frame Anchors: Not less than 0.042 inch (1.0 mm) thick.
- E. Door Silencers: Three on strike jambs of single-door frames and two on heads of double-door frames.
- F. Grout Guards: Provide where mortar might obstruct hardware operation.
- G. Prepare doors and frames to receive mortised and concealed hardware according to ANSI A250.6 and ANSI A115 Series standards.
- H. Reinforce doors and frames to receive surface-applied hardware.
- I. Prime Finish: Manufacturer's standard, factory-applied coat of lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install hollow metal frames to comply with ANSI/SDI A250.11.
 1. Fire-Rated Frames: Install according to NFPA 80.
- B. Provide clearances between doors and frames as indicated in ANSI/SDI A250.11.
- C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying rust-inhibitive primer.

END OF SECTION 081113

SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Samples for factory-finished doors. Shop Drawings indicating location, size, hand and elevation of each door. Dimensions and locations of mortises and holes.

PART 2 - PRODUCTS

2.1 DOOR CONSTRUCTION, GENERAL

- A. Quality Standard: WDMA I.S.1-A.
- B. Obtain flush wood doors through one source from one manufacturer.
- C. Fire-Rated Wood Doors: Labeled by a testing and inspecting agency acceptable to authorities having jurisdiction based on testing according to NFPA 252.
- D. Provide doors made with adhesives and composite wood products that do not contain urea formaldehyde.
- E. WDMA I.S.1-A Performance Grade:
 - 1. Heavy Duty unless otherwise indicated.
- F. Provide 5 ¼" solid wood top, bottom and intermediate rails and stiles to prevent thru-bolting of door hardware closers and other hardware items, or provide structural composite lumber cores.
- G. Fire-Protection-Rated Doors: Provide core specified or mineral core as needed to provide fire-protection rating indicated. Provide the following for mineral-core doors:
 - 1. Composite blocking where required to eliminate through-bolting hardware.
 - 2. Laminated-edge construction.
 - 3. Formed-steel edges and astragals for pairs of doors.

2.2 FABRICATION AND FINISHING

- A. Factory fit doors to suit frame-opening sizes indicated and to comply with clearances specified.

- B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3.
- C. Shop prime faces and edges of doors, including cutouts, with one coat of wood primer as specified in Division 09 Section "Painting"

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install doors to comply with manufacturer's written instructions and WDMA I.S.1-A, and as indicated.
 - 1. Install fire-rated doors to comply with NFPA 80.
- B. Align and fit doors in frames with uniform clearances and bevels.
- C. Clearances: As follows unless otherwise indicated:
 - 1. 1/8 inch (3.2 mm) at heads, jambs, and between pairs of doors.
 - 2. 1/8 inch (3.2 mm) from bottom of door to top of decorative floor finish or covering.
 - 3. 1/4 inch (6.4 mm) from bottom of door to top of threshold.
 - 4. Comply with NFPA 80 for fire-rated doors.
- D. Rehang or replace doors that do not swing or operate freely.

END OF SECTION 081416

SECTION 084113 - ALUMINUM-FRAMED ENTRANCES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data, Shop Drawings, and color Samples.
 - 1. For entrance doors, include hardware schedule.

PART 2 - PRODUCTS

2.1 ALUMINUM-FRAMED ENTRANCES

- A. Basis of Design Products:
 - 1. Kawneer Trifab 601T.
- B. Accessible Entrances: Comply with ICC/ANSI A117.1.
- C. Performance Requirements:
 - 1. Air Infiltration: Limited to 0.06 cfm/sq. ft. (0.03 L/s per sq. m) of system surface area when tested according to ASTM E 283 at a static-air-pressure difference of 6.24 lbf/sq. ft. (300 Pa).
 - 2. Water Penetration: Systems do not evidence water leakage when tested according to ASTM E 331 at minimum differential pressure of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).
 - 3. Thermal Conductance: Average U-factor of not more than 0.69 Btu/sq. ft. x h x deg F (3.92 W/sq. m x K)] when tested according to AAMA 1503.
- D. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated; ASTM B 209 (ASTM B 209M) sheet; ASTM B 221 (ASTM B 221M) extrusions.
- E. Glazing: As specified in Division 08 Section "Glazing."
- F. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
- G. Doors: 1-3/4-inch- (44.5-mm-) thick glazed doors with minimum 0.125-inch- (3.2-mm-) thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods. Provide snap-on extruded-aluminum glazing stops, and preformed gaskets.
 - 1. Door Design: Medium stile; 3-1/2-inch (88.9-mm) nominal width. Thermally broken.

2. Accessible Doors: Smooth surfaced for width of door in area within 10 inches (255 mm) above floor or ground plane.
 3. Interior Doors: Provide ANSI/BHMA A156.16 silencers, three on strike jamb of single-door frames and two on head of double-door frames.
 4. Exterior Doors: Provide compression weather stripping at fixed stops. At other locations, provide sliding weather stripping retained in adjustable strip mortised into door edge.
 5. Hardware: As specified in Division 08 Section "Door Hardware".
- H. Fasteners and Accessories: Compatible with adjacent materials, corrosion resistant, nonstaining, and nonbleeding. Use concealed fasteners except for application of door hardware.
- I. Fabrication: Fabricate framing in profiles indicated for flush glazing (without projecting stops). Provide subframes and reinforcing of types indicated or, if not indicated, as required for a complete system. Factory assemble components to greatest extent possible. Disassemble components only as necessary for shipment and installation.
1. Door Framing: Reinforce to support imposed loads. Factory assemble door and frame units and factory install hardware to greatest extent possible. Reinforce door and frame units for hardware indicated. Cut, drill, and tap for factory-installed hardware before finishing components.
- J. Aluminum Finish: Fluoropolymer two-coat coating system complying with AAMA 2604.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Isolate metal surfaces in contact with incompatible materials, including wood, by painting contact surfaces with bituminous coating or primer, or by applying sealant or tape recommended by manufacturer.
- B. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
- C. Set continuous sill members and flashing in full sealant bed as specified in Division 07 Section "Joint Sealants" to produce weathertight installation.
- D. Install framing components true in alignment with established lines and grades to the following tolerances:
 1. Variation from Plane: Limit to 1/8 inch in 12 feet (3 mm in 3.7 m); 1/4 inch (6 mm) over total length.
 2. Alignment: For surfaces abutting in line, limit offset to 1/16 inch (1.5 mm). For surfaces meeting at corners, limit offset to 1/32 inch (0.8 mm).

3. Diagonal Measurements: Limit difference between diagonal measurements to 1/8 inch (3 mm).
- E. Install doors without warp or rack. Adjust doors and hardware to provide tight fit at contact points and smooth operation.

END OF SECTION 084113

SECTION 085113 - ALUMINUM WINDOWS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data, shop drawings and color Samples.
- B. Warranties: Agreement to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.

Window, glazing units and aluminum finish: 10 years from date of Substantial Completion

PART 2 - PRODUCTS

2.1 ALUMINUM WINDOWS

- A. Basis of Design Products:
 - 1. Kawneer Trifab 601T
- B. Window Types:
 - 1. Fixed.
- C. Performance Requirements: AAMA/WDMA/CSA 101/I.S.2/A440.
 - 1. Performance Class: CW.
 - 2. Performance Grade: 30.
 - 3. Condensation-Resistance Factor: 45 per AAMA 1503.
 - 4. Thermal Transmittance: Whole-window U-factor not more than 0.30 Btu/sq. ft. x h x deg F (1.71 W/sq. m x K) wind velocity and winter temperatures per AAMA 1503.
 - 5. Solar Heat-Gain Coefficient: Whole-window SHGC not more than 0.40, per NFRC 200.
- D. Construction: Provide units with a concealed, thermal break.
- E. Glaze units with clear, low-e coated sealed insulating glass, complying with Division 08 Section "Glazing."
- F. Finish: Fluoropolymer 2-coat coating system complying with AAMA 2604.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Set units level, plumb, and true to line, without warp or rack of frames and panels. Provide proper support and anchor securely in place.
- B. Set sill members in bed of sealant or with gaskets, as indicated, to provide weathertight construction.
- C. Adjust operating panels, screens, and hardware to provide a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts.
- D. Clean aluminum surfaces and glass immediately after installing windows. Remove nonpermanent labels from glass surfaces.

END OF SECTION 085113

PART 1 - GENERAL

1.1 Refer to "General and Special Conditions", and "Instructions to Bidders", Division 1 of Specifications. Requirements of these Sections and the project drawings shall govern work in this section.

1.2 Work Included:

- A. Furnish all items of Finish Hardware specified, scheduled, shown or required herein except those items specifically excluded from this section of the specification.
- B. Specific Omissions: Hardware for the following is specified or indicated elsewhere, unless specifically listed in the hardware sets:
 - 1. Windows
 - 2. Cabinets of all kinds, including open wall shelving and locks.
 - 3. Signs, except as noted.
 - 4. Toilet accessories of all kinds including grab bars.
 - 5. Installation
 - 6. Rough hardware
 - 7. Angle sill threshold
 - 8. Corner guards
 - 9. Access doors and panels

1.3 Quality Assurance

- A. Requirements of Regulatory Agencies:
 - 1. Furnish finish hardware to comply with the requirements of laws, codes, ordinances, and regulations of the governmental authorities having jurisdiction where such requirements exceed the requirements of the Specifications.
 - 2. Furnish finish hardware to comply with the requirements of the regulations for public building accommodations for physically handicapped persons of the governmental authority having jurisdiction and to comply with Americans with Disabilities Act.
 - 3. Provide hardware for fire-rated openings in compliance with NFPA 80 and state and local building code requirements. Provide only hardware that has been tested and listed by UL for types and sizes of doors required and complies with requirements of door and door frame labels.
 - 4. Where emergency exit devices are required on fire-rated doors that carry supplementary marking on the doors UL labels indicating "Fire Door to be equipped with Fire Exit Hardware" provide UL label on exit devices indicating "Fire Exit Hardware".
- B. Hardware Supplier:

1. Shall be an established firm dealing in contract builders' hardware. He must have adequate inventory, qualified personnel on staff and be located within 100 miles of the project. Only domestic manufacturers are acceptable and the distributor must be a factory-authorized dealer for all materials required. The supplier shall be or have in employment an Architectural Hardware Consultant. (AHC)

C. Electrified Door Hardware Supplier:

1. Shall be an experienced door hardware supplier who has completed projects with electrified door hardware similar in material, design, and extent to that indicated for this project, whose work has resulted in construction with a record of successful in-service performance, and who is acceptable to manufacturer of primary materials.
2. Shall prepare data for electrified door hardware, including shop drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this project.
3. Shall have experience in providing consulting services for electrified door hardware installations.

D. Pre-construction Meeting:

1. Prior to development of the Hardware Schedule, a Finish Hardware Meeting will be held at the Architect's office. The Contractor and the Hardware Supplier's personnel, directly responsible for preparing the Hardware Schedule, shall meet with the Architect and the Architect's Hardware Consultant. The purpose of the meeting is to review the contract documents' hardware schedule requirements and will include, but not be limited to the following:
 - a. Review specification requirements for hardware schedule, formats, hardware locations, opening descriptions, and other information specified.
 - b. Review products specified versus products proposed.
 - c. Hardware Supplier shall distribute, at the meeting, samples of schedules from other projects of similar nature prepared by the same person as will prepare schedule for this project.

E. Pre-installation Meeting:

1. Before hardware installation, Contractor shall request a hardware installation seminar be conducted on the installation of hardware; specifically that of locksets, closers, exit devices, overhead stops and coordinators. Manufacturer's representatives of the above products, in conjunction with the hardware supplier for the project, shall present the seminar. Seminar to be held at job site and attended by installers of hardware for aluminum, hollow metal and wood doors. Seminar to address proper coordination and installation of hardware, per finish hardware schedule for this specific project, by using installation manuals, hardware schedule, templates, physical product samples and installation video's.
2. When any electrical or pneumatic hardware is specified this meeting shall also include the following trades/installers: Electrical, Security, Alarm systems and Architect.
3. Convene one week prior to commencing work of this Section
4. Coordinate with Section 01039

5. The Hardware Supplier shall include the cost of this seminar in his proposal.

F. Manufacturer:

1. Obtain each type of hardware (latch and lock sets, hinges, closers, etc.) from a single manufacturer, although several may be indicated as offering products complying with requirements.

1.4 Submittals:

- A. See Section 01300 – Administrative Requirements, for submittal procedures.

B. Hardware Schedule

1. Submit proper number of Hardware Schedules to allow the Architect to retain two copies for his use, plus the number of copies required by the Contractor for his distribution and use. In any event, do not submit more than six copies.
2. Include the following:
 - a. Preface sheet listing category only and manufacturer's names of items being furnished as follows:

CATEGORY	SPECIFIED	SCHEDULED
Hinges	Manufacturer A	Manufacturer B
Lock sets	Manufacturer X	Manufacturer X
Kick Plates	Open	Manufacturer Z

3. Hardware Locations: Refer to Article 3.1 B.2 Locations.
4. Opening Description: Single or pair, number, room locations, hand, active leaf, degree of swing, size, door material, frame material, and UL listing.
5. Hardware Description: Quantity, category, product number, fasteners, and finish.
6. Headings that refer to the specified Hardware Set Numbers.
7. Scheduling Sequence shown in Hardware Sets.
8. Product data of each hardware item, and shop drawings where required, for special conditions and specialty hardware.
9. Riser drawings, wiring drawings and system operation description.
10. "Vertical" scheduling format only. "Horizontal" schedules will be returned "Not Approved."
11. Typed Copy.
12. Double-Spacing.
13. 8-1/2 x 11 inch sheets
14. U.S. Standard Finish symbols or BHMA Finish symbols.
15. Generally, follow guidelines established in Door & Hardware Institute Handbook (DHI) Sequence and Format for the Hardware Schedule. Modified as above.

C. Product Data:

1. Submit, in booklet form using supplier's schedule covers as binders. Product data of items of hardware listed in supplier's schedule.
2. Submit product data concurrently with hardware schedule.

D. Inspection Report:

1. Submit inspection report specified in 3.1.C.2. for locksets, exit devices, ADA special closers, door closers and all electrical hardware.

E. Samples:

1. Prior to submittal of the final hardware schedule and prior to final ordering of finish hardware, submit one sample, if required, of each type of exposed hardware unit, finished as required and tagged with full description for coordination with schedule.
2. Samples will be returned to the supplier. Units, which are acceptable and remain undamaged through submittal, review and field comparison procedures may, after final check of operation, be used in the work, within limitations of keying coordination requirements.

F. Submit to Contractor, two copies each of parts and service manuals and two each of any special installation or adjustment tools. Include for locksets, exit devices, door closers and any electrical products.

1.5 Product Delivery, Storage, and Handling

- A. Label each item of hardware with the appropriate door number and Hardware Schedule heading number, and deliver to the installer so designated by the contractor.

1.6 Warranties

- A. Closers shall carry manufacturer's 10-year warranty against manufacturing defects and workmanship.
- B. Balance of items shall carry a manufacturer's 1-year warranty against manufacturing defects and workmanship.
- C. During the warranty period, replace defective work, including labor, materials and other costs incidental to the work. Inspect the work within 24 hours after receipt of notice from the Owner. Replace work found to be defective as defined in the Contract Documents.

PART 2 - PRODUCT

- 2.1 Furnish each category with the products of only one manufacturer unless specified otherwise; this requirement is mandatory whether various manufacturers are listed or not.
- 2.2 Provide the products of manufacturer designated or if more than one manufacturer is listed, the comparable product of one of the other manufacturers listed. Where only one manufacturer or product is listed, "no substitution" is implied.
 - A. Hinges:
 1. Numbers used in sets are Ives. Equal products of any B.H.M.A. member are also acceptable.
 - B. Locksets and Latchsets – Grade 1 Mortise Type with Tubular Lever Trim:
 1. Function numbers are Schlage L9000 series with 03N lever trim.
 - a. Corbin-Russwin ML2000 series with LSM lever trim will also be acceptable.
 - C. Exit Devices – Exterior Doors:
 1. Function numbers are Von Duprin 35A series. (No substitutions)
 - D. Exit Devices – Interior Doors:
 1. Function numbers are Von Duprin 98 series.
 - a. Sargent 80 series will also be acceptable.
 - E. Push and Pull Hardware:
 1. Numbers used in sets are Ives. Equal products of any B.H.M.A. member are also acceptable.
 - F. Closers and Handicap Operators:
 1. Refer to door and frame details and furnish accessories such as drop plates, panel adapters, spacers and supports as required to correctly install door closers. State degree of door swing in the hardware schedule.
 2. IR-LCN Series as listed in sets. (No substitutions)
 - G. Overhead Holders and Stops:
 1. Type, function and fasteners must be same as Glynn-Johnson specified. Size per manufacturer's selector chart. Plastic end caps, hold open mechanisms and shock blocks are not allowed. End caps must be finished same as balance of unit.
 2. Manufacture products using base material of Brass/Bronze for US3, US4, & US10B finished products and 300 Stainless Steel for US32 & US32D finished products.
 3. Type, function, SPECIAL TEMPLATING and fasteners must be the same as Glynn-Johnson specified. Size per manufacturer's selector chart.
 - H. Thresholds:

1. Type and size and indicated on sil details.

- a. National Guard Products
- b. Pemko
- c. Reese

I. Miscellaneous:

1. Furnish items not categorized in the above descriptions but specified by manufacturer's names in Hardware Sets.

J. Fasteners:

1. Furnish fasteners of the proper type, size, quantity and finish. Use machine screws and expansion shields for attaching hardware to concrete or masonry, and wall grip inserts at hollow wall construction. Supply sex bolts for closers at lead-lined or UL listed wood doors only. Supply sex bolts when UL listing of wood doors requires them. Furnish machine screws for attachment to reinforced hollow metal doors and frames and reinforced aluminum doors and frames. Furnish full thread wood screws for attachment to solid wood doors and frames. "TEK" type screws are not acceptable.

2.3 Finishes:

- A. Provide finishes as indicated in sets.

2.4 Templates and Hardware Location:

- A. Furnish hardware made to template. Supply required templates and hardware locations to the door and frame manufacturers.
- B. Furnish metal template to frame/door supplier for continuous hinge.
- C. Refer to Article 3.1 B.2, Locations, and coordinate with templates.

2.5 Cylinders Key Control and Keying:

- A. All locking devices shall be supplied prepared for "Best" seven pin cylinders.
- B. Furnish cylinders with construction cores for all items capable of being locked. All final cores, and keys, shall be furnished and installed by the W.S.U. Key Shop.

PART 3 - EXECUTION

3.1 Installation

A. General:

1. Install hardware according to manufacturers installations and to manufacturers template dimensions. Attach all items of finish hardware to doors, frames, walls, etc. with fasteners furnished and required by the manufacture of the item.
2. Refer to Article 2.5, cylinders and keying regarding conversion of construction cores to final cores.

B. Locations:

1. Dimensions are from finish floor to center line of items.
2. Include this list in Hardware Schedule.

<u>CATEGORY</u>	<u>DIMENSION</u>
Exit Device Touchbar	Per Template
Push-Pull Units	40" Pull Portion
Lock Sets	Frame Manufacturer's Standard

3.2 Hardware Sets:

HW SET: 01

1	EA	CONTINUOUS HINGE	112HD EPT	DKB	IVE
1	EA	BY SECTION 28 10 00	EPT-10	695	VON
1	EA	BY SECTION 28 10 00	RXLXLC-35A-EO	626	VON
1	EA	DOOR PULL	8190-2-N0	630	IVE
1	EA	SURFACE CLOSER	4021	695	LCN
1	EA	OVERHEAD STOP	900S	613	GLY
1	SET	WEATHER SEAL	BY FRAME SUPPLIER		B/O
1	EA	DOOR SWEEP	C627DKB	DKB	NGP
1	EA	THRESHOLD	425	AL	NGP
1	EA	BY SECTION 28 10 00	GE#1076D		SEN

OPERATION: THE DOOR IS MONITORED BY THE DEPARTMENT OF PUBLIC SAFETY.

HW SET: 02

1	EA	CONTINUOUS HINGE	112HD EPT	DKB	IVE
1	EA	BY SECTION 28 10 00	EPT-10	695	VON
1	EA	BY SECTION 28 10 00	EL-LXRXC-35A-NL-OP	626	VON
1	EA	RIM CYLINDER	1E72	626	BES
1	EA	DOOR PULL	8190-2-NO	630	IVE
1	EA	BY SECTION 28 10 00	4642 (RHR LEAF)	695	LCN
1	EA	OVERHEAD STOP	900S	613	GLY
1	SET	WEATHER SEAL	BY FRAME SUPPLIER		B/O
1	EA	DOOR SWEEP	C627DKB	DKB	NGP
1	EA	THRESHOLD	425	AL	NGP
1	EA	BY SECTION 28 10 00	POWER SUPPLY	GRY	VON
1	EA	BY SECTION 28 10 00	GE#1076D		SEN
1	EA	BY SECTION 28 10 00	CARD READER		B/O
2	EA	BY SECTION 28 10 00	8310-853T	630	LCN

OPERATION: THE CARD READER & THE SECURITY SYSTEM SCHEDULE WILL UNLOCK THE DOORS FOR ENTRY. WHEN THE DOOR IS UNLOCKED ELECTRICALLY, THE WALL SWITCHES LOCATED ON EACH SIDE OF THE DOOR WILL ACTIVATE THE BARRIER FREE OPERATOR. THE DOOR IS MONITORED BY THE DEPARTMENT OF PUBLIC SAFETY.

HW SET: 03

1	EA	CONTINUOUS HINGE	112HD	DKB	IVE
1	EA	SURFACE CLOSER	4021	695	LCN
1	EA	OVERHEAD STOP	900S	613	GLY
1	EA	PUSH PULL UNIT	9190HD-2-NO	630	IVE

HW SET: 04

1	EA	CONTINUOUS HINGE	112HD	DKB	IVE
1	EA	BY SECTION 28 10 00	4642 (RHR LEAF)	695	LCN
1	EA	OVERHEAD STOP	900S	613	GLY
1	EA	PUSH PULL UNIT	9190HD-2-NO	630	IVE
2	EA	BY SECTION 28 10 00	8310-853T	630	LCN

HW SET: 05

1	EA	CONTINUOUS HINGE	224HD-EPT	628	IVE
1	EA	BY SECTION 28 10 00	RXLX-98-EO	626	VON
1	EA	SURFACE CLOSER	4111 SCUSH X ST-1586	689	LCN
1	SET	WEATHER SEAL	700NA	AL	NGP

Harwell Field Building
Wayne State University
080-232104

Silveri Architects
BIDS 04-29-16

1	EA	DOOR SWEEP	C627A	AL	NGP
1	EA	THRESHOLD	425	AL	NGP
1	EA	BY SECTION 28 10 00	GE#1076D		SEN
1	EA	BY SECTION 28 10 00	WALL MOUNTED ALARM HORN		B/O

HW SET: 06

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	INDICATOR PRIVACY LOCK	L9486BDC 03N L583-363 L283-722	626	SCH
1	EA	SURFACE CLOSER	4111 SCUSH	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE

HW SET: 07

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	L9080BDC 03N	626	SCH
1	EA	SURFACE CLOSER	4011 DEL	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE
1	EA	WALL STOP	WS33	626	IVE

HW SET: 08

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	STOREROOM LOCK	L9080BDC 03N X KNURLED LEVER	626	SCH
1	EA	SURFACE CLOSER	4011 DEL X ST-1544	689	LCN
1	EA	OVERHEAD STOP	100S	630	GLY
1	EA	KICK PLATE	8400 10" X 2" LDW	630	IVE

HW SET: 09

3	EA	HINGE	5BB1 4.5 X 4.5	652	IVE
1	EA	OFFICE/ENTRY LOCK	L9050BDC 03N L583-363	626	SCH
1	EA	WALL STOP	WS33	626	IVE

HW SET: 10

1	EA	REMOVABLE CENTER POST	SL-61-KR	DKB	SPE
1	EA	MORTISE CYLINDER	1E74 X ADAMS-RITE CAM	613	BES
1	EA	CONTINUOUS HINGE	112HD EPT	DKB	IVE
1	EA	BY SECTION 28 10 00	EPT-10	695	VON
1	EA	BY SECTION 28 10 00	RXLXLC-35A-EO	626	VON
1	EA	DOOR PULL	8190-2-N0	630	IVE
1	EA	SURFACE CLOSER	4021	695	LCN
1	EA	OVERHEAD STOP	900S	613	GLY
1	SET	WEATHER SEAL	BY FRAME SUPPLIER		B/O
1	EA	DOOR SWEEP	C627DKB	DKB	NGP
1	EA	THRESHOLD	425	AL	NGP

Harwell Field Building
Wayne State University
080-232104

Silveri Architects
BIDS 04-29-16

1 EA BY SECTION 28 10 00

GE#1076D

SEN

OPERATION: THE DOOR IS MONITORED BY THE DEPARTMENT OF PUBLIC SAFETY.

HW SET: 11

1	EA	REMOVABLE CENTER POST	SL-61-KR	DKB	SPE
1	EA	MORTISE CYLINDER	1E74 X ADAMS-RITE CAM	613	BES
1	EA	CONTINUOUS HINGE	112HD	DKB	IVE
1	EA	SURFACE CLOSER	4021	695	LCN
1	EA	OVERHEAD STOP	900S	613	GLY
1	EA	PUSH PULL UNIT	9190HD-2-NO	630	IVE

END OF SECTION 08710

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data and 12-inch- (300-mm-) square Samples.
- B. Fire-Resistance-Rated Assemblies: Provide products that comply with NFPA 80 and are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for applications indicated.
- C. Safety Glass: Category II materials complying with testing requirements in 16 CFR 1201.
- D. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated.
 - 1. +GANA Publications: GANA's "Glazing Manual."
 - 2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- E. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- F. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS

- A. Float Glass: ASTM C 1036, Type I, Quality-Q3.
- B. Heat-Treated Float Glass: ASTM C 1048; Type I; Quality-Q3.
- C. Laminated Glass: ASTM C 1172, and complying with testing requirements in 16 CFR 1201 for Category II materials.
- D. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190.

2.2 INSULATING-GLASS TYPES

- A. Exterior Window Type:
 - 1. Viracon Low-e-coated, clear insulating glass. VE 1-45 1" IGU.
- B. Glazed Aluminum Door Type:
 - 1. Viracon Low-e-coated, clear insulating glass. VE 1-45 1" IGU.

2.3 MONOTLITHIC-GLASS TYPES

- A. Interior Glass Type:
 - 1. Clear fully-tempered float glass. .25 inch thickness, provide safety glazing labeling.

2.4 GLAZING SEALANTS

- A. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.
- B. Glazing Sealants for Fire-Rated Glazing Products: Products that are approved by testing agencies that listed and labeled fire-resistant glazing products with which they are used for applications and fire-protection ratings indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with combined recommendations of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are contained in GANA's "Glazing Manual."
- B. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- C. Remove nonpermanent labels, and clean surfaces immediately after installation.

END OF SECTION 088000

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 PANEL PRODUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Steel Framing and Furring:
 - Clark Steel Framing Systems.
 - Dale Industries, Inc. - Dale/Incor.
 - Dietrich Industries, Inc.
 - National Gypsum Company.
 - Unimast, Inc.
 - Western Metal Lath & Steel Framing Systems.
 - 2. Gypsum Board and Related Products:
 - American Gypsum Co.
 - G-P Gypsum Corp.
 - Lafarge North America Inc.
 - National Gypsum Company
 - United States Gypsum Co. (USG Corp.)
- A. Provide in maximum lengths available to minimize end-to-end butt joints.
- B. Interior Gypsum Board: ASTM C 36/C 36M or ASTM C 1396/C 1396M, in thickness indicated, with manufacturer's standard edges. Type X at all metal framed partitions.
- C. Interior Toilet Room Gypsum Board: Water-Resistant Gypsum Backing Board, ASTM C 630/C 630M or ASTM C 1396/C 1396M, in thickness indicated. Type X.

2.2 ACCESSORIES

- A. Trim Accessories: ASTM C 1047, formed from galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.
 - 1. Provide cornerbead at outside corners unless otherwise indicated.
 - 2. Provide LC-bead (J-bead) at exposed panel edges.
 - 3. Provide control joints where indicated.
- B. Joint-Treatment Materials: ASTM C 475/C 475M.
 - 1. Joint Tape: Paper unless otherwise recommended by panel manufacturer.
 - 2. Joint Compounds: Setting-type taping compound and drying-type, ready-mixed, compounds for topping.
 - 3. Finish Coat: Use setting tape, sandable topping compound.
 - 4. Skim Coat: For final coat of Level 5 finish, use setting tape, sandable topping compound.
- C. Sound-Attenuation Blankets: ASTM C 665, Type I (unfaced).
- D. Steel Drill Screws: ASTM C 1002.
 - 1. Use screws complying with ASTM C 954 for fastening panels to steel members from .033 to .122 inch thick.

2.3 STEEL PARTITION FRAMING

- A. Components, General: Refer to Section 054000 "Cold-Formed Metal Framing"
 - 1. Comply with ASTM C 754 for conditions indicated.
 - 2. Steel Sheet Components: ASTM C 645, ASTM A 653/A 653M.
 - 3. Steel Studs and Runners: ASTM C 645

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install gypsum board to comply with ASTM C 840.
 - 1. Isolate gypsum board assemblies from abutting structural and masonry work. Provide edge trim and acoustical sealant.
- B. Finishing Gypsum Board: ASTM C 840.
 - 1. At concealed areas, unless a higher level of finish is required for fire-resistance-rated assemblies, provide Level 1 finish: Embed tape at joints.

2. At substrates for tile, provide Level 2 finish: Embed tape and apply separate first coat of joint compound to tape, fasteners, and trim flanges.
3. Unless otherwise indicated, provide Level 4 finish: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges.

3.2 STEEL SUSPENDED CEILING AND SOFFIT FRAMING

- A. Suspend ceiling hangers from building structure as follows:
 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or ceiling suspension system.
 2. Where width of ducts and other construction within ceiling plenum interferess with the location of hangers, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
 3. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eye-screws, or other devices and fasteners that are secure and appropriate for substrate.
 4. Do not attach hangers to steel roof deck, ducts, pipes or conduit. Attach hangers to structural members
- B. Installation Tolerances: Install steel framing components for suspended ceilings so members for panel attachment are level to within 1/8 inch in 12 feet (3 mm in 3.6 m).
- C. Sway-brace suspended steel framing with hangers used for support
- D. Install suspended steel framing components in sizes and spacings indicated, but not less than that required by the referenced steel framing and installation standards.
 1. Hangers: 48 inches (1219 mm) o.c.
 2. Carrying Channels (Main Runners): 48 inches (1219 mm) o.c.
 3. Furring Channels (Furring Members): 16 inches (406 mm) o.c.
- E. Grid Suspension System: Attach perimeter wall track or angle where grid suspension system meets vertical surfaces

3.3 STEEL PARTITION

- A. Install tracks (runners) at floors, ceilings, and structural walls and columns where gypsum board assemblies abut other construction:
 1. Where studs are installed directly against exterior walls, install asphalt-felt or foam-gasket isolation strip between studs and wall.
- B. Installation Tolerance: Install each steel framing and furring member so fastening surfaces vary not more than 1/8 inch from the plane formed by the faces of adjacent framing.

- C. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.
 - 1. Cut studs 1/2 inch short of full height to provide perimeter relief.
 - 2. For fire-resistance-rated and STC-rated partitions that extend to the underside of floor/roof slabs and decks or other continuous solid-structure surfaces to obtain ratings, install framing around structural and other members extending below floor/roof slabs and decks, as needed to support gypsum board closures and to make partitions continuous from floor to underside of solid structure.
- D. Install steel studs and furring in sizes and spacings indicated, but not less than that required by the referenced steel framing and installation standards.
 - 1. Single-Layer Construction: 16 inches (406 mm) o.c., unless otherwise indicated.
 - 2. Multilayer Construction: 16 inches (406 mm) o.c., unless otherwise indicated.
 - 3. Cementitious Backer Units: 16 inches (406 mm) o.c., unless otherwise indicated
- E. Frame door openings to comply with GA-600 and with gypsum board manufacturer's applicable written recommendations, unless otherwise indicated. Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
 - 1. Install two studs at each jamb.
 - 2. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint.
 - 3. Extend jamb studs through suspended ceilings and attach to underside of floor or roof structure above.
- F. Frame openings other than door openings the same as required for door openings, unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
- G. Z-Furring Members:
 - 1. Erect insulation vertically and hold in place with Z-furring members spaced 24 inches o.c.
 - 2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
 - 3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches (300 mm) from corner and cut insulation to fit.

END OF SECTION 092900

SECTION 093000 - TILING

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data for each type of product indicated and Samples for tile and grout.
- B. Obtain tile of each type and color or finish from same production run for each contiguous area
- C. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use.

PART 2 - PRODUCTS

2.1 CERAMIC TILE

- A. Ceramic tile that complies with Standard grade requirements in ANSI A137.1, "Specifications for Ceramic Tile."
- B. Tile Type CT-1: Factory-mounted porcelain ceramic mosaic tile.
 - 1. Products:
 - a. Florim USA Basaltine.
 - 2. Module Size: Refer to Schedule in Drawings, Sheet A.03.
 - 3. Color and Pattern: Refer to Schedule in Drawings, Sheet A.03.
 - 4. Grout Color: Refer to Schedule in Drawings, Sheet A.03.
 - 5. Trim Units: Schluter Systems Dilex Ahka base trim, Schluter Systems Schiene top trim.

2.2 INSTALLATION MATERIALS

- A. VOC Limit for Adhesives and Fluid-Applied Waterproofing Membranes: 65 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Setting and Grouting Materials: Comply with material standards in ANSI's "Specifications for the Installation of Ceramic Tile" that apply to materials and methods indicated.
 - 1. Thin-Set Mortar Type: Latex-portland cement.
 - a. Available Products:

- 1) TEC Full Flex Premium Thin Set Mortar.
2. Grout Type: Polymer modified.
 - a. Available Products:
 - 1) TEC Power Grout Unsanded. Refer to Schedule in Drawings, Sheet A.03.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with TCA's "Handbook for Ceramic Tile Installation" for TCA installation methods specified in tile installation schedules. Comply with parts of ANSI A108 Series "Specifications for Installation of Ceramic Tile" that are referenced in TCA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
- B. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- C. Lay tile in grid pattern unless otherwise indicated. Align joints where adjoining tiles on floor, base, walls, and trim are the same size.
- D. Install cementitious backer units and treat joints according to ANSI A108.11.
- E. Install stone thresholds in same type of setting bed as adjacent floor unless otherwise indicated.
- F. Interior Floor Tile Installation Method(s):
 1. Over Concrete Subfloors: TCA F113 (thin-set mortar)
- G. Interior Wall Tile Installation Method(s):
 1. Over Concrete and Masonry: TCA W202 (thin-set mortar).
 2. Over Metal Studs or Furring: TCA W244 (thin-set mortar on cementitious backer units or fiber cement underlayment).

END OF SECTION 093000

SECTION 095123 - ACOUSTICAL TILE CEILINGS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 ACOUSTICAL TILE

- A. ACT-1:

- 1. Armstrong 2824 Calla
- 2. White, Tegular
- 3. 24 inches x 24 inches
- 4. Suspension: 9/16 Suprafine, White

- B. ACT-2:

- 1. Armstrong 1713 Schoolzone Fine Fissured
- 2. White, Square Lay-In
- 3. 24 inches x 24 inches
- 4. Suspension: 15/16 Prelude, White

- C. ACT-3:

- 1. Armstrong 6487 Woodworks Vector
- 2. Maple, Tegular, W5 Perforation
- 3. 24 inches x 72 inches
- 4. Suspension: 9/16 Suprafine, Bronze

- D. AWP-1:

1. Armstrong 5819 Woodworks Wall
 2. Maple, , W5 Perforation
 3. 24 inches x 108 inches
 4. Mounting: Z clip
- E. Surface-Burning Characteristics: ASTM E 1264, tested per ASTM E 84.

2.2 SUSPENSION SYSTEM

- A. Ceiling Suspension System: Direct Hung ASTM C 635, heavy-duty structural classification.
- B. Attachment Devices: Size for 5 times the design load indicated in ASTM C 635, Table 1, Direct Hung, unless otherwise indicated.
- C. Wire Hangers, Braces, and Ties: Zinc-coated carbon-steel wire; ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
1. Size: Provide yield strength at least 3 times the hanger design load (ASTM C 635, Table 1, Direct Hung), but not less than 0.135-inch- (3.5-mm-) diameter wire.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Ceiling Suspension System Installation: Comply with ASTM C 636 and CISCAs "Ceiling Systems Handbook."
1. Wall panels: Z clips installed per manufacturer's recommendations.
- B. Install acoustical tiles in coordination with suspension system and exposed moldings and trim. Place splines or suspension system flanges into kerfed edges so tile-to-tile joints are closed by double lap of material.
1. Fit adjoining tile to form flush, tight joints. Scribe and cut tile for accurate fit at borders and around penetrations through tile.
- C. Arrange directionally patterned acoustical panels as indicated on Drawings.

END OF SECTION 095123

SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data and Samples.

PART 2 - PRODUCTS

2.1 RESILIENT BASE

- A. Products: ASTM F 1861. Rubber. Refer to schedule in Drawings.
- B. Color and Pattern: Refer to schedule in Drawings.
- C. Height: 2 ½".
- D. Length: Coils.
- E. Style: Standard straight base.
- F. Corners: Provide matching prefabricated units. Required at all bullnosed corners.

2.2 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement or blended hydraulic cement-based formulation provided or approved by flooring manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by manufacturer to suit products and substrate conditions.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Prepare concrete substrates according to ASTM F 710.
- B. Adhesively install resilient wall base and accessories.
- C. Install wall base in maximum lengths possible.
- D. END OF SECTION 096513

SECTION 099100 - PAINTING

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Interior paint and coatings systems including surface preparation.
- B. Exterior paint and coatings systems including surface preparation.

1.2 SUBMITTALS

- A. Product Data: For each paint system indicated.
- B. Verification Samples: For each finish product specified, submit samples that represent actual product, color, and sheen.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: A firm or individual experienced in applying paints and coatings similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
- B. Paint exposed surfaces. If a color of finish, or a surface is not specifically mentioned, Owner Representative will select from standard products, colors and sheens available.
- C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels unless indicated.
- D. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship, color and sheen.
 - 1. Finish surfaces for verification of products, colors and sheens.
 - 2. Finish area designated by Owner Representative.
 - 3. Do not proceed with remaining work until the Owner Representative approves the mock-up.

1.4 PROJECT CONDITIONS

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

1.5 EXTRA MATERIALS

- A. Furnish extra paint materials from the same production run as the materials applied and in the quantities described below. Package with protective covering for

storage and identify with labels describing contents. Deliver extra materials to Owner.

- B. Furnish Owner with an additional one percent of each material and color, but not less than 1 gal (3.8 l) or 1 case, as appropriate.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers:
Sherwin-Williams
Owner approved equal

2.2 APPLICATIONS/SCOPE

- A. Interior Paints and Coatings:
 - 1. Metal: Aluminum, galvanized steel.
 - 2. Metal: Structural steel, joists, trusses, beams, partitions and similar items.
 - 3. Drywall: Drywall board, Gypsum board.
- B. Exterior Paints and Coatings:
 - 1. Metal: Galvanized steel.

2.3 PAINT MATERIALS - GENERAL

- A. Paints and Coatings.
 - 1. Unless otherwise indicated, provide factory-mixed coatings. When required, mix coatings to correct consistency in accordance with manufacturer's instructions before application. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.
- B. Primers: Where the manufacturer offers options on primers for a particular substrate, use primer categorized as "best" by the manufacturer.
- C. Color: Refer to Finish Schedule for paint colors, and as selected.

2.4 INTERIOR PAINT SYSTEMS

- A. METAL: Galvanized; Ceilings, Duct work.
 - 1. Multi-Surface Acrylic Coating System:
 - a. Gloss Finish High Performance:
 - 1) 1st Coat: S-W Pro Industrial Multi-Surface Acrylic, B66-500 Series.
 - 2) 2nd Coat: S-W Pro Industrial Multi-Surface Acrylic, B66-500 Series (5.0 mils wet, 2.0 mils dry per coat).
- B. DRYWALL - (Walls, Ceilings, Gypsum Board and similar items)

1. Latex Systems:
 - a. Low Sheen Finish:
 - 1) 1st Coat: S-W ProMar 200 Zero VOC Interior Latex Primer, B28W2600 (4 mils wet, 1.5 mils dry).
 - 2) 2nd Coat: S-W ProMar 200 Zero VOC Latex Low Sheen Enamel, B24-2600 Series.
 - 3) 3rd Coat: S-W ProMar 200 Zero VOC Latex Low Sheen Enamel, B24-2600 Series (4 mils wet, 1.6 mils dry per coat).

2.5 EXTERIOR PAINT SYSTEMS

A. Galvanized-Metal Substrates:

- 1) Pigmented Polyurethane over Vinyl Wash Primer System:
 - a) Prime Coat: Primer, vinyl wash: S-W DTM Wash Primer, B71Y1, at 0.7 to 1.3 mils dry, per coat.
 - b) First Topcoat: Polyurethane, two-component, pigmented, matching topcoat.
 - c) Second Topcoat: Polyurethane, two-component, pigmented, semi-gloss: S-W Acrolon 218 HS Acrylic Polyurethane, B65-650 Series, at 3.0 to 6.0 mils dry, per coat.
 - d) Second Topcoat: Polyurethane, two-component, pigmented, gloss: S-W Acrolon 218 HS Acrylic Polyurethane, B65-600 Series, at 3.0 to 6.0 mils

PART 3 EXECUTION

3.1 EXAMINATION

- A. Do not begin installation until substrates have been properly prepared; notify Owner Representative of unsatisfactory conditions before proceeding. If substrate preparation is the responsibility of another installer, notify Owner Representative of unsatisfactory preparation before proceeding.
- B. Proceed with work only after conditions have been corrected and approved by all parties, otherwise application of coatings will be considered as an acceptance of surface conditions.

3.2 SURFACE PREPARATION

- A. General: Surfaces shall be dry and in sound condition. Remove oil, dust, dirt, loose rust, peeling paint or other contamination to ensure good adhesion.
 1. Remove mildew before painting by washing with a solution of 1 part liquid household bleach and 3 parts of warm water. Apply the solution and scrub the mildewed area. Allow the solution to remain on the surface for 10 minutes. Rinse thoroughly with clean water and allow the surface to dry a minimum of 48 hours before painting. Wear protective glasses or goggles, waterproof gloves, and protective clothing. Quickly wash off any of the mixture that comes in contact with your skin. Do not add detergents or ammonia to the bleach/water solution.
 2. Remove items including but not limited to thermostats, electrical outlets, switch

covers and similar items prior to painting. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.

- B. Aluminum: Remove all oil, grease, dirt, oxide and other foreign material by cleaning per SSPC-SP1, Solvent Cleaning.
- C. Block (Cinder and Concrete): Remove all loose mortar and foreign material. Surface must be free of laitance, concrete dust, dirt, form release agents, moisture curing membranes, loose cement, and hardeners. Concrete and mortar must be cured at least 30 days at 75 degrees F (24 degrees C). The pH of the surface should be between 6 and 9, unless the products are designed to be used in high pH environments. On tilt-up and poured-in-place concrete, commercial detergents and abrasive blasting may be necessary to prepare the surface. Fill bug holes, air pockets, and other voids with a cement patching compound.
- D. Concrete, SSPC-SP13 or NACE 6: This standard gives requirements for surface preparation of concrete by mechanical, chemical, or thermal methods prior to the application of bonded protective coating or lining systems. The requirements of this standard are applicable to all types of cementitious surfaces including cast-in-place concrete floors and walls, precast slabs, masonry walls, and shotcrete surfaces. An acceptable prepared concrete surface should be free of contaminants, laitance, loosely adhering concrete, and dust, and should provide a sound, uniform substrate suitable for the application of protective coating or lining systems.
- E. Drywall - Interior: Must be clean and dry. All nail heads must be set and spackled. Joints must be taped and covered with a joint compound. Spackled nail heads and tape joints must be sanded smooth and all dust removed prior to painting.
- F. Galvanized Metal: Clean per SSPC-SP1 using detergent and water or a degreasing cleaner to remove greases and oils. Apply a test area, priming as required. Allow the coating to dry at least one week before testing. If adhesion is poor, Brush Blast per SSPC-SP7 is necessary to remove these treatments.
- G. Steel: Structural, Plate, And Similar Items: Should be cleaned by one or more of the surface preparations described below. These methods are used throughout the world for describing methods for cleaning structural steel. Visual standards are available through the Society of Protective Coatings. A brief description of these standards together with numbers by which they can be specified follow.
 - 1. Solvent Cleaning, SSPC-SP1: Solvent cleaning is a method for removing all visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants. Solvent cleaning does not remove rust or mill scale. Change rags and cleaning solution frequently so that deposits of oil and grease are not spread over additional areas in the cleaning process. Be sure to allow adequate ventilation.
 - 2. Hand Tool Cleaning, SSPC-SP2: Hand Tool Cleaning removes all loose mill scale, loose rust, and other detrimental foreign matter. It is not intended that adherent mill scale, rust, and paint be removed by this process. Before hand tool cleaning, remove visible oil, grease, soluble welding residues, and salts by the methods outlined in SSPC-SP1.
 - 3. Power Tool Cleaning, SSPC-SP3: Power Tool Cleaning removes all loose mill scale, loose rust, and other detrimental foreign matter. It is not intended that adherent mill scale, rust, and paint be removed by this process. Before power tool cleaning,

- remove visible oil, grease, soluble welding residues, and salts by the methods outlined in SSPC-SP1.
4. White Metal Blast Cleaning, SSPC-SP5 or NACE 1: A White Metal Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP1 or other agreed upon methods.
 5. Commercial Blast Cleaning, SSPC-SP6 or NACE 3: A Commercial Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except for staining. Staining shall be limited to no more than 33 percent of each square inch of surface area and may consist of light shadows, slight streaks, or minor discoloration caused by stains of rust, stains of mill scale, or stains of previously applied paint. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP1 or other agreed upon methods.
 6. Brush-Off Blast Cleaning, SSPC-SP7 or NACE 4: A Brush-Off Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, loose mill scale, loose rust, and loose paint. Tightly adherent mill scale, rust, and paint may remain on the surface. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP 1 or other agreed upon methods.
 7. Power Tool Cleaning to Bare Metal, SSPC-SP11: Metallic surfaces that are prepared according to this specification, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxide corrosion products, and other foreign matter. Slight residues of rust and paint may be left in the lower portions of pits if the original surface is pitted. Prior to power tool surface preparation, remove visible deposits of oil or grease by any of the methods specified in SSPC-SP1, Solvent Cleaning, or other agreed upon methods.
 8. Near-White Blast Cleaning, SSPC-SP10 or NACE 2: A Near White Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except for staining. Staining shall be limited to no more than 5 percent of each square inch of surface area and may consist of light shadows, slight streaks, or minor discoloration caused by stains of rust, stains of mill scale, or stains of previously applied paint. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP1 or other agreed upon methods.
 9. High- and Ultra-High Pressure Water Jetting for Steel and Other Hard Materials: SSPC-SP12 or NACE 5: This standard provides requirements for the use of high- and ultra-high pressure water jetting to achieve various degrees of surface cleanliness. This standard is limited in scope to the use of water only without the addition of solid particles in the stream.
 10. Water Blasting, SSPC-SP12/NACE No. 5: Removal of oil grease dirt, loose rust, loose mill scale, and loose paint by water at pressures of 2,000 to 2,500 psi at a flow of 4 to 14 gallons per minute.

3.3 INSTALLATION

- A. Apply all coatings and materials with the manufacturer's specifications in mind. Mix

and thin coatings according to manufacturer's recommendations.

- B. Do not apply to wet or damp surfaces. Wait at least 30 days before applying to new concrete or masonry. Or follow manufacturer's procedures to apply appropriate coatings prior to 30 days. Test new concrete for moisture content. Wait until wood is fully dry after rain or morning fog or dew.
- C. Apply coatings using methods recommended by manufacturer.
- D. Uniformly apply coatings without runs, drips, or sags, without brush marks, and with consistent sheen.
- E. Apply coatings at spreading rate required to achieve the manufacturers recommended dry film thickness.
- F. Regardless of number of coats specified, apply as many coats as necessary for complete hide, and uniform appearance.

3.4 PROTECTION

- A. Protect finished coatings from damage until completion of project.
- B. Touch-up damaged coatings after substantial completion, following manufacturer's recommendation for touch up or repair of damaged coatings. Repair any defects that will hinder the performance of the coatings.

END OF SECTION 088000

SECTION 101400 - SIGNAGE

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data, Shop Drawings, and Samples.
- B. Regulatory Requirements: Comply with applicable provisions in ICC/ANSI A117.1.
- 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.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Aluminum Castings: Alloy recommended by sign manufacturer for casting process used and for use and finish indicated.
- B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy and temper recommended by aluminum producer and finisher, with not less than the strength and durability of 5005-H15.
- C. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy and temper recommended by aluminum producer and finisher, with not less than the strength and durability properties of 6063-T5.
- D. Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), Type UVA (UV absorbing).
- E. Plastic Laminate: High-pressure laminate engraving stock with face and core in contrasting colors.
- F. Applied Vinyl: Die-cut characters from vinyl film of nominal thickness of 3 mils (0.076 mm) with pressure-sensitive adhesive backing, suitable for exterior applications.

2.2 SIGNS

- A. Room Signage: Basis of Design - Best Sign Systems H300 Series ADA sign. 5/8" Standard Medium copy raised 1/32". ADA compliant. Matte finish characters with contrasting background. Holes and screw mounting with drywall anchors. Sign color matching screw heads. Provide color samples for Owner Representative approval prior to fabrication.

1. (2) Restroom signs: 6" x 8".
2. (3) Room signs: 6" x 6"
- B. Display Hall Dimensional Characters: Die-cut characters from vinyl film of nominal thickness of 3 mils (0.076 mm) with pressure-sensitive adhesive backing.
 1. Size and Color: As indicated in interior elevations, Sheet A22. Provide artwork for Owner Representative approval prior to fabrication.
- C. Exterior Channel Letter Sign: 24" high, 6" deep channel letter. Aluminum returns with translucent acrylic face. Internally lit. Provide shop drawing including channel letter font and spacing for Owner Representative approval. Refer to Drawing 3 / A3.2.
 1. Finishes and Colors: Refer to Drawing 3 / A3.2..
 2. Illuminated Signs: Manufacturer's standard LED lighting including transformers, insulators, and other components. Refer to Drawing 3 / A3.2.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Locate signs where indicated or directed by Architect. Install signs level, plumb, and at heights indicated, with sign surfaces free from distortion and other defects in appearance.

END OF SECTION 101400

SECTION 102800 - TOILET AND CUSTODIAL ACCESSORIES

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Product Data.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, No. 4 finish (satin), 0.0312-inch (0.8-mm) minimum nominal thickness unless otherwise indicated.
- B. Brass: ASTM B 19, ASTM B 16 (ASTM B 16M), or ASTM B 30.
- C. Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063-T6 or 6463-T6.
- D. Sheet Steel: ASTM A 1008/A 1008M, 0.0359-inch (0.9-mm) minimum nominal thickness.
- E. Galvanized-Steel Sheet: ASTM A 653/A 653M, G60 (Z180).
- F. Chromium Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).
- G. Baked-Enamel Finish: Factory-applied, gloss-white, baked-acrylic-enamel coating.
- H. Tempered Glass: ASTM C 1048, Kind FT (fully tempered).
- I. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.
- J. Galvanized-Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- K. Fasteners: Screws, bolts, and other devices of same material as accessory unit, tamper and theft resistant when exposed, and of galvanized steel when concealed.
- L. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

2.2 TOILET AND BATH ACCESSORIES

- A. Available Manufacturers:

Bobrick, or as scheduled.

Soap Dispenser TA-1:

Refer to Toilet and Custodial Accessories Schedule, Sheet A.03.

Toilet Tissue Dispenser TA-2:

Refer to Toilet and Custodial Accessories Schedule, Sheet A.03.

Mirror TA-3:

Refer to Toilet and Custodial Accessories Schedule, Sheet A.03.

Grab Bar Group TA-4:

Refer to Toilet and Custodial Accessories Schedule, Sheet A.03.

Sanitary Napkin Disposal Unit TA-5:

Refer to Toilet and Custodial Accessories Schedule, Sheet A.03.

Paper Towel Dispenser TA-6:

Refer to Toilet and Custodial Accessories Schedule, Sheet A.03.

Utility Shelf / Mop Rack TA-7:

Refer to Toilet and Custodial Accessories Schedule, Sheet A.03.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
 - 1. Install grab bars to withstand a downward load of at least 250 lbf (1112 N), when tested according to method in ASTM F 446.
- B. Adjust accessories for unencumbered, smooth operation and verify that mechanisms function properly. Replace damaged or defective items. Remove temporary labels and protective coatings.

END OF SECTION 102800

SECTION 107313 - AWNINGS

PART 1 - GENERAL

1.1 SECTION REQUIREMENTS

- A. Submittals: Shop Drawings and color Samples.
- B. Verify dimensions by field measurements before fabrication and indicate on Shop Drawings.

PART 2 - PRODUCTS

2.1 AWNINGS

- A. Available Manufacturers:
 - 1. Belle Isle Awning.
- B. Performance Requirements: Provide awnings capable of withstanding design loads per local codes and ordinances.

2.2 AWNING FABRICS

- A. Available Products:
 - 1. Firesist. Refer to Drawings sheet A.12.
- B. Flame-Resistance Ratings: Passes NFPA 701.
- C. Bottom Hem: Straight Valance.

2.3 AWNING FRAMES

- A. Steel Frames:
 - 1. Traditional Steel Pipe, galvanized.
 - 2. Steel Finish: Mill.
- B. Anchors, Fasteners, Fittings, Hardware, and Installation Accessories: Corrosion-resistant, weather-resistant, 3/8" lag bolt.

2.4 AWNING FABRICATION

- A. Fabrics: Reinforce wear points and hardware attachment points with webbing.
- B. Fabric Edges and Seams: Folded and stitched.
- C. Frames: Preassemble awning frames in the shop to greatest extent possible.
 - 1. Form exposed work true to line and level with accurate angles and straight edges.
 - 2. Traditional galvanized pipe and fitting assembly.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install awnings securely connected to supports, free of rack, and in proper relation to adjacent construction.
- B. Attach fabric to frames to ensure tight, wrinkle-free fit of fabric to frame.
- C. Slip fit frame connections accurately together to form hairline joints.
- D. Galvanized Surfaces: Clean field connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 107313

SECTION 20 0500 - MECHANICAL GENERAL REQUIREMENTS

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SUMMARY	1
1.3 INDUSTRY STANDARDS	1
1.4 PERFORMANCE REQUIREMENTS	2
1.5 QUALITY ASSURANCE	3
1.6 CODES, PERMITS AND FEES	3
1.7 DRAWINGS	4
1.8 MATERIAL AND EQUIPMENT MANUFACTURERS	4
1.9 INSPECTION OF SITE	4
1.10 ITEMS REQUIRING PRIOR APPROVAL	5
1.11 SUBMITTALS	5
1.12 COORDINATION DRAWINGS	6
1.13 OPERATION AND MAINTENANCE INSTRUCTIONAL MANUALS	6
1.14 RECORD DRAWINGS	6
1.15 INSTRUCTION OF OWNER PERSONNEL	7
1.16 WARRANTY	7
PART 2 - PRODUCTS	7
PART 3 - EXECUTION	7
3.1 REFRIGERANT HANDLING	7
3.2 WORK INVOLVING OTHER TRADES	8
3.3 ACCEPTANCE PROCEDURE	8

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. AABC - Associated Air Balance Council; www.aabc.com.
 2. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
 3. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
 4. ABMA - American Boiler Manufacturers Association; www.abma.com.
 5. AGA - American Gas Association; www.aga.org.
 6. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
 7. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.

8. ANSI - American National Standards Institute; www.ansi.org.
9. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
10. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
11. ASSE - American Society of Sanitary Engineering; www.asse-plumbing.org.
12. ASTM - ASTM International; www.astm.org.
13. AWS - American Welding Society; www.aws.org.
14. AWWA - American Water Works Association; www.awwa.org.
15. CDA - Copper Development Association; www.copper.org.
16. CGA - Compressed Gas Association; www.cganet.com.
17. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
18. CSA - CSA International; (Formerly: IAS - International Approval Services); www.csa-international.org.
19. CSI - Construction Specifications Institute (The); www.csinet.org.
20. CTI - Cooling Technology Institute; (Formerly: Cooling Tower Institute); www.cti.org.
21. FM Approvals - FM Approvals LLC; www.fmglobal.com.
22. HI - Hydraulic Institute; www.pumps.org.
23. ICC - International Code Council; www.iccsafe.org.
24. IEEE - Institute of Electrical and Electronics Engineers, Inc. (The); www.ieee.org.
25. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.okstate.edu.
26. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
27. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; www.mss-hq.org.
28. NADCA - National Air Duct Cleaners Association; www.nadca.com.
29. NAIMA - North American Insulation Manufacturers Association; www.naima.org.
30. NEBB - National Environmental Balancing Bureau; www.nebb.org.
31. NECA - National Electrical Contractors Association; www.necanet.org.
32. NEMA - National Electrical Manufacturers Association; www.nema.org.
33. NETA - InterNational Electrical Testing Association; www.netaworld.org.
34. NFPA - National Fire Protection Association; www.nfpa.org.
35. NSF - NSF International; www.nsf.org.
36. NSPE - National Society of Professional Engineers; www.nspe.org.
37. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
38. STI - Steel Tank Institute; www.steeltank.com.
39. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www.tema.org.
40. UL - Underwriters Laboratories Inc.; www.ul.com.
41. USGBC - U.S. Green Building Council; www.usgbc.org.

- 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.
 - 1. Contract Documents are complimentary, and what is required by one shall be as binding as if required by all. In the event of inconsistencies or disagreements within the Construction Documents bids shall be based on the most expensive combination of quality and quantity of the work indicated.
- 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.
- D. Refer to Division 22 Section "Domestic Water Piping" for purchase and installation of potable water meters.

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.
- f. Temporary aspects of the construction process.

- G. If deviations (not substitutions) from Contract Documents are deemed necessary by the Contractor, details of such deviations, including changes in related portions of the project and the reasons therefore, shall be submitted with the submittal for approval.

1.12 COORDINATION DRAWINGS

- A. Submit project specified coordination drawings for review in compliance with Division 01 Specification Sections.

1.13 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:
1. PDF electronic file. Assemble each manual into a composite electronically indexed file. Submit on digital media acceptable to Architect.
 - 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. 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.

1.14 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.

1.15 INSTRUCTION OF OWNER PERSONNEL

- A. Before final inspection, instruct Owner's designated personnel in operation, adjustment, and maintenance of mechanical equipment and systems at agreed upon times. A minimum of 8 hours of formal instruction to Owner's personnel shall be provided for each building. Additional hours are specified in individual specification sections.
- B. For equipment requiring seasonal operation, perform instructions for other seasons within six months.
- C. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.
- D. In addition to individual equipment training provide overview of each mechanical system. Utilize the as-built documents for this overview.
- E. Prepare and insert additional data in operation and maintenance manual when need for such data becomes apparent during instruction.

1.16 WARRANTY

- A. Warranty: Comply with the requirements in Division 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 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:
 - 1. ASHRAE Standard 15 and Related Revisions: Safety Code for Mechanical Refrigeration.

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 8 08 (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.

3.2 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.

3.3 ACCEPTANCE PROCEDURE

- A. Upon successful completion of start-up and recalibration, but prior to building acceptance, substantial completion and commencement of warranties, the Architect/Engineer shall be requested in writing to observe the satisfactory operation of all mechanical control systems.
- B. The Contractor shall demonstrate operation of equipment and control systems, including each individual component, to the Owner and Architect/Engineer.
- C. After correcting all items appearing on the punch list, make a second written request to the Owner and Architect/Engineer for observation and approval.
- D. After all items on the punch list are corrected and formal approval of the mechanical systems is provided by the Architect/Engineer, the Contractor shall indicate to the Owner in writing the commencement of the warranty period.
- E. Operation of the following systems shall be demonstrated:
1. HVAC Systems.
 2. Domestic Hot Water Heaters.
 3. Domestic Hot Water Mixing Stations.
 4. Temperature Controls.
- F. For systems requiring seasonal operation, demonstrate system performance within six months when weather conditions are suitable.

END OF SECTION 20 0500

SECTION 20 0510 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SUMMARY	2
1.3 DEFINITIONS	2
1.4 SUBMITTALS	2
1.5 QUALITY ASSURANCE	3
1.6 DELIVERY, STORAGE, AND HANDLING	3
1.7 COORDINATION	3
PART 2 - PRODUCTS	4
2.1 MANUFACTURERS	4
2.2 PIPE, TUBE, AND FITTINGS	4
2.3 JOINING MATERIALS	4
2.4 PIPE THREAD COMPOUNDS	5
2.5 TRANSITION FITTINGS	6
2.6 DIELECTRIC FITTINGS	6
2.7 MODULAR MECHANICAL SEALS	7
2.8 SLEEVES	7
2.9 ESCUTCHEONS	7
2.10 GROUT	8
2.11 EPOXY BONDING COMPOUND	8
2.12 LEAK DETECTOR SOLUTION	8
2.13 PIPE ROOF PENETRATION ENCLOSURES	8
PART 3 - EXECUTION	9
3.1 PIPING SYSTEMS - COMMON REQUIREMENTS	9
3.2 PIPING JOINT CONSTRUCTION	11
3.3 ACCESS DOORS	13
3.4 EQUIPMENT CONNECTIONS	13
3.5 PIPING CONNECTIONS	14
3.6 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS	14
3.7 PAINTING	14
3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES	14
3.9 EPOXY BONDING TO EXISTING MATERIALS	15
3.10 JACKING OF PIPE	15
3.11 ERECTION OF WOOD SUPPORTS AND ANCHORAGES	15
3.12 GROUTING	15
3.13 CUTTING, CORING AND PATCHING	15
3.14 EXCAVATION AND BACKFILLING	16
3.15 FLASHING	16
3.16 LUBRICATION	16
3.17 FILTERS	16
3.18 CLEANING	16

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 22 Section "Domestic Water Piping" for flushing and cleaning of potable water piping.

3. Division 23 Section "Piping Systems Flushing and Chemical Cleaning" for flushing and cleaning of HVAC piping.

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, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in 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:
 1. ABS: Acrylonitrile-butadiene-styrene plastic.
 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. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.
- B. Comply with NSF 14, "Plastics Piping System Components and Related Materials," for plastic, potable domestic water piping and components. Include marking "NSF-pw" on piping.
- C. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for potable domestic water piping and components.
- D. Comply with NSF 372, "Drinking Water System Components – Lead Content" for potable domestic water piping and components.
- E. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- F. 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.
- G. 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."
- H. Soldering: Qualify processes and operators according to AWS B2.3/2.3M, "Specification for Soldering Procedure and Performance Qualification."

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Storage and Protection: Provide adequate weather protected storage space for all mechanical equipment and materials deliveries to the job site. Storage locations will be designated by the Owner's Representative. Equipment stored in unprotected areas must be provided with temporary protection.
 - 1. Protect equipment and materials from theft, injury or damage.
 - 2. Protect equipment outlets, pipe and duct openings with temporary plugs or caps.
 - 3. Materials with enamel or glaze surface shall be protected from damage by covering and/or coating as recommended in bulletin "Handling and Care of Enameled Cast Iron Plumbing Fixtures", issued by the Plumbing Fixtures Manufacturer Association, and as approved.
 - 4. Electrical equipment furnished by Mechanical Trades and installed by the Electrical Trades: Turn over to Electrical Trades in good condition, receive written confirmation of same.
 - 5. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
 - 6. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations. Coordinate with other trades to ensure accurate locations and sizes of mechanical spaces, chases, slots, shafts, recesses and openings.

- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Install Work to avoid interference with work of other trades including, but not limited to, Architectural and Electrical Trades. Remove and relocate any work that causes an interference at Contractor's expense.
- D. Coordinate requirements for and provide access panels and doors for mechanical items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."
- E. The mechanical trades shall be responsible for all damage to other work caused by their work or through the neglect of their workers.
 - 1. All patching and repair of any such damaged work shall be performed by the trades which installed the work. The cost shall be paid by the Mechanical Trades.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 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:
 - 1. Ferrous pipe: Standard weight, forged steel weld neck flanges.
 - 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 B 32, lead-free, antimony-free, silver-bearing alloys. Include water-flushable flux according to ASTM B 813.
 - 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.
 - I. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
 - 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.
 - K. Solvent Cements for Joining PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
- 2.4 PIPE THREAD COMPOUNDS
- A. Pipe thread compounds for the fluid service compatible with piping materials provided.
 - B. Compounds for potable water service and similar applications acceptable to U.S. Department of Agriculture (USDA) or Food and Drug Administration (FDA). Compounds containing lead are prohibited.
 - C. Inorganic zinc-rich coatings or corrosion inhibited proprietary compounds for galvanized carbon steel systems to coat raw carbon steel surfaces, in lieu of subsequent painting.
 - 1. Manufacturers:
 - a. Carboline "Carbo-Zinc 12."
 - b. Tnemec.
 - c. Koppers.
 - D. Use tetrafluoroethylene (Teflon) tape 2 to 3 mils thick for natural gas system threaded joints.
 - 1. Manufacturers:
 - a. Cadillac Plastic.
 - b. Permacel.
 - c. Other approved.

2.5 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dresser Industries, Inc.; DMD Div.
 - c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
 - d. JCM Industries.
 - e. Smith-Blair, Inc.
 - f. Viking Johnson.
 - 2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
 - 3. Underground Piping NPS 2 and Larger: AWWA C219, metal sleeve-type coupling.
 - 4. Aboveground Pressure Piping: Pipe fitting.
- B. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Manufacturers:
 - a. IPEX Inc. (formerly Eslon Thermoplastics).
- C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
 - 1. Manufacturers:
 - a. Thompson Plastics, Inc.
- D. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
 - 1. Manufacturers:
 - a. NIBCO INC.
 - b. NIBCO, Inc.; Chemtrol Div.
- E. Flexible Transition Couplings for Underground Nonpressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
 - 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Fernco, Inc.
 - c. Mission Rubber Company.
 - d. Plastic Oddities, Inc.
 - e. Can-Tex Industries Division of Harsco Corp. "CT-Adaptors".
 - f. Joint Inc., "Caulder".

2.6 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Brass Unions, Brass Nipples, Brass Couplings: For systems up to 286 deg F.
- D. Dielectric-Flange Kits: Include full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
 - 1. Manufacturers:
 - a. Advance Products & Systems, Inc.
 - b. Calpico, Inc.
 - c. Capitol Manufacturing Co.
 - d. Central Plastics Company.
 - e. Epco Sales, Inc.
 - f. Pipeline Seal and Insulator, Inc.
 - g. Watts Water Technologies, Inc.; Watts Regulator Co.
 - h. Zurn Industries, Inc.; Wilkins Div.
 - 2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

2.7 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:
 - a. Advance Products & Systems, Inc.; Innerlynx.
 - 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: Carbon steel. Include two for each sealing element.
 - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.8 SLEEVES

- A. Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, and 0.375 inch wall galvanized, plain ends.
- B. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with set screws.

2.9 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
 - 1. New Piping:

- a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
- b. Chrome-Plated Piping or Piping in High Humidity Areas: One-piece, cast-brass type with polished chrome-plated finish.
- c. Insulated Piping: One-piece, stamped-steel type with spring clips.
- d. Bare Piping in Finished Spaces: One-piece, stamped-steel type.
- e. Bare Piping in Unfinished Service Spaces or Equipment Rooms: Split-plate, stamped-steel type with concealed hinge and set screw.

2.10 GROUT

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

2.11 EPOXY BONDING COMPOUND

- A. Two-component system suitable for bonding wet or dry concrete to each other and to other materials.
- B. Manufacturers:
 - 1. Euco 452 #450; Euclid Chemical Co.
 - 2. Epobond; L & M Construction Chemicals.
 - 3. Sikadur 87; Sika Corp.

2.12 LEAK DETECTOR SOLUTION

- A. Commercial leak detector solution for pipe system testing.
- B. Manufacturers:
 - 1. American Gas and Chemicals Inc.; Leak Tec.
 - 2. Cole-Parmer Inst. Co.; Leak Detector.
 - 3. Guy Speaker Co. Inc.; Squirt 'n Bubbles.

2.13 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.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Refer to piping application schedules on the Drawings.
- B. Install piping according to the following requirements and Division 21, 22, and 23 Sections specifying piping systems, and in accordance with manufacturer's instructions.
- C. 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.
- D. 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.
- E. 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.
- F. Weld-o-lets and thread-o-lets can be used for annular flow measuring devices, temperature control components, and thermal wells in steel pipe. Pipe taps shall be drilled and deburred. Torch cutting is not acceptable.
- G. Brazolets can be used for annular flow measuring devices, temperature control components, and thermal wells in copper tube. Pipe taps shall be drilled and deburred. Torch cutting is not acceptable.
- H. Clean and lubricate elastomer joints prior to assembly.
- I. Clean damaged galvanized surfaces and touch-up with a zinc rich coating.
- J. Install piping to conserve building space and not interfere with use of space.
- K. Group piping whenever practical at common elevations.
- L. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- M. Slope piping and arrange systems to drain at low points.
- N. Slope horizontal piping containing noncondensable gases 1 inch per 100 feet, upward in the direction of the flow.
- O. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- P. 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.

- Q. 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.
- R. Do not penetrate building structural members unless specifically indicated on drawings.
- S. Install piping above accessible ceilings to allow sufficient space for ceiling panel and light fixture removal.
- T. Install valves with stems upright or horizontal, not inverted.
- U. Provide clearance for installation of insulation and access to valves and fittings.
- V. 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.
- W. 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.
- X. Install piping free of sags and bends.
- Y. Install fittings for changes in direction and branch connections.
- Z. 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.
- AA. Install piping to allow application of insulation.
- BB. Select system components with pressure rating equal to or greater than system operating pressure.
- CC. After completion, fill, clean, and treat systems. Refer to Division 23 Sections "Hydronic Piping," "Piping Systems Flushing and Chemical Cleaning," and "HVAC Water Treatment."
- DD. Install escutcheons for penetrations of walls below ceiling, and ceilings.
- EE. Sleeves are not required for core-drilled holes in poured concrete walls.
- FF. Permanent sleeves are not required for holes formed by removable PE sleeves in poured concrete walls.
- GG. Install sleeves for pipes passing through footings and foundation walls, masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
 - 1. Cut sleeves to length for mounting flush with both surfaces of walls.
 - a. Exception: Extend sleeves installed in floors 2 inches above finished floor level.
 - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
 - 3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
 - a. Schedule 40 Black Steel Sleeves: For pipes smaller than NPS 12 penetrating interior walls.

- b. 0.375 Inch Wall Black Steel Sleeves: For pipes NPS 12 and larger penetrating interior walls.
 - c. Schedule 40 Galvanized Steel Sleeves: For pipes smaller than NPS 12 penetrating floors, and roof slabs.
 - d. 0.375 Inch Wall Galvanized Steel Sleeves: For pipes NPS 12 and larger penetrating floors and roof slabs.
 - 4. Seal sleeves in concrete floors roof slabs and masonry walls with grout.
 - 5. Seal sleeves in plaster/gypsumboard partitions with plaster or dry wall compound and caulk with non-hardening silicone sealant to provide airtight installation.
 - 6. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- HH. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and modular mechanical seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing modular mechanical seals.
- 1. Install Schedule 40 galvanized steel pipe for sleeves smaller than 12 inches in diameter.
 - 2. Install 0.375 galvanized steel pipe for sleeves 12 inches and larger in diameter.
 - 3. Modular Mechanical Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble modular mechanical seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- II. New, Poured Concrete, Underground, Exterior-Wall and Slab on Grade Pipe Penetrations: Install water stop sleeves prior to pour. Seal pipe penetrations using modular mechanical seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing modular mechanical seals.
- 1. Modular Mechanical Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble modular mechanical seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- JJ. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Specification Sections for materials.
- KK. Seal openings around pipes in sleeves and around duct openings through walls, floors and ceilings, and where floors, fire rated walls and smoke barriers are penetrated. Fire and/or smoke barriers shall be UL listed firestopping and shall have a fire rating equal to or greater than the penetrated barrier. Refer to Division 07 Specification Sections for materials.
- LL. Pipe Roof Penetration Enclosures:
- 1. Coordinate delivery of roof penetration enclosures to jobsite.
 - 2. Locate and set curbs on roof.
 - 3. Framing, flashing, and attachment to roof structure are specified under Division 07.
 - 4. Attach cap to curbs, cut pipe boots to fit pipe, and clamp boots to pipe or conduit.
- MM. Verify final equipment locations for roughing-in.
- NN. 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.
- S. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 5. PVC Nonpressure Piping: Join according to ASTM D 2855.
 6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- T. Remake joints which fail pressure tests with new materials including pipe, fittings, gaskets and/or a filler.

3.3 ACCESS DOORS

- A. Provide access doors for installation by architectural trades unless noted otherwise. Provide access doors in the walls, as required to make all valves, controls, coils, motors, air vents, filters, electrical boxes and other equipment installed by the Contractor accessible. Minimum size 12 inches x 12 inches. Provide access doors in the ceiling, for accessibility as mentioned above, 24 inches x 24 inches minimum size. Areas with accessible ceilings (ceilings where lay-in panels are not fastened in place and can be individually removed without removal of adjacent tiles) will not require access doors. Refer to Division 08 Section "Access Doors and Frames" for manufacturers and model numbers and additional information.
- B. When access doors are in fire resistant walls or ceilings, they shall bear the Underwriters' Laboratories, Inc., Label, with time design rating equal to or greater than the wall or ceiling unless they were a part of the tested assembly.

3.4 EQUIPMENT CONNECTIONS

- A. Make connections to equipment, fixtures, and other items included in the work in accordance with the submittals and rough-in measurements furnished by the manufacturers of the particular equipment furnished.
1. Any and all additional connections not shown on the drawings but shown on the equipment manufacturer's submittal or required for the successful operation of the equipment shall be installed as part of this Contract at no additional charge to the Owner.
- B. All piping connections to pumps, coils, and other equipment shall be installed without strain at the pipe connection of this equipment. When directed, remove the bolts in flanged connections or disconnect piping to demonstrate that piping has been so connected.

3.5 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, where indicated on Drawings, at final connection to each piece of equipment and at all control valves.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, where indicated on Drawings, at final connection to each piece of equipment and at all control valves.

3.6 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are indicated. Housekeeping pad locations and sizes shall be coordinated by mechanical contractor prior to the placement of concrete slabs.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.
- E. For suspended equipment, furnish and install all inserts, rods, structural steel frames, brackets and platforms required. Obtain approval of Architect for same including loads, locations and methods of attachment.
- F. 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.

3.7 PAINTING

- A. Painting of mechanical systems, equipment, and components is specified in Division 09.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 Section "Metal Fabrications" for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.
- C. Where pipe and/or equipment support members must be welded to structural building framing, Contractor shall seek prior approval from Architect and structural engineer. Scrape, brush clean, and apply one coat of zinc rich primer after welding.

- D. Field Welding: Comply with AWS D1.1.

3.9 EPOXY BONDING TO EXISTING MATERIALS

- A. Use epoxy bonding compound to set sleeves or pipes in existing concrete to bond new concrete and/or grout to existing materials or to bond dissimilar materials.
- B. The compound, when applied in accordance with the manufacturer's instructions, shall be capable of initial curing within 48 hours at temperatures as low as 40 deg F and shall be capable of bonding any combination of the following properly prepared materials: Wet or dry, cured or uncured concrete or mortar; vitrified clay; cast iron and carbon steel.

3.10 JACKING OF PIPE

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

3.11 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor mechanical materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.12 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.

3.13 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.

3.14 EXCAVATION AND BACKFILLING

- A. Refer to Division 31 Specification Sections.
- B. Provide all excavation, trenching, tunneling and backfilling required for the mechanical work.
- C. Provide all pumping and/or well pointing required for the mechanical work.
- D. Provide foundations if required to support underground piping.
- E. Backfill all excavations with well-tamped granular material. Backfill all excavations under wall footings with lean mix concrete up to underside of footings and extend concrete within excavation a minimum of four (4) feet each side of footing. Granular backfill shall be placed in layers not more than 8 inches in thickness, 95 percent compaction throughout with approved compaction equipment. Tamp, roll as required. Excavated material shall not be used.

3.15 FLASHING

- A. Provide all flashing required for mechanical work. Refer to Division 07 Specification Sections.

3.16 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.

3.17 FILTERS

- A. Provide and maintain filters in air handling systems throughout the construction period and prior to final acceptance of the building. Do not run air handling equipment, without all prefilters and final filters as specified.
- B. Immediately prior to final building acceptance by the Owner, Contractor shall:
 - 1. Replace all disposable type air filters with new units.

3.18 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. Flushing, cleaning, and disinfection of domestic water piping is specified in Division 22 Section "Domestic Water Piping."
- C. 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.
- D. 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 0529 - HANGERS AND SUPPORTS

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 DEFINITIONS	1
1.3 PERFORMANCE REQUIREMENTS	1
1.4 SUBMITTALS	2
1.5 QUALITY ASSURANCE	2
PART 2 - PRODUCTS	2
2.1 MANUFACTURERS	2
2.2 HANGER ROD MATERIAL	2
2.3 STEEL PIPE HANGERS AND SUPPORTS	2
2.4 TRAPEZE PIPE HANGERS	3
2.5 METAL FRAMING SYSTEMS	3
2.6 METAL INSULATION SHIELDS	3
2.7 FASTENER SYSTEMS	4
2.8 ROOF MOUNTED EQUIPMENT SUPPORTS	4
2.9 EQUIPMENT SUPPORTS	5
2.10 MISCELLANEOUS MATERIALS	5
PART 3 - EXECUTION	5
3.1 HANGER AND SUPPORT APPLICATIONS	5
3.2 HANGER AND SUPPORT INSTALLATION	6
3.3 EQUIPMENT SUPPORTS	8
3.4 METAL FABRICATIONS	9
3.5 ADJUSTING	9

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 20 Section "Mechanical General Requirements."
 - 3. Division 20 Section "Basic Mechanical Materials and Methods."
 - 4. 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. 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.
 - 3. Equipment supports.
- B. 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."
 - 2. AWS D1.2, "Structural Welding Code--Aluminum."
 - 3. AWS D1.3, "Structural Welding Code--Sheet 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, and schedules and details on the Drawings for where to use specific hanger and support types.

B. Manufacturers:

1. Anvil International, Inc.
2. B-Line by Eaton.
3. Carpenter & Paterson, Inc.
4. Hilti USA.
5. ERICO International Corp.
6. PHD Manufacturing, Inc.

C. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.4 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.5 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:

1. Anvil International, Inc.; Anvil-Strut.
2. B-Line by Eaton.
3. Power-Strut Div.; Tyco International, Ltd.
4. Unistrut Corp.; Tyco International, Ltd.
5. Hilti USA.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.6 METAL INSULATION SHIELDS

A. Manufacturers:

1. Anvil International, Inc.
2. B-Line by Eaton.
3. Carpenter & Paterson, Inc.
4. ERICO International Corp.
5. PHD Manufacturing, Inc.

B. Description: MSS SP-69, Type 40, protective shields. Shields shall span an arc of 180 degrees.

C. Shield Dimensions for Pipe: Not less than the following:

1. NPS 1/4 to NPS 2: 12 inches long and 0.048 inch thick.

2.7 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
1. Manufacturers:
 - a. B-Line by Eaton.
 - b. Empire Industries, Inc.
 - c. Hilti, Inc.
 - d. ITW Ramset/Red Head.
 - e. MKT Fastening, LLC.
 - f. Powers Fasteners.
- B. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application. Exception: Do not use chemical fasteners to support hanger systems for fire protection piping.
1. Manufacturers:
 - a. Hilti, Inc.
 - b. ITW Ramset/Red Head.
 - c. MKT Fastening, LLC.
 - d. Powers Fasteners.
 2. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 3. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
 4. Washer and Nut: Zinc-coated steel.
- C. Threaded Inserts: Galvanized malleable iron or galvanized steel for 3/4 inch bolts.
1. Manufacturers:
 - a. Superior Concrete Accessories; Threaded Insert.
 - b. Dayton Sure-Grip and Shore Co.
 - c. Richmond Screw Anchor Co.
- D. Slotted Inserts: Continuous galvanized steel with temporary slot fillers and complete with nuts, studs, washers and the like, for 3/4 inch bolts.
1. Manufacturers:
 - a. B-Line by Eaton; B22-I Continuous Concrete Insert.
 - b. Unistrut Corp.; P-3200 Continuous Insert.
 - c. Hohman and Barnard, Inc.
 - d. Richmond Screw Anchor Co.
 - e. Hilti, Inc.; CIS13812/PG.

2.8 ROOF MOUNTED EQUIPMENT SUPPORTS

- A. Roof Rail-Type Equipment Stands: Welded 18 gage galvanized steel shell, base plate and counter flashing. Factory installed chemically treated wood nailer. Fully mitered end sections. Internal bulkhead reinforcement.

1. Roof Rail Type Supports: Coordinate installation and type with Architectural Trades. Top shall be level and extend a minimum of 10 inches above top of roof insulation.

- a. Manufacturers:

- 1) Pate.
- 2) Thybar; TEMS Series.
- 3) Roof Products and Systems.
- 4) Greenheck.
- 5) Creative Metals.

2.9 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.10 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.
 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Refer to application schedules on the Drawings.
- B. For insulated pipe, oversize hanger elements to accommodate insulation thickness.
- C. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- D. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- E. Use hangers and supports with galvanized, metallic coatings for outdoor applications or where exposed to outdoor conditions.
- F. Use hangers and supports with plastic coating, or galvanized metallic coatings for applications in corrosive atmospheres.
- G. Use metal framing, with plastic coating, or galvanized metallic coatings for metal framing in corrosive atmospheres.
- H. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- I. Use padded hangers for piping that is subject to scratching.

- J. 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.
- 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. Steel Frame Structure 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.
- 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. Spring supports, within specified limitations: Constant support type, where necessary to avoid transfer of load from support to support or onto connected equipment; otherwise, variable support type located at points subject to vertical movement.
- I. Where necessary, brace piping and supports against reaction, sway and vibration.
- J. Do not hang piping from joist pans, floor decks, roof decks, equipment, ductwork, or other piping.
- K. Install turnbuckles, swing eyes and clevises to accommodate temperature changes, pipe accessibility, and adjustment for load pitch. Rod couplings are not acceptable.
- L. 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.
- M. 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.
- N. 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.
- O. Support vertical risers independently of connected horizontal piping whenever practical, with supports at the base and at intervals to accommodate system range of load with thermal conditions. Support vertical risers at each floor penetration for piping in shafts or chases. Guide for lateral stability. Fit horizontal piping connected to moving risers with two spring supports connected adjacent to riser, spaced according to required hanger spacing.
- P. For risers at temperatures of 100 deg F or less place riser clamps under fittings. Support carbon steel pipe at each operating level or floor and at not more than 15-foot intervals for pipe 2 inches and smaller, and at not more than 20 foot intervals for pipe 2-1/2 inches and larger.
- Q. 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.
- R. Attach supporting elements connected to structural steel columns to preclude vertical slippage and cascading failure.
- S. Attach pipe hangers and other supporting elements to roof purlins and trusses at panel points.
- T. Where eccentric loading beam clamps are approved and where other work is supported by similar eccentric loading support element from the same structural member, locate eccentric loading support elements to minimize structural member torsion load.
- U. Limit the location of supporting elements for piping and equipment, when supported from roof, to panel points of the bar joists.
- V. Building structure shall not be reinforced except as approved by the Architect in writing.
- W. 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.
- X. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- Y. Fastener System Installation:
1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- Z. Roof-Mounting Equipment Stand Installation:
1. Curb or Rail Mounting Type Stands: Assemble components or fabricate stand and mount on permanent, stationary roof curb or rail. Refer to Division 07 Section "Roof Accessories" for curb and rail installation.
 2. Maintain support manufacturer's recommended spacing.
- AA. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- BB. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- CC. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- DD. Install lateral bracing with pipe hangers and supports to prevent swaying.
- EE. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- FF. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- GG. 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.
- HH. 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.

END OF SECTION 20 0529

SECTION 20 0553 - MECHANICAL IDENTIFICATION

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SUBMITTALS	1
1.3 QUALITY ASSURANCE	1
1.4 COORDINATION	1
PART 2 - PRODUCTS	2
2.1 MANUFACTURERS	2
2.2 EQUIPMENT IDENTIFICATION DEVICES.....	2
2.3 PIPING IDENTIFICATION DEVICES.....	2
2.4 DUCT IDENTIFICATION DEVICES.....	3
2.5 WARNING TAGS.....	3
PART 3 - EXECUTION	3
3.1 APPLICATIONS, GENERAL.....	3
3.2 EQUIPMENT IDENTIFICATION	3
3.3 PIPING IDENTIFICATION	4
3.4 DUCT IDENTIFICATION.....	4
3.5 WARNING-TAG INSTALLATION.....	4
3.6 ADJUSTING.....	4
3.7 CLEANING.....	4

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

- A. ASME Compliance: Comply with ASME (ANSI) A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping.

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.
 - 4. Craftmark.
 - 5. Brimar Industries, Inc.
 - 6. Marking Services Inc. (MSI).
 - 7. Kolbi Pipe Marker Co.

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 DUCT IDENTIFICATION DEVICES

- A. Duct Markers: Vinyl, 2-inch minimum character height, with permanent pressure sensitive adhesive. Include direction and quantity of airflow, air handling unit or fan number, and duct service (such as supply, return, and exhaust).

2.5 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags; of plasticized card stock with matte finish suitable for writing.
 - 1. Size: 3 by 5-1/4 inches minimum.
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as DANGER, CAUTION, or DO NOT OPERATE.
 - 4. Color: Yellow background with black lettering.

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. Fuel-burning units, including boilers, furnaces, heaters, stills, and absorption units.
 - 2. Pumps, compressors, chillers, condensers, and similar motor-driven units.
 - 3. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
 - 4. Fans, blowers, primary balancing dampers, and mixing boxes.
 - 5. Packaged HVAC central-station and zone-type units.
- B. Install equipment markers with permanent adhesive on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.
 - 1. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 - 2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
 - 3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
 - a. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 - b. 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. Area Served: Equipment serving different areas of a building other than where the equipment is installed shall be permanently marked in a manner that, in addition to identifying the equipment as specified in this Section, also identifies the area it serves.

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.
- 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.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced markers.

3.4 DUCT IDENTIFICATION

- A. Identify ductwork with vinyl markers and flow direction arrows.
- B. Locate markers at air handling units, each side of floor and wall penetrations, near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 WARNING-TAG INSTALLATION

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

3.6 ADJUSTING

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

3.7 CLEANING

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

END OF SECTION 20 0553

SECTION 20 0700 - MECHANICAL INSULATION

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SUMMARY	1
1.3 DEFINITIONS	1
1.4 INDOOR PIPING INSULATION SYSTEMS DESCRIPTION	2
1.5 INDOOR DUCT AND PLENUM INSULATION SYSTEMS DESCRIPTION	2
1.6 QUALITY ASSURANCE	2
1.7 DELIVERY, STORAGE, AND HANDLING	2
1.8 COORDINATION	2
PART 2 - PRODUCTS	2
2.1 INSULATION MATERIALS, GENERAL REQUIREMENTS	2
2.2 PIPE INSULATION MATERIALS	3
2.3 DUCTWORK INSULATION MATERIALS	3
2.4 FACTORY-APPLIED JACKETS	3
PART 3 - EXECUTION	4
3.1 EXAMINATION	4
3.2 PREPARATION	4
3.3 COMMON INSTALLATION REQUIREMENTS	4
3.4 PENETRATIONS	5
3.5 GENERAL PIPE INSULATION INSTALLATION	5
3.6 GLASS-FIBER AND MINERAL WOOL PIPE INSULATION INSTALLATION	6
3.7 DUCT AND PLENUM INSULATION INSTALLATION	7
3.8 FINISHES	8

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.
 - 4. Division 22 Section "Plumbing Fixtures: for protective shielding guards."

1.2 SUMMARY

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

1.3 DEFINITIONS

- A. ASJ: All-service jacket.
- B. FSK: Foil, scrim, kraft paper.
- C. FSP: Foil, scrim, polyethylene.

- D. PVC: Polyvinyl Chloride.
- E. PVDC: Polyvinylidene chloride.
- F. SSL: Self-sealing lap.

1.4 INDOOR PIPING INSULATION SYSTEMS DESCRIPTION

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are scheduled on the Drawings, or identified for each piping system and pipe size range.

1.5 INDOOR DUCT AND PLENUM INSULATION SYSTEMS DESCRIPTION

- A. Acceptable indoor duct and plenum insulation materials and thicknesses are scheduled on the Drawings.

1.6 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, 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.
- B. Ductwork Maximum Temperature Limits: Based on ASTM C 411 test procedures.

1.7 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.

1.8 COORDINATION

- A. Coordinate size and location of supports, hangers, 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.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS, GENERAL REQUIREMENTS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.

- B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Adhesives used shall be fire resistant in their dry states and UL listed.

2.2 PIPE INSULATION MATERIALS

- A. Glass-Fiber, Preformed Pipe Insulation, Type I:
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. Johns Manville; Micro-Lok.
 - b. Knauf Insulation; 1000 Pipe Insulation.
 - c. Manson Insulation Inc.; Alley-K.
 - d. Owens Corning; Fiberglas Pipe Insulation.
 - 2. Type I, 850 deg F Materials: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ or ASJ-SSL. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

2.3 DUCTWORK INSULATION MATERIALS

- A. Blanket Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.
 - a. CertainTeed Corp.; Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Duct Wrap.
 - d. Manson Insulation Inc.; Alley Wrap FSK.
 - e. Owens Corning; All-Service Duct Wrap.

2.4 FACTORY-APPLIED JACKETS

- A. Insulation systems indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 - 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 - 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 - 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

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.

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 required, 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.
- 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.

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.
- B. Insulation Installation at Interior Wall and Partition Penetrations that Are Not Fire Rated: Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations:
1. Terminate ductwork insulation at angle closure of fire damper sleeves.
 2. Install pipe insulation continuously through penetrations of fire-rated walls and partitions.
 - a. Firestopping is specified in Division 07 Section "Through-Penetration Firestop Systems."

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this Article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible Elastomeric, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

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 DUCT AND PLENUM INSULATION INSTALLATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions. Adhesive may be omitted from top surface of horizontal rectangular ducts.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not over compress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
8. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
9. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
10. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.8 FINISHES

- A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system specified in Division 09 painting Sections.
- B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Do not field paint aluminum or stainless-steel jackets.

END OF SECTION 20 0700

SECTION 22 0523 – GENERAL DUTY VALVES FOR PLUMBING

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 DELIVERY, STORAGE, AND HANDLING	2
PART 2 - PRODUCTS	2
2.1 VALVES, GENERAL	2
2.2 BRONZE BALL VALVES	3
2.3 DRAIN VALVES	3
2.4 SOURCE QUALITY CONTROL	3
PART 3 - EXECUTION	4
3.1 EXAMINATION	4
3.2 VALVE INSTALLATION	4
3.3 JOINT CONSTRUCTION	4
3.4 ADJUSTING	4

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 21 fire-suppression piping and fire pump Sections for fire-protection valves.
 - 2. Division 20 Section "Mechanical Identification" for valve tags and charts.
 - 3. Division 22 piping Sections for specialty valves applicable to those Sections only.

1.2 SUMMARY

- A. This Section includes valves for general 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. Certification that products for use in potable water systems comply with NSF 61 and NSF 372.

1.5 QUALITY ASSURANCE

- A. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.
- B. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.
- C. NSF Compliance: NSF 61 and NSF 372 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.
- 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. 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 unless otherwise noted. Wetted surfaces

of valves contacted by consumable water shall contain not more than 0.25 percent weighted average lead content.

- E. Valve Sizes: Same as upstream pipe, unless otherwise indicated.
- F. Valve Actuators:
 - 1. Lever Handle: For quarter-turn valves NPS 6 and smaller.
- G. Extended Valve Stems: On insulated valves.
- H. 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.
- I. Threaded: With threads according to ASME B1.20.1.

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 77CLF-140/240.
 - b. Hammond Valve.
 - c. Milwaukee Valve Company; UPBA400S/450S.
 - d. NIBCO INC.; Models S-585-70-66-LF/T-585-70-66-LF.
 - e. Watts Water Technologies, Inc.

2.3 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.

2.4 SOURCE QUALITY CONTROL

- A. Identification: Factory label or color coding to identify lead free valves.

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 and 22 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.

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 22 0523

SECTION 22 11 13 - FACILITY WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Contractor shall refer to and familiarize themselves with the Ferris State University Construction Standards. Where these specifications or the plans differ from the standard details or specifications of the university, the university standards shall apply.
- C. Materials and installation requirements are generally indicated on the plans. Materials indicated in these specifications only apply if indicated on the plans and allowed by the regulating authority. Contractor is responsible for confirming allowable materials and installation requirements with the regulating authority and including these requirements in their bid.
- D. CAD files will be made available for use in construction staking. Contact the engineer regarding applicable fee and requirements for signing of the CAD File Transfer Agreement.

1.2 SUMMARY

- A. This Section includes water-distribution piping and related components outside the building for the water supply system (for domestic water system).
- B. Water meters may be provided by the regulating authority. Contractor shall confirm with the regulating authority and pay the required fees for the meter.

1.3 DEFINITIONS

- A. EPDM: Ethylene propylene diene terpolymer rubber.
- B. HDPE: High density polyethylene plastic
- C. PVC: Polyvinyl chloride plastic.
- D. DI – Ductile Iron .

1.4 SUBMITTALS

- A. Contractor shall confirm that the materials provided meet the requirements of the regulating authority, and provide material certification to the engineer. Material certification shall state that the products meet or exceed the requirements indicated on the plans and the requirements of the regulating authority.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with requirements of utility company supplying water, including materials, installation, tapping of water mains, testing, and disinfection.
- B. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
 - 1. Ensure that valves are dry and internally protected against rust and corrosion.
 - 2. Protect valves against damage to threaded ends and flange faces.
 - 3. Set valves in best position for handling. Set valves closed to prevent rattling.
- B. During Storage: Use precautions for valves, including fire hydrants, according to the following:
 - 1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
 - 2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
- C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
- D. Deliver piping 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.
- E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
- F. Protect flanges, fittings, and specialties from moisture and dirt.
- G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:
 - 1. Notify construction manager (or architect if there is no construction manager) no fewer than three days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of water-distribution service without construction manager's or architect's written permission.

1.8 COORDINATION

- A. Coordinate connection to water main with utility company and make connection per their requirements.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

- A. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper.
 - 1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
 - 2. Copper, Pressure-Seal Fittings:
 - a. **NPS 2 (DN 50)** and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
 - b. **NPS 2-1/2 (DN 65)** Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.
- B. Hard Copper Tube: ASTM B 88, Type K, water tube, drawn temper.
 - 1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.
 - a. **NPS 2 (DN 50)** and Smaller: Wrought-copper fitting with EPDM O-ring seal in each end.
 - b. **NPS 2-1/2 (DN 65)**: Bronze fitting with stainless-steel grip ring and EPDM O-ring seal in each end.

- C. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
- D. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.2 DUCTILE-IRON PIPE AND FITTINGS

- A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 - 1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - 2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
- B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
 - 1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
 - 2. Gaskets: AWWA C111, rubber.
- C. Grooved-Joint, Ductile-Iron Pipe: AWWA C151, with cut, rounded-grooved ends.
 - 1. Grooved-End, Ductile-Iron Pipe Appurtenances:
 - a. Available Manufacturers: Subject to compliance with requirements of regulating authority.
 - b. Grooved-End, Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
 - c. Grooved-End, Ductile-Iron-Piping Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
- D. Flanges: ASME 16.1, Class 125, cast iron.

2.3 CORROSION-PROTECTION PIPING ENCASEMENT (use only if specified on the plans or required by the regulating authority)

- A. Encasement for Underground Metal Piping:
 - 1. Standards: ASTM A 674 or AWWA C105.
 - 2. Form: Sheet or tube.
 - 3. Material: LLDPE film of 0.008-inch (0.20-mm) minimum thickness.

4. Color: Black

2.4 GATE VALVES

A. AWWA, Gate Valves:

1. Available Manufacturers: Subject to compliance with requirements of the regulating authority.
2. Stem (rising or non-rising), and Gate Valve seating (metal seated or resilient seated) to meet requirements of the regulating authority and/or as shown on the standard detail sheets included with the plan:

2.5 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:

1. Available Manufacturers: Subject to compliance with requirements of the regulating authority.
2. Description: Sleeve and valve compatible with drilling machine.
 - a. Standard: MSS SP-60.
 - b. Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
 - c. Valve: per requirements of regulating authority.

- B. Valve Boxes: If requirements are not indicated on the plans or standard detail sheets, comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches (125 mm) in diameter.

1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

- C. Indicator Posts (only if indicated on the plan or required by the regulating authority): UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

2.6 WATER METERS

- A. Water meters will be furnished by utility company. Contractor is responsible for paying the cost of the water meter.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications and in accordance with the regulating authority. Where these specifications differ from the requirements of the regulating authority, those requirements shall govern.
- B. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
- C. Do not use flanges or unions for underground piping.
- D. Flanges, unions, grooved-end-pipe couplings, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
- E. Underground water-service piping [NPS 4 to NPS 12] shall be the following:
 - 1. Ductile Iron – use Class of pipe as required by City of Detroit.

3.3 VALVE APPLICATIONS

- A. General Application: As indicated in the plans and standard detail sheets, and as allowed by the regulating authority.

3.4 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. See Division 22 Section "Common Work Results for Plumbing" for piping-system common requirements.

3.5 PIPING INSTALLATION

- A. Water-Main Connection: Tap water main according to requirements of water utility company and of size and in location indicated. Coordinate with the water utility company to provide necessary inspection of watermain installation.
- B. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.
- C. Bury piping with depth of cover over top at least 60 inches but not less than the minimum required by the regulating authority.

- D. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed. These locations will be indicated on the plans, however, the contractor can propose this installation method in areas where it would be beneficial to minimize disturbance to existing conditions.
- E. Extend water-service piping inside building wall and stub at 12" above floor elevation at the location dictated on the mechanical plans. Coordinate with the interior plumbing plans and the construction manager, owner, or general contractor to confirm this location.
 - 1. Terminate piping with caps, plugs, or flanges as required for piping material. Connections to building-water-piping systems will be done by the interior plumbing contractor.
- F. Install underground piping with restrained joints and/or thrust blocks at horizontal and vertical changes in direction (as indicated on the standard detail sheets or as required by the regulating authority). Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

3.6 JOINT CONSTRUCTION

- A. See Division 22 Section "Common Work Results for Plumbing" for basic piping joint construction.
- B. Make pipe joints according to the following:
 - 1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
 - 2. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure. Refer to Division 22 Section "Common Work Results for Plumbing" for joining piping of dissimilar metals.

3.7 ANCHORAGE INSTALLATION

- A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following (as long as the regulating authority approves of their use):
 - 1. Concrete thrust blocks.
 - 2. Locking mechanical joints.
 - 3. Set-screw mechanical retainer glands.
 - 4. Bolted flanged joints.
 - 5. Pipe clamps and tie rods.
- B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for all piping systems:

- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.8 VALVE INSTALLATION

- A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box unless gate well is indicated on the plan.
- B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600 and AWWA M44.
- C. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.
- D. UL/FMG, Valves Other Than Gate Valves: Comply with NFPA 24.

3.9 CONNECTIONS

- A. Connect water-distribution piping to existing water main. Use connection method as dictated by the regulating authority.

3.10 FIELD QUALITY CONTROL

- A. Piping Tests: Conduct piping tests according to requirements of the regulating authority. If testing methods are not dictated by the regulating authority, test as follows: Conduct tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
- B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.
 - 1. Increase pressure in 50-psig (350-kPa) increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig (0 kPa). Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts (1.89 L) per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.
- C. Prepare reports of testing activities.

3.11 IDENTIFICATION

- A. If required by the regulating authority, install continuous underground detectable warning tape during backfilling of trench for underground water-distribution piping. Locate below

finished grade, directly over piping. Underground warning tapes are specified in Division 31 Section "Earth Moving."

3.12 CLEANING

- A. Clean and disinfect water-distribution piping in accordance with the requirements of the regulating authority. When requirements are not given clean and disinfect as follows:
 - 1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
 - 2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
 - a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
 - b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
 - c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.
- B. Prepare reports of purging and disinfecting activities.

END OF SECTION 221113

SECTION 22 1116 - DOMESTIC WATER PIPING

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SUMMARY	1
1.3 PERFORMANCE REQUIREMENTS	1
1.4 SYSTEMS DESCRIPTION	2
1.5 SUBMITTALS	2
1.6 QUALITY ASSURANCE	2
PART 2 - PRODUCTS	2
2.1 MANUFACTURERS	2
2.2 COPPER TUBE AND FITTINGS	2
2.3 VALVES	2
PART 3 - EXECUTION	3
3.1 PIPING SYSTEM INSTALLATION	3
3.2 JOINT CONSTRUCTION	3
3.3 WATER METER INSTALLATION	3
3.4 HANGER AND SUPPORT INSTALLATION	3
3.5 CONNECTIONS	4
3.6 FIELD QUALITY CONTROL	4
3.7 ADJUSTING	5
3.8 CLEANING AND DISINFECTION	5

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 20 Section "Mechanical General Requirements."
 - 2. Division 20 Section "Basic Mechanical Materials and Methods" for materials and methods common to mechanical piping systems.
 - 3. Division 20 Section "Hangers and Supports."
 - 4. Division 22 Section "Plumbing Valves" for general duty plumbing valves.
 - 5. Division 22 Section "Domestic Water Piping Specialties" for water distribution piping specialties.

1.2 SUMMARY

- A. This Section includes domestic water piping and water meters inside the building.
- B. Water meters will be furnished by utility company for installation by Contractor.

1.3 PERFORMANCE REQUIREMENTS

- A. Where not indicated on the Drawings, provide components and installation capable of producing domestic water piping systems with 125 psig, unless otherwise indicated.

1.4 SYSTEMS DESCRIPTION

- A. Potable and non-potable domestic water piping system materials are scheduled on the Drawing.

1.5 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Water Samples: Specified in Part 3 "Cleaning" Article.
- C. Field quality-control test reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.
- C. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components – Lead Content for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.
 - 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought- copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 - 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends. Furnish Class 300 flanges if required to match piping.
 - 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.3 VALVES

- A. General-duty plumbing valves; and drain valves are specified in Division 22 Section "Plumbing Valves."

PART 3 - EXECUTION

3.1 PIPING SYSTEM INSTALLATION

- A. Basic piping installation requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."
- B. Install sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 20 Section "Basic Mechanical Materials and Methods."
- C. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance.
- D. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
 - 1. Install hose-end drain valves at low points in water mains, risers, and branches.

3.2 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."

3.3 WATER METER INSTALLATION

- A. Rough-in domestic water piping for water meter installation and install water meters according to utility company's requirements.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Pipe hanger and support devices are specified in Division 20 Section "Hangers and Supports." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer than 100 Feet: MSS Type 49, spring cushion rolls, if indicated.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Division 20 Section "Hangers and Supports."
- C. Support vertical piping and tubing at base and at each floor.
- D. Install hangers for drawn-temper copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 3/4 and Smaller: 60-inches with 3/8-inch rod.
2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.

- E. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect domestic water piping to distribution side of water meter with shutoff valve.
- C. Install piping adjacent to equipment and machines to allow service and maintenance.
- D. Connect domestic water piping to the following:
1. Water Heaters: Cold-water supply and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Fixtures."
 3. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.6 FIELD QUALITY CONTROL

- A. Inspect domestic water piping as follows:
1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
 3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- B. Test domestic water piping as follows:
1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 4. Cap and subject piping to static water pressure of 150 psig. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

3.7 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
 - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
 - b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.8 CLEANING AND DISINFECTION

A. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

B. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities.

END OF SECTION 22 1116

SECTION 22 1119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 PERFORMANCE REQUIREMENTS	1
1.3 SUBMITTALS	1
1.4 QUALITY ASSURANCE	2
PART 2 - PRODUCTS	2
2.1 BACKFLOW PREVENTERS.....	2
2.2 TEMPERATURE-ACTUATED WATER MIXING VALVES	2
2.3 STRAINERS FOR DOMESTIC WATER PIPING	3
2.4 WALL HYDRANTS	3
2.5 WATER HAMMER ARRESTERS	4
PART 3 - EXECUTION	4
3.1 INSTALLATION	4
3.2 CONNECTIONS	4
3.3 FIELD QUALITY CONTROL	4
3.4 ADJUSTING.....	5

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 20 Section "Mechanical General Requirements."
 - 2. Division 20 Section "Basic Mechanical Materials and Methods."
 - 3. Division 22 Section "Domestic Water Piping" for water meters.
 - 4. Division 22 Section "Drinking Fountains and Water Coolers" for water filters for water coolers.

1.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.
- C. Flow Reports and Settings: For calibrated balancing valves.
- D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
- B. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.
- C. NSF Compliance:
 - 1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
 - 2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."
 - 3. Comply with NSF 372, "Drinking Water System Components – Lead Content" for components with wetted surfaces in contact with potable water.

PART 2 - PRODUCTS

2.1 BACKFLOW PREVENTERS

- A. Double-Check Backflow-Prevention Assemblies:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. FEBCO; a Division of Watts Water Technologies, Inc.
 - c. Watts Water Technologies, Inc.; Ames Fire & Waterworks.
 - d. Watts Water Technologies, Inc.; Watts Regulator Co.
 - e. Zurn Plumbing Products Group; Wilkins Div.
 - 2. Standard: ASSE 1015.
 - 3. Operation: Continuous-pressure applications, unless otherwise indicated.
 - 4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
 - 5. Body: Bronze for NPS 2 and smaller;
 - 6. End Connections: Threaded for NPS 2 and smaller.
 - 7. Configuration: Designed for horizontal, straight through flow.
 - 8. Accessories:
 - a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 and smaller.

2.2 TEMPERATURE-ACTUATED WATER MIXING VALVES

- A. Water-Temperature Limiting Devices:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.; Model MVD (34D Series).
 - b. Bradley Corporation.
 - c. Lawler Manufacturing Company, Inc.
 - d. Leonard Valve Company; Series 170-LF and 270-LF.
 - e. Watts Water Technologies, Inc.; Powers Division; Hydroguard Series e480 and LM495.
 - f. Watts Water Technologies, Inc.; Watts Regulator Co.
 - g. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1070.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: 1/2-inch union or 3/8-inch compression; with integral check valves.
7. Accessories: Adjustable temperature-control knob.
8. Outlet Temperature Range: Adjustable from 85 deg F to 120 deg F. Set at 105 deg F.
9. Minimum Flow Rate: 0.5 gpm.
10. Valve Finish: Chrome plated.

2.3 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Manufacturers:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. Keckley.
 - c. Metraflex.
 - d. Mueller Steam Specialty.
 - e. NIBCO, Inc.
 - f. Spence.
 - g. SSI Equipment, Inc.
 - h. Watts Water Technologies, Inc.
 - i. Yarway.
2. CWP: 200 psig minimum, unless otherwise indicated.
3. SWP: 125 psig minimum, unless otherwise indicated.
4. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
5. End Connections: Threaded or soldered for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
6. Screen: Stainless steel with round perforations, unless otherwise indicated.
7. Drain: Factory-installed, hose-end drain valve.

2.4 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Water Technologies, Inc.; Watts Regulator co.
 - f. Woodford Manufacturing Company.
 - g. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.21.3M for self-draining wall hydrants.
3. Pressure Rating: 125 psig.
4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounting with cover.

9. Box and Cover Finish: Polished nickel bronze or chrome plated.
10. Nozzle and Wall-Plate Finish: Polished nickel bronze.
11. Operating Keys(s): One with each wall hydrant.

2.5 WATER HAMMER ARRESTERS

A. Water Hammer Arresters (Copper Tube Type):

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. MIFAB, Inc.
 - b. PPP Inc.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Watts Water Technologies, Inc.; Watts Regulator Co.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.
- B. Install backflow preventers in each water supply. Comply with authorities having jurisdiction.
- C. Install temperature-actuated water mixing valves with strainers, and check stops or shutoff valves on inlets and with shutoff valve on outlet.
- D. Install Y-pattern strainers for water on supply side of each backflow preventer.
- E. Install outlet boxes recessed in wall. Install 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."
- F. Install water hammer arresters in water piping according to PDI-WH 201.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping and specialties.

3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
 1. Test each double-check backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.

- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.4 ADJUSTING

- A. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 22 1119

SECTION 22 13 13 - FACILITY SANITARY AND COMBINED SEWERS

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. Where these specifications differ from the standard details or specifications of the governing agency, the agency standards shall apply.
- B. Contractor shall refer to and familiarize themselves with the Ferris State University Construction Standards. Where these specifications or the plans differ from the standard details or specifications of the university, the university standards shall apply
- C. Materials and installation requirements are generally indicated on the plans. Materials indicated in these specifications only apply if indicated on the plans and allowed by the regulating authority. Contractor is responsible for confirming allowable materials and installation requirements with the regulating authority and including these requirements in their bid.
- D. CAD files will be made available for use in construction staking. Contact the engineer regarding applicable fee and requirements for signing of the CAD File Transfer Agreement.

1.2 SUMMARY

- A. This Section includes gravity-flow, nonpressure sanitary sewerage outside the building, with the following components:
 - 1. Cleanouts.
 - 2. Manholes

1.3 DEFINITIONS

- A. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

- A. Product Data and shop drawing submittals are not required. Contractor shall confirm that the materials provided meet the requirements of the regulating authority, and provide material certification to the engineer. Material certification shall state that the products meet or exceed the requirements indicated on the plans and the requirements of the regulating authority.
- B. Field quality-control test reports.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic manholes, pipe, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes according to manufacturer's written rigging instructions.

1.6 PROJECT CONDITIONS

- A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Architect, Construction Manager, and Owner no fewer than two days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements of the regulating authority.

2.2 PIPING MATERIALS

- A. Refer to plans for types of pipe, fitting, and joining materials.
- B. Materials are generally indicated on the plans. Materials indicated in these specifications only apply if indicated on the plans and allowed by the regulating authority. Contractor is responsible for confirming allowable materials and installation requirements with the regulating authority and including these requirements in their bid

2.3 PVC PIPE AND FITTINGS

- A. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.
- B. PVC Sewer Pipe and Fittings, NPS 18 and Larger: ASTM F 679, T-2 wall thickness, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

- C. PVC Profile Gravity Sewer Pipe and Fittings: ASTM F 794 pipe, with bell-and-spigot ends; ASTM D 3034 fittings, with bell ends; and ASTM F 477, elastomeric seals.

2.4 Reinforced Concrete Pipe

- A. Reinforced concrete pipe shall conform to ASTM C-76.72A, Type III & Type IV.
- B. Joints shall be premium rubber joint as acceptable to the Engineer unless otherwise specified on the drawings.

2.5 MANHOLES

- A. Standard Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints. Refer to plans for standard detail

2.6 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
 - 1. Cement: ASTM C 150, Type II.
 - 2. Fine Aggregate: ASTM C 33, sand.
 - 3. Coarse Aggregate: ASTM C 33, crushed gravel.
 - 4. Water: Potable.
- B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.
 - 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 - 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.
- C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
 - 1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - a. Invert Slope: 1 percent through manhole.
 - 2. Benches: Concrete, sloped to drain into channel.
 - a. Slope: 8 percent.

- D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.
 - 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 - 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

2.7 CLEANOUTS

- A. Gray-Iron Cleanouts: Use in pavement areas. ASME A112.36.2M, round, gray-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include gray-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
 - 1. Top-Loading Classification: Heavy duty.
 - 2. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.
- B. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING APPLICATIONS

- A. Gravity-Flow, Nonpressure Sewer Piping: Pipe material is indicated on the plans. Use only pipe materials indicated on the plans and acceptable to the regulating authority.

3.3 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

- C. Install manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or combination of both.
- F. Install gravity-flow, nonpressure, sewer piping according to the following:
 - 1. Install piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated on the drawings.
 - 2. Install piping at depths indicated on the plans.
 - 3. Install piping below frost line.
 - 4. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.

3.4 PIPE JOINT CONSTRUCTION

- A. Basic piping joint construction is specified in Division 22 Section "Common Work Results for Plumbing" Where specific joint construction is not indicated, follow piping manufacturer's written instructions.
- B. Join gravity-flow, nonpressure, piping according to the following:
 - 1. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.
 - 2. Join dissimilar pipe materials with nonpressure-type, flexible couplings.

3.5 MANHOLE INSTALLATION

- A. General: Install manholes complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Form continuous concrete channels and benches between inlets and outlet.
- D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops of manholes in lawn areas to the rim elevations indicated on the plan

3.6 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade.
 - 1. Use light-duty, top-loading classification cleanouts in earth areas.
 - 2. Use heavy-duty, top-loading classification cleanouts in paved areas.

- B. Set with tops one inch above surrounding grade in nonpaved areas.
- C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.7 CONNECTIONS

- A. Extend sewer piping to within 5' of building. Connection to building piping will be made by the plumbing contractor.
- B. Make connections to existing piping and underground manholes.
 - 1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
 - 2. Make branch connections from side into existing piping, NPS 21 or larger, or to underground manholes by cutting opening into existing unit large enough to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall, unless otherwise indicated. On outside of pipe or manhole wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
 - a. Use concrete that will attain minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.
 - b. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
 - 3. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.8 CLOSING ABANDONED SANITARY SEWERAGE SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Fill with flowable grout prior to enclosing if indicated on the plans. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
 - 1. Close open ends of piping with at least 8-inch thick, brick masonry bulkheads.
 - 2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
- B. Abandoned Manholes: Excavate around manhole as required and use procedure indicated on the plans:
- C. Backfill to grade according to Division 31 Section "Earth Moving."

3.9 IDENTIFICATION

- A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground manholes only if required by the regulating authority.
 - 1. Use detectable warning tape over piping and over edges of underground manholes.

3.10 FIELD QUALITY CONTROL

- A. Test new piping system according to requirements of regulating authority and provide test reports as required. If a testing method is not specified, test as follows:
- B. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Submit separate report for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - c. Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 4. Reinspect and repeat procedure until results are satisfactory.
- C. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 1. Do not enclose, cover, or put into service before inspection and approval.
 - 2. Test completed piping systems according to requirements of authorities having jurisdiction.
 - 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 - 4. Submit separate report for each test.
 - 5. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
 - a. Allowable leakage is maximum of 50 gal./inch of nominal pipe size per mile of pipe, during 24-hour period.
 - b. Close openings in system and fill with water.
 - c. Purge air and refill with water.
 - d. Disconnect water supply.
 - e. Test and inspect joints for leaks.

6. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:

- a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
- b. Option: Test concrete gravity sewer piping according to ASTM C 924.

D. Leaks and loss in test pressure constitute defects that must be repaired.

E. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.11 CLEANING

A. Clean interior of piping of dirt and superfluous material. Flush with potable water.

END OF SECTION 221313

SECTION 22 1316 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 DEFINITIONS	1
1.3 SYSTEMS DESCRIPTIONS	2
1.4 SUBMITTALS	2
1.5 QUALITY ASSURANCE	2
PART 2 - PRODUCTS	2
2.1 MANUFACTURERS	2
2.2 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS	2
2.3 PVC PIPE AND FITTINGS	3
PART 3 - EXECUTION	3
3.1 EXCAVATION	3
3.2 PIPING SYSTEM INSTALLATION	3
3.3 JOINT CONSTRUCTION	4
3.4 SPECIALTY PIPE FITTING INSTALLATION	4
3.5 HANGER AND SUPPORT INSTALLATION	4
3.6 CONNECTIONS	5
3.7 IDENTIFICATION	5
3.8 FIELD QUALITY CONTROL	5
3.9 CLEANING	6

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 20 Section "Mechanical General Requirements".
 - 2. Division 20 Section "Basic Mechanical Materials and Methods".
 - 3. Division 22 Section "Drainage Piping Specialties".

1.2 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.
- C. LLDPE: Linear, low-density polyethylene plastic.
- D. NBR: Acrylonitrile-butadiene rubber.
- E. PE: Polyethylene plastic.
- F. PVC: Polyvinyl chloride plastic.
- G. TPE: Thermoplastic elastomer.

1.3 SYSTEMS DESCRIPTIONS

- A. Sanitary waste and vent piping system materials are scheduled on the Drawing.

1.4 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Field quality-control inspection and test reports.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Cast-iron soil pipe shall be marked with the collective trademark of Cast Iron Soil Pipe Institute (CISPI).
- C. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

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 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. CISPI, Hubless-Piping Couplings:
 - 1. Manufacturers:
 - a. ANACO-Husky; McWane Plumbing Group.
 - b. Ferguson Enterprises, Inc.; ProFlo (Private labeled IDEAL-TRIDON).
 - c. IDEAL-TRIDON.
 - d. Mission Rubber Company; a division of MCP Industries, Inc.
 - e. Tyler Pipe; McWane Plumbing Group.
 - 2. Standards: CISPI 310.
 - 3. Description: NSF certified for compliance with CISPI 310. Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: Schedule 40, ASTM D 2665, drain, waste, and vent.
 - 1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING SYSTEM INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Basic piping installation requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."
- C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- D. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.
- E. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 20 Section "Basic Mechanical Materials and Methods."
- F. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- G. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- H. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- I. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Sanitary Drain: 1/8-inch per foot downward in direction of flow, unless otherwise noted.
 - 2. Horizontal Sanitary Drainage Piping: 1/8-inch per foot downward in direction of flow, unless otherwise noted.

- J. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.
- K. Install underground PVC soil and waste drainage piping according to ASTM D 2321.
- L. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."
- B. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
- C. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.4 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
 - 1. Install transition couplings at joints of piping with small differences in OD's.
 - 2. In Drainage Piping: Shielded, nonpressure transition couplings.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 20 Section "Hangers and Supports." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Install individual, straight, horizontal piping runs according to the following:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
 - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Division 20 Section "Hangers and Supports."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 - 2. NPS 3: 60 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.

- F. Install supports for vertical cast-iron soil piping every 15 feet.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.7 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Division 20 Section "Mechanical Identification."

3.8 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on

roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

3.9 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 22 1316

SECTION 22 1319 - DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 DEFINITIONS	1
1.3 SUBMITTALS	2
1.4 QUALITY ASSURANCE	2
1.5 COORDINATION	2
PART 2 - PRODUCTS	2
2.1 CAST-IRON CLEANOUTS	2
2.2 FLOOR DRAINS	3
2.3 ROOF FLASHING ASSEMBLIES	3
2.4 TRAP SEAL PROTECTION DEVICES	4
2.5 THROUGH-PENETRATION FIRESTOP ASSEMBLIES	4
2.6 ROOF DRAINS	4
2.7 MISCELLANEOUS DRAINAGE PIPING SPECIALTIES	4
PART 3 - EXECUTION	5
3.1 INSTALLATION	5
3.2 CONNECTIONS	6
3.3 FLASHING INSTALLATION	6
3.4 PROTECTION	7

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 20 Section "Mechanical General Requirements."
 - 2. Division 20 Section "Basic Mechanical Materials and Methods."

1.2 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FOG: Fats, oils, and greases.
- C. FRP: Fiberglass-reinforced plastic.
- D. HDPE: High-density polyethylene plastic.
- E. PE: Polyethylene plastic.
- F. PP: Polypropylene plastic.
- G. PUR: Polyurethane plastic.
- H. PVC: Polyvinyl chloride plastic.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories.
- B. Shop Drawings:
 - 1. Show fabrication and installation details for frost-resistant vent terminals.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For drainage piping specialties to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary and storm piping specialty components.

1.5 COORDINATION

- A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CAST-IRON CLEANOUTS

- A. Size: Cleanouts shall be same nominal size as the pipe they serve up to 4 inches. For pipes larger than 4 inches nominal size, minimum size of cleanout shall be 4 inches.
- B. Cast-Iron Floor Cleanouts (On-Grade Interior Floor Areas):
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.; C1220-R.
 - c. Sioux Chief Manufacturing Company, Inc.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 4023S-F.
 - e. Tyler Pipe; Wade Div.
 - f. Watts Drainage Products Inc.
 - g. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASME A112.36.2M.
 - 3. Type: Adjustable housing.
 - 4. Body or Ferrule: Cast iron.
 - 5. Clamping Device: Not required.
 - 6. Outlet Connection: Spigot.
 - 7. Closure: Brass, bronze, or plastic plug with tapered threads.
 - 8. Adjustable Housing Material: Cast iron with threads, set-screws or other device.
 - 9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy with scoriated cover in service areas, and recessed cover to accept floor finish material in finished floor areas.
 - 10. Frame and Cover Shape: Round.
 - 11. Top Loading Classification: Medium Duty.
 - 12. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

- C. Cast-Iron Wall Cleanouts (Finished Wall Areas):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.; Model 58790-20.
 - b. MIFAB, Inc.; C1460-RD.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
 2. Standard: ASME A112.36.2M. Include wall access.
 3. Body: Hub-and-spigot, cast-iron soil pipe T-branch or hubless, cast-iron soil pipe test tee as required to match connected piping.
 4. Closure: Countersunk or raised-head, drilled-and-threaded bronze or brass plug with tapered threads.
 5. Wall Access: Round, deep, chrome-plated bronze flat, chrome-plated brass or stainless-steel cover plate with screw.

2.2 FLOOR DRAINS

- A. Cast-Iron Floor Drains (Toilet Rooms and Janitor's Closet) FD-1:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Sioux Chief Manufacturing Company, Inc.; Finish Line Adjustable Drainage System.
 - d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 2005Y-A.
 - e. Tyler Pipe; Wade Div.
 - f. Watts Drainage Products Inc.
 - g. Zurn Plumbing Products Group; Specification Drainage Operation.
 2. Standard: ASME A112.6.3.
 3. Pattern: Floor drain.
 4. Body Material: Gray iron.
 5. Seepage Flange: Required.
 6. Clamping Device: Required.
 7. Outlet: Bottom.
 8. Coating on Interior and Exposed Exterior Surfaces: Enamel.
 9. Top or Strainer Material: Nickel bronze.
 10. Top of Body and Strainer Finish: Nickel bronze.
 11. Top Shape: Round, with vandal proof screws.
 12. Dimensions of Top or Strainer: 7 inch diameter.
 13. Top Loading Classification: Light Duty.
 14. Inlet Fitting: Gray iron, with spigot outlet.

2.3 ROOF FLASHING ASSEMBLIES

- A. Roof Flashing Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company; Elmdor/Stoneman Div.
 - b. Thaler Metal Industries Ltd.
- B. Description: Manufactured assembly consisting of metal flashing collar and skirt with boot reinforcement and counterflashing fitting.

2.4 TRAP SEAL PROTECTION DEVICES

A. Barrier Type Trap Seal Protection Devices:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Smith, Jay R. Mfg. Co.; Quad Close Trap Seal Device Fig. 2692.
 - b. SureSeal Manufacturing; Inline Floor Drain Trap Sealer.
2. Standard: ASSE 1072-2007.
3. Sealing Element: Neoprene rubber or chemically resistant elastomer.
4. Size: 2 inch, 3 inch, 3-1/2 inch, or 4 inch.
5. Gravity Drain Outlet Connection: Compression fit sealing gasket 80 durometer.

2.5 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ProSet Systems Inc.
2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.

2.6 ROOF DRAINS

A. Metal Roof Drains RD-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 1015/1074.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.4
3. Pattern: Roof drain.
4. Body Material: Cast iron.
5. Dimensions of Body: Minimum 10 inch diameter body.
6. Combination Flashing Ring and Gravel Stop: Required.
7. Flow-Control Weirs: Not required.
8. Outlet: Bottom.
9. Dome Material: Cast iron, or ductile iron.
10. Extension Collars: Required.
11. Underdeck Clamp: Required.
12. Sump Receiver: Required.
13. Standpipe: 2 inches high where overflow drains are indicated.

2.7 MISCELLANEOUS DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
 2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch- minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.
 3. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.
- B. Conductor Nozzles DNZ-1:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company; Josam Div.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.; Model 1770-NB-BS.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.; RD-940-83.
 - f. Zurn Plumbing Products Group; Specification Drainage Operation.
 2. Description: Bronze body with threaded inlet, bronze wall flange with mounting holes, and bird screen.
 3. Size: Same as connected conductor.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 4. Locate at base of each vertical soil and waste stack.
- C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 1. Position floor drains for easy access and maintenance.
 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.

- c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
 - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
 - 4. Install individual deep traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- F. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- G. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07.
 - 1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
 - 2. Position roof drains for easy access and maintenance.
- H. Install deep-seal traps on floor drains and other waste outlets.
- I. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- J. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- K. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.
- L. Install wood-blocking reinforcement for wall-mounting-type specialties.
- M. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 20, 21, 22, and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
 - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
 - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
 - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 22 1319

SECTION 22 1413 - STORM DRAINAGE PIPING

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 DEFINITIONS	1
1.3 SYSTEMS DESCRIPTIONS	1
1.4 SUBMITTALS	1
1.5 QUALITY ASSURANCE	2
PART 2 - PRODUCTS	2
2.1 MANUFACTURERS	2
2.2 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS	2
2.3 PVC PIPE AND FITTINGS	2
PART 3 - EXECUTION	2
3.1 EXCAVATION	2
3.2 PIPING SYSTEM INSTALLATION	3
3.3 JOINT CONSTRUCTION	3
3.4 HANGER AND SUPPORT INSTALLATION	3
3.5 CONNECTIONS	4
3.6 FIELD QUALITY CONTROL	4
3.7 CLEANING	5

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 20 Section "Mechanical General Requirements."
 - 2. Division 20 Section "Basic Mechanical Materials and Methods."
 - 3. Division 22 Section "Drainage Piping Specialties."

1.2 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. LLDPE: Linear, low-density polyethylene plastic.
- C. PE: Polyethylene plastic.
- D. PVC: Polyvinyl chloride plastic.
- E. TPE: Thermoplastic elastomer.

1.3 SYSTEMS DESCRIPTIONS

1.4 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.

1.5 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Cast-iron soil pipe shall be marked with the collective trademark of Cast Iron Soil Pipe Institute (CISPI).
- C. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

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 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. CISPI, Hubless-Piping Couplings:
 - 1. Manufacturers:
 - a. ANACO-Husky; McWane Plumbing Group.
 - b. Ferguson Enterprises, Inc.; ProFlo (Private labeled IDEAL-TRIDON).
 - c. IDEAL-TRIDON.
 - d. Mission Rubber Company; a division of MCP Industries, Inc.
 - e. Tyler Pipe; McWane Plumbing Group.
 - 2. Standards: CISPI 310.
 - 3. Description: NSF certified for compliance with CISPI 310. Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.3 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: Schedule 40, ASTM D 2665, drain, waste, and vent.
 - 1. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 31 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING SYSTEM INSTALLATION

- A. Basic piping installation requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."
- B. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Drainage Piping Specialties."
- C. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.
- D. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 20 Section "Basic Mechanical Materials and Methods."
- E. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- F. Make changes in direction for storm piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- G. Lay buried building drain piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- H. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
 - 1. Building Storm Drain: 1/8-inch per foot downward in direction of flow, unless otherwise noted.
 - 2. Horizontal Storm-Drainage Piping: 1/8-inch per foot downward in direction of flow, unless otherwise noted.
- I. Install underground PVC storm drainage piping according to ASTM D 2321.
- J. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.3 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."
- B. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.
- C. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Pipe hangers and supports are specified in Division 20 Section "Hangers and Supports." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:

- a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet, if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.
- B. Install supports according to Division 20 Section "Hangers and Supports."
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 2. NPS 3: 60 inches with 1/2-inch rod.
 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect storm drainage piping to roof drains and storm drainage specialties.

3.6 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.
 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

3.7 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 22 1413

SECTION 22 3410 – CONDENSING, FUEL-FIRED DOMESTIC WATER HEATERS

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SUBMITTALS	1
1.3 QUALITY ASSURANCE	2
1.4 COORDINATION	2
PART 2 - PRODUCTS	2
2.1 MANUFACTURERS	2
2.2 INSTANTANEOUS, GAS WATER HEATERS	2
2.3 EXPANSION TANKS	3
2.4 WATER HEATER ACCESSORIES	3
2.5 SOURCE QUALITY CONTROL	4
PART 3 - EXECUTION	4
3.1 WATER HEATER INSTALLATION	4
3.2 CONNECTIONS	5
3.3 FIELD QUALITY CONTROL	5
3.4 DEMONSTRATION	5

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 Section includes the following:
 - 1. Division 20 Section "Mechanical General Requirements."
 - 2. Division 20 Section "Basic Mechanical Materials and Methods."

1.2 SUBMITTALS

- A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail water heater assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection
 - 1. Wiring Diagrams: Power, signal, and control systems. Differentiate between manufacturer-installed and field-installed wiring.
- C. Product Certificates: For each type of water heater, signed by product manufacturer.
- D. Source quality-control test reports.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For water heaters to include in operation and maintenance manuals.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain same type of water heaters through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of water heaters and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a NRTL acceptable to authorities having jurisdiction, and marked for intended use.
- D. ASME Compliance:
 - 1. Where ASME-code construction is indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 - 2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.
 - 3. Where ASME-code construction is indicated, fabricate and label commercial direct-fired storage water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV, HLW.
- E. ASHRAE Standards: Comply with performance efficiencies prescribed for the following:
 - 1. ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings," for commercial water heaters.
 - 2. ASHRAE 90.2, "Energy Efficient Design of New Low-Rise Residential Buildings," for household water heaters.
- F. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with potable water.

1.4 COORDINATION

- A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

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 INSTANTANEOUS, GAS WATER HEATERS

- A. Description: Comply with ANSI Z21.10.3/CSA 4.3, except storage is not required.
 - 1. Manufacturers:
 - a. Bosch Thermotechnology; Bosch Therm C Series.
 - b. Navien America Inc.; NP/NR Series.
 - c. NORITZ America Corporation; NCC/NRC Series.

2. Construction: Piping or tubing complying with NSF 61 barrier materials for potable water, without storage capacity.
 - a. Tappings: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig.
 - c. Heat Exchanger:
 - 1) Main: Copper or stainless steel tubing.
 - 2) Secondary: Stainless steel tubing.
 - d. Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2.
 - e. Burner: For use with tankless water heaters and for natural-gas fuel.
 - f. Automatic Ignition: Manufacturer's proprietary system for automatic, gas ignition.
 - g. Temperature Control: Adjustable thermostat.
 - h. Jacket: Metal with enameled finish or plastic.
3. Support: Bracket for wall mounting.
4. Capacity and Characteristics: Refer to Schedule on Drawings.

2.3 EXPANSION TANKS

- A. Description: Steel, pressure-rated tank, ASME-code constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
 1. Manufacturers:
 - a. AMTROL Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett; Xylem Inc.
 - d. Taco, Inc.
 - e. Wessels Co.
 2. Construction:
 - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
 - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
 - c. Air-Charging Valve: Factory installed.
 3. Capacity and Characteristics: Refer to Schedule on Drawings.

2.4 WATER HEATER ACCESSORIES

- A. Gas Shutoff Valves: ANSI Z21.15/CGA 9.1, manually operated. Furnish for installation in piping.
- B. Gas Pressure Regulators: ANSI Z21.18, appliance type. Include pressure rating, capacity, and pressure differential required between gas supply and water heater.
- C. Combination Temperature and Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select each relief valve with sensing element that extends into storage tank.
 1. Gas Water Heaters: ANSI Z21.22/CSA 4.4.
 2. Oil-Fired Water Heaters: ASME rated and stamped and complying with ASME PTC 25.3.

- D. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.
- E. Flue Side Condensate Neutralizer:
 - 1. Description: Designed to raise the PH level of flue side condensate to near neutral prior to condensate entering the sanitary drainage system.
 - 2. Materials: Neutralizer constructed of PVC pipe and fittings mounted on channel strut base with galvanized or stainless steel clamps and hardware; and charged with calcium carbonate.
 - 3. Manufacturers:
 - a. BKI Industries, Inc.; Acid Neutralizer Kits.
 - b. J.J.M. Boiler Works; JM Neutralizing Tubes.
 - c. Any of the approved water heater manufacturers.
- F. Venting: Combustion air inlet and vent piping materials and through roof terminations per manufacturer's requirements.

2.5 SOURCE QUALITY CONTROL

- A. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test water heater storage tanks before shipment to minimum of one and one-half times pressure rating.
- C. Prepare test reports.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

- A. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- B. Install gas water heaters according to NFPA 54.
- C. Install gas shutoff valves on gas supplies to gas water heaters without shutoff valves.
- D. Install gas pressure regulators on gas supplies to gas water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
- E. Install combination temperature and pressure relief valves in water piping for water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- F. Install water heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 20 Section "Valves" for hose-end drain valves.
- G. Install combustion air inlet and vent through roof in accordance with manufacturer's installation instructions.

- H. Install thermometer on outlet piping of water heaters. Retain option in paragraph below only if required.
- I. Fill water heaters with water.
- J. Install expansion tanks with isolation and drain valves. Charge expansion tanks with air.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.
- C. Connect vent to full size of water heater flue outlet.
- D. Ground equipment according to Division 26 Section "Grounding and Bonding."
- E. 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, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water heaters. Refer to Division 20 Section "Mechanical General Requirements."

END OF SECTION 22 3410

SECTION 22 4200 - PLUMBING FIXTURES

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 DEFINITIONS	1
1.3 SUBMITTALS	2
1.4 QUALITY ASSURANCE	2
PART 2 - PRODUCTS	3
2.1 HIGH EFFICIENCY TOILETS	3
2.2 HIGH EFFICIENCY TOILET FLUSHOMETERS	3
2.3 TOILET SEATS	3
2.4 LAVATORIES	4
2.5 LAVATORY FAUCETS	4
2.6 SERVICE BASINS	5
2.7 SINK FAUCETS	5
2.8 FIXTURE SUPPLIES	6
2.9 PROTECTIVE SHIELDING GUARDS	6
2.10 FIXTURE SUPPORTS	6
PART 3 - EXECUTION	7
3.1 EXAMINATION	7
3.2 INSTALLATION	7
3.3 CONNECTIONS	8
3.4 FIELD QUALITY CONTROL	8
3.5 ADJUSTING	8
3.6 CLEANING	9
3.7 PROTECTION	9

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 10 Section "Toilet and Bath Accessories."
 - 2. Division 20 Section "Mechanical General Requirements."
 - 3. Division 20 Section "Basic Mechanical Materials and Methods."
 - 4. Division 22 Section "Drinking Fountains and Water Coolers."
 - 5. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers; individual-fixture, water tempering valves; and specialty fixtures not included in this Section.
 - 6. Division 22 Section "Drainage Piping Specialties" for floor drains, and specialty fixtures not included in this Section.

1.2 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

- D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.
- E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.
- F. FRP: Fiberglass-reinforced plastic.
- G. PMMA: Polymethyl methacrylate (acrylic) plastic.
- H. PVC: Polyvinyl chloride plastic.
- I. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.3 SUBMITTALS

- A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Coordination Drawings: Counter cutout templates for mounting of counter-mounted plumbing fixtures.
- D. Operation and Maintenance Data: For plumbing fixtures and trim to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
 - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
- C. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for plumbing fixtures for people with disabilities.
- D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- E. Regulatory Requirements: Comply with requirements in Public Law 111-380, "Reduction of Lead in Drinking Water Act," about lead content in materials that will be in contact with potable water for human consumption.
- F. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," and NSF 372 Drinking Water System Components – Lead Content for potable domestic water piping and components.
- G. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

- H. Comply with applicable ANSI, ASME, ASSE, ASTM, ICC, NSF, and UL standards and other requirements specified for plumbing fixtures, trim, fittings, components, and features.

PART 2 - PRODUCTS

- A. Water Closets, WC-1:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard Companies, Inc.; Madera 16-1/2 Elongated Toilet.
 - b. Kohler Co.; K-4405.
 - c. Crane Plumbing Co.
 2. Description: Accessible, floor-mounting, floor-outlet, vitreous-china fixture designed for flushometer valve operation.
 - a. Style: Flushometer valve.
 - 1) Bowl Type: Elongated with siphon-jet design. Include bolt caps matching fixture.
 - 2) Supply Spud Location: Top.
 - 3) Height: 16-1/2 to 16-3/4 inches, universal/accessible.
 - 4) Design Consumption: 1.6 gal./flush.
 - 5) Color: White.
 - b. Flushometer: FV-2-1
 - c. Toilet Seat: TS-1.

2.2 WATER CLOSET FLUSHOMETERS

- A. Flushometers, FV-2-1:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Sloan Valve Company.
 - b. Zurn Plumbing Products Group; ZEMS6000-WS1-IS.
 2. Description: Flushometer for water-closet-type fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, courtesy flush feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.
 - a. Internal Design: Diaphragm or piston operation.
 - b. Style: Concealed.
 - c. Inlet Size: NPS 1.
 - d. Trip Mechanism: Hard-wired, electric-sensor actuator.
 - e. Consumption: 1.6 gal./flush.
 - f. Tailpiece Size: NPS 1-1/2 and standard length to top of bowl.
 - g. Transformer: 1 required for up to 8 flushometers.

2.3 TOILET SEATS

- A. Toilet Seats, TS-1:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bemis Manufacturing Company; 1955SSC/1955SSCT.
 - b. Centoco Manufacturing Corp.
 - c. Church Seats; 295SSC/295SSCT.
 - d. Olsonite Seat Company; Model 10SSC/10SSCT.
 - e. Sanderson Plumbing Products, Inc.; Beneke Div.

- f. Zurn Plumbing Products Group; 5955STS-WH.
- 2. Description: Toilet seat for water-closet-type fixture.
 - a. Material: Molded, solid plastic.
 - b. Configuration: Open front without cover.
 - c. Size: Elongated.
 - d. Hinge Type: SC, self-sustaining, check.
 - e. Class: Standard commercial.
 - f. Color: White.

2.4 LAVATORIES

A. Lavatories, LAV-1:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard Companies, Inc.; Aqualyn Model 0475.028.
 - b. Kohler Co.; K 2196-4 Pennington.
 - c. Sloan Valve Company.
 - d. Zurn Plumbing Products Group; Z5114.
- 2. Description: Accessible, counter-mounting, vitreous-china fixture.
 - a. Type: Self-rimming.
 - b. Oval Lavatory Size: 20 by 17 inches.
 - c. Faucet Hole Punching: Three holes, 2-inch centers.
 - d. Color: White.
 - e. Faucet: LF-1
 - f. Water Temperature Limiting Device: Required.
 - g. Drain: Grid.
 - h. Drain Piping: NPS 1-1/4 chrome-plated, cast-brass P-trap; NPS 1-1/4, 17 gage tubular brass waste to wall; and wall escutcheon.

2.5 LAVATORY FAUCETS

A. Lavatory Faucets, LF-1:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard Companies, Inc.; Innsbrook Model 6518 VA.2AC.
 - b. Chicago Faucets; Model 115.736.21.1.
 - c. Delta Faucet Company; Model 591-LGHGMHDF with Converter or 591T Series.
 - d. Geberit Manufacturing, Inc.
 - e. Kohler Co.; K13463 (with K13478-A escutcheon), K13480 power supply.
 - f. Moen Commercial.
 - g. Sloan Valve Company.
 - h. Speakman Company.
 - i. Zurn Plumbing Products Group; Z6917-CWB.
- 2. Description: Faucet suitable for 4 inch centers, grid strainer, and no lift rod hole.
 - a. Body Material: Commercial, solid brass.
 - b. Finish: Polished chrome plate.
 - c. Mounting: Deck, concealed.
 - d. Inlet(s): NPS 1/2.

- e. Spout Outlet: Vandal proof spray, 0.5 gpm.
- f. Operation: Sensor/Hard-wired.
- g. Step-Down Transformers: Required.

2.6 SERVICE BASINS

A. Service Basins, SS-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Acorn Engineering Company.
 - b. Crane Plumbing, LLC; Fiat Products; an American Standard Brand.
 - c. Florestone Products Co., Inc.
 - d. Precast Terrazzo Enterprises, Inc.
 - e. Stern-Williams Co., Inc.
 - f. Crane Plumbing, LLC; Fiat Products; an American Standard Brand.
 - g. Ferguson Enterprises, Inc.; ProFlo.
 - h. Florestone Products Co., Inc.
 - i. Mustee, E. L. & Sons, Inc.
 - j. Swan Corporation (The).
 - k. Zurn Plumbing Products Group; Light Commercial Operation.
2. Description: Flush-to-wall, floor-mounting, precast terrazzo fixture with rim guard.
 - a. Shape: Square.
 - b. Size: 24 by 24 inches.
 - c. Height: 12 inches with dropped front.
 - d. Tiling Flange: Not required.
 - e. Rim Guard: On all top surfaces.
 - f. Color: Not applicable.
 - g. Faucet: SF-1.
 - h. Drain: Grid with NPS 3 outlet.

2.7 SINK FAUCETS

A. Sink Faucets, SF-1:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard Companies, Inc.
 - b. Chicago Faucets; Model 897.
 - c. Delta Faucet Company; Model 28C2383.
 - d. Kohler Co.
 - e. Moen Commercial.
 - f. Speakman Company; SC5811-RCP-LEV-5H-WHK.
 - g. Symmons Industries, Inc.
 - h. T & S Brass and Bronze Works, Inc.
 - i. Zurn Plumbing Products Group.
2. Description: Service sink faucet with stops in shanks, vacuum breaker, hose-thread outlet, and pail hook. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor. Include 5 foot rubber hose and wall mounted hose clamp.
 - a. Body Material: Commercial, solid brass.
 - b. Finish: Polished chrome plate.

- c. Maximum Flow Rate: 2.5 gpm, unless otherwise indicated.
- d. Mixing Valve: Two handle.
- e. Centers: 8 inches.
- f. Mounting: Back/wall.
- g. Handle(s): Lever.
- h. Inlet(s): NPS 1/2.
- i. Spout Type: Rigid, solid brass with wall brace and pail hook.
- j. Spout Outlet: Hose thread.
- k. Vacuum Breaker: Required.
- l. Operation: Noncompression, manual.

2.8 FIXTURE SUPPLIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. BrassCraft; a Masco Company.
 - 2. McGuire Mfg. Co., Inc.
 - 3. Any of the approved plumbing fixture manufacturers.
- B. Description: Chrome-plated brass, loose-key or screwdriver angle stops with brass stems; rigid, chrome-plated copper risers; and chrome-plated wall flanges.

2.9 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers (PSG-1):
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Engineered Brass Co.
 - b. Insul-Tect Products Co.; a Subsidiary of MVG Molded Products.
 - c. McGuire Manufacturing Co., Inc.
 - d. Plumberex Specialty Products Inc.
 - e. TCI Products; SG-200BV.
 - f. TRUEBRO, Inc.
 - g. Zurn Plumbing Products Group; Z8946-3-NT.
 - 2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.10 FIXTURE SUPPORTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Josam Company.
 - 2. MIFAB Manufacturing Inc.
 - 3. Smith, Jay R. Mfg. Co.
 - 4. Tyler Pipe; Wade Div.
 - 5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
 - 6. Zurn Plumbing Products Group; Specification Drainage Operation.
- B. Urinal Supports:
 - 1. Description: For wall-mounting, urinal-type fixture. Include steel uprights with feet.
 - 2. Accessible-Fixture Support: Include rectangular steel uprights.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
 - 1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
 - 2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
 - 3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.
- C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.
- D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.
- E. Install wall-mounting fixtures with tubular waste piping attached to supports.
- F. Install counter-mounting fixtures in and attached to casework.
- G. Install fixtures level and plumb according to roughing-in drawings. Install accessible fixtures at heights required by local codes.
- H. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
 - 1. Exception: Fixtures with flushometer valves, and faucets or valves with integral stops.
- I. Install ASSE 1070 water-temperature limiting devices on supplies for lavatories and sinks that will be used for handwashing, and where specified. Refer to Division 20 Section "Domestic Water Piping Specialties."
- J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.
- L. Install protective shielding guards PSG-1 on exposed traps and supplies of lavatories, and sinks used for hand washing.
- M. Install toilet seats on water closets.
- N. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

- O. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.
- P. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- Q. Install traps on fixture outlets.
 - 1. Exception: Omit trap on fixtures with integral traps.
 - 2. Exception: Omit trap on indirect wastes, unless otherwise indicated.
- R. Install hot-water dispensers in back top surface of sink or in countertop with spout over sink.
- S. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 20 Section "Basic Mechanical Materials and Methods."
- T. Set service basins in leveling bed of cement grout. Grout is specified in Division 20 Section "Basic Mechanical Materials and Methods."
- U. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 7 Section "Joint Sealants."

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Individual water line branches, waste lines, vents, and traps for connection to individual fixtures, fixture fittings and specialties shall be in accordance with the schedule on the Drawings.
- D. Ground equipment according to Division 26 Section "Grounding and Bonding."
- E. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.
- B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

- B. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.
- C. Replace washers and seals, or cartridges of leaking and dripping faucets and stops.
- D. Install fresh batteries in sensor-operated mechanisms.

3.6 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
 - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
 - 2. Remove sediment and debris from drains.
- B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 4200

SECTION 22 4700 - DRINKING FOUNTAINS, WATER COOLERS, AND CUSPIDORS

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 DEFINITIONS	1
1.3 SUBMITTALS	2
1.4 QUALITY ASSURANCE	2
PART 2 - PRODUCTS	2
2.1 PRESSURE (ELECTRIC) WATER COOLERS	2
2.2 FIXTURE SUPPORTS	3
PART 3 - EXECUTION	3
3.1 EXAMINATION	3
3.2 APPLICATIONS	4
3.3 INSTALLATION	4
3.4 CONNECTIONS	4
3.5 FIELD QUALITY CONTROL	4
3.6 ADJUSTING.....	5
3.7 CLEANING.....	5

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 20 Section "Mechanical General Requirements."
 - 2. Division 20 Section "Basic Mechanical Materials and Methods."

1.2 DEFINITIONS

- A. Accessible Drinking Fountain or Water Cooler: Fixture that can be approached and used by people with disabilities.
- B. Cast Polymer: Dense, cast-filled-polymer plastic.
- C. Drinking Fountain: Fixture with nozzle for delivering stream of water for drinking.
- D. Fitting: Device that controls flow of water into or out of fixture.
- E. Fixture: Drinking fountain or water cooler.
- F. Remote Water Cooler: Electrically powered equipment for generating cooled drinking water.
- G. TDS: Total dissolved solids.
- H. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

1.3 SUBMITTALS

- A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For fixtures 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. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for fixtures for people with disabilities.
- C. Regulatory Requirements: Comply with requirements in the U.S. Architectural & Transportation Barriers Compliance Board's "Uniform Federal Accessibility Standards (UFAS), 1985-494-187" about fixtures for people with disabilities.
- D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- E. AHRI Standard: Comply with AHRI's "Directory of Certified Drinking Water Coolers" for style classifications.
- F. AHRI Standard: Comply with AHRI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with AHRI's "Directory of Certified Drinking Water Coolers" for type and style classifications.
- G. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

PART 2 - PRODUCTS

2.1 PRESSURE (ELECTRIC) WATER COOLERS

- A. Water Coolers
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AcornAqua; a division of Acorn Engineering Company.
 - b. Elkay Manufacturing Co.; EZH2O System LZSTL8WSLK.
 - c. Halsey Taylor.
 - d. Haws Corporation.
 - e. Oasis Corporation.
 - f. Sunroc Corp.
 - 2. Description: Accessible, AHRI 1010, Type PB, pressure with bubbler, Style W, wall-mounting water cooler for adult/child-mounting height with bottle filling station.

- a. Cabinet: Bilevel with two attached cabinets baked enamel finish or vinyl-covered steel with stainless-steel top, and single filtered cooler with bottle filling station.
- b. Bubbler: One, flexible or elastomeric overmolded, with adjustable stream regulator, located on each cabinet deck.
- c. Control: Push bar.
- d. Supply: NPS 3/8 with ball, gate, or globe valve.
- e. Filter: Complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
- f. Drain(s): Grid with NPS 1-1/4 minimum horizontal waste and trap complying with ASME A112.18.1.
- g. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
 - 1) Capacity: 8 gph of 50 deg F cooled water from 80 deg F inlet water and 90 deg F ambient air temperature.
 - 2) Electrical Characteristics: 1/5 hp; 120-V ac; single phase; 60 Hz.
- h. Bottle Filling Station: Recessed design constructed of 18 gage Type 300 series stainless steel and ABS plastic. Include:
 - 1) Electronic sensor for no-touch activation.
 - 2) Automatic 20-second shut-off timer.
 - 3) 1.1 gpm flow rate
 - 4) Anti-microbial protected plastic components.
- i. Support: Refer to "Fixture Supports" Article.

2.2 FIXTURE SUPPORTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Josam Co.
 - 2. MIFAB Manufacturing, Inc.
 - 3. Smith, Jay R. Mfg. Co.
 - 4. Tyler Pipe; Wade Div.
 - 5. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
 - 6. Zurn Plumbing Products Group; Specification Drainage Operation.
- B. Description: ASME A112.6.1M, water cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.
 - 1. Type I: Hanger-type carrier with two vertical uprights.
 - 2. Type II: Bilevel, hanger-type carrier with three vertical uprights.
 - 3. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.
- B. Examine walls and floors for suitable conditions where fixtures are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.
- B. Use mounting frames for recessed water coolers, unless otherwise indicated.
- C. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

3.3 INSTALLATION

- A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.
- B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.
- C. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 20 Section "Valves."
- E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 20 Section "Basic Mechanical Materials and Methods."
- G. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 7 Section "Joint Sealants."

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 20 and 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding."
- D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.5 FIELD QUALITY CONTROL

- A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.
 - 1. Remove and replace malfunctioning units and retest as specified above.
 - 2. Report test results in writing.

3.6 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust water cooler temperature settings.

3.7 CLEANING

- A. After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 22 4700

SECTION 23 0500 - COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SUMMARY	1
1.3 SUBMITTALS	1
1.4 QUALITY ASSURANCE	2
1.5 ENVIRONMENTAL REQUIREMENTS	2
PART 2 - PRODUCTS	2
2.1 MANUFACTURERS	2
2.2 FAN SHAFTS	2
2.3 FAN POWER TRANSMISSION	2
2.4 SHEAVES	3
2.5 V-BELT FAN DRIVES	3
2.6 FAN DRIVE, SHAFT, AND COUPLING GUARDS	3
2.7 BELT DRIVE GUARDS	4
2.8 V-BELTS	4
2.9 V-BELT DRIVE MOTOR BASES	4
2.10 AIR HANDLING SYSTEM BALANCING PROVISIONS	4
2.11 FLEXIBLE COUPLINGS (DIRECT DRIVE)	5
2.12 MOTOR REQUIREMENTS	5
2.13 FAN BEARINGS	5
2.14 IDENTIFICATION	5
2.15 ACCESSORIES	5
PART 3 - EXECUTION	5
3.1 INSTALLATION	5

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.
- B. Fan Performance Data: AMCA Standard 210.
- 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

- A. V-Belt Type Fan Drives: In accordance with Engineering Standard Specification for Drives Using Multiple V-Belts, sponsored by the Mechanical Power Transmission Association and the Rubber Manufacturer's Association.
- 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 constant speed fans at or above 2 inches of total static pressure, Contractor shall provide and install two sets of fixed sheaves. First set shall be installed for initial start-up and shall be based on scheduled data. The second set shall be installed after system balance is complete and shall be based on actual field conditions.
- C. For all constant speed fans below 2 inches total static pressure, Contractor shall provide and install two sets of adjustable sheaves. First set shall be installed for initial start-up and shall be based on scheduled data. The second set shall be installed after the balance is complete and shall be based on actual field conditions, and selected at mid-range of the sheave.
- D. Set pitch diameters of fixed pitch and adjustable or variable pitch sheaves when adjusted as specified, at not less than that recommended by NEMA Standard MG1-14.42.
- E. For companion sheaves for adjustable or variable pitch drives, furnish wide groove spacing to match driving sheaves.
- F. 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.
- B. Provide sheaves, sized as recommended by the Balancing Agent, for the adjustment of fan speed for each existing air handling system requiring rebalancing during air quantity balancing operations. Furnish sheaves as specified in this Section.

2.11 FLEXIBLE COUPLINGS (DIRECT DRIVE)

- A. Fan shaft shall be connected to the motor shaft through a flexible coupling. The flexible member shall be a tire shape, in shear, or a solid mass serrated edge disc shape, made of chloroprene materials and retained by fixed flanges. Flexible coupling shall act as a dielectric connector and shall not transmit sound, vibration or end thrust.
- B. Manufacturer:
 - 1. Falk Corporation (The).

2.12 MOTOR REQUIREMENTS

- A. Furnish motors in accordance with Division 20 Section "Motors."

2.13 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 L₁₀ 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 L₁₀ life requirements.

2.14 IDENTIFICATION

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

2.15 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

SECTION 23 0593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SUMMARY	1
1.3 DEFINITIONS	2
1.4 SUBMITTALS	3
1.5 QUALITY ASSURANCE	3
1.6 PROJECT CONDITIONS	4
1.7 COORDINATION	4
1.8 WARRANTY	4
PART 2 - PRODUCTS (NOT APPLICABLE)	4
PART 3 - EXECUTION	4
3.1 EXAMINATION	4
3.2 PREPARATION	5
3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING	6
3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS	6
3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS	6
3.6 PROCEDURES FOR CONDENSING UNITS	7
3.7 TOLERANCES	8
3.8 REPORTING	8
3.9 FINAL REPORT	8
3.10 INSPECTIONS	13
3.11 ADDITIONAL TESTS	14

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 20 Section "Mechanical General Requirements."
 - 2. Division 20 Section "Basic Mechanical Materials and Methods."
 - 3. Division 23 Section "Common Work Results for HVAC."

1.2 SUMMARY

- A. This Section includes testing, adjusting, and balancing to produce design objectives for the following:
 - 1. Air Systems:
 - a. Constant-volume air systems.
 - 2. Verifying that automatic control devices are functioning properly.
 - 3. Reporting results of activities and procedures specified in this Section.
- B. Include rebalancing of air systems, or system portions affected by recommended sheave changes.

1.3 DEFINITIONS

- A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
- B. AHJ: Authority having jurisdiction.
- C. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.
- D. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
- E. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.
- F. NC: Noise criteria.
- G. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
- H. RC: Room criteria.
- I. Report Forms: Test data sheets for recording test data in logical order.
- J. Smoke-Control System: An engineered system that uses fans to produce airflow and pressure differences across barriers to limit smoke movement.
- K. Smoke-Control Zone: A space within a building that is enclosed by smoke barriers and is a part of a zoned smoke-control system.
- L. Stair Pressurization System: A type of smoke-control system that is intended to positively pressurize stair towers with outdoor air by using fans to keep smoke from contaminating the stair towers during an alarm condition.
- M. 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.
- N. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
- O. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
- P. 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.
- Q. TAB: Testing, adjusting, and balancing.
- R. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
- S. Test: A procedure to determine quantitative performance of systems or equipment.
- T. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

- A. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.
- B. Sample Report Forms: Submit two sets of sample TAB report forms.
- C. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. TAB Firm Qualifications: Engage a TAB firm certified by either AABC or NEBB.
- B. Approved Balancing Agencies.
 - 1. The TAB firm selected shall be from the following list:
 - a. Absolut Balance Company, Inc.; South Lyon, MI.
 - b. Airflow Testing Inc.; Lincoln Park, MI.
 - c. Barmatic Inspecting Co., Inc.; Lincoln Park, MI.
 - d. Ener-Tech Testing; Holly, MI.
 - e. Enviro-Aire/Total Balance Co.; St. Clair Shores, MI.
 - f. International Test & Balance Inc.; Southfield, MI.
 - g. Aireconomics, Inc.; Grand Rapids, MI.
 - h. Pro-MEC Engineering Services, Inc.; Grand Ledge, MI.
 - i. Hi-Tech Test & Balance; Freeland, MI.
 - j. Integrity Test & Balance, Inc.; Cedar, MI.
- C. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.
 - 1. Agenda Items: Include at least the following:
 - a. Submittal distribution requirements.
 - b. The Contract Documents examination report.
 - c. TAB plan.
 - d. Work schedule and Project-site access requirements.
 - e. Coordination and cooperation of trades and subcontractors.
 - f. Coordination of documentation and communication flow.
- D. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.
- E. TAB Report Forms: Use standard forms from 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." TAB firm's forms approved by Architect.
- F. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

- G. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
 - 1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.6 PROJECT CONDITIONS

- A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

- A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.
- B. Notice: Provide seven days advance notice for each test. Include scheduled test dates and times.
- C. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.8 WARRANTY

- A. National Project Performance Guarantee: If AABC standards are used, provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:
 - 1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
 - 2. Systems are balanced to optimum performance capabilities within design and installation limits.
- B. Special Guarantee: If NEBB standards are used, provide a guarantee on NEBB forms stating that NEBB will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee shall include the following provisions:
 - 1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
 - 2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.
- B. Examine system and equipment test reports.

- C. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
- D. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- E. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.
- F. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.
- G. Examine equipment for installation and for properly operating safety interlocks and controls.
- H. Examine automatic temperature system components to verify the following:
 - 1. Dampers, valves, and other controlled devices are operated by the intended controller.
 - 2. Dampers and valves are in the position indicated by the controller.
 - 3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
 - 4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
 - 5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
 - 6. Sensors are located to sense only the intended conditions.
 - 7. Sequence of operation for control modes is according to the Contract Documents.
 - 8. Controller set points are set at indicated values.
 - 9. Interlocked systems are operating.
 - 10. Changeover from heating to cooling mode occurs according to indicated values.
- I. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:
 - 1. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.
 - 2. Maximum Allowable Leakage: Leakage rates are scheduled on the Drawings.
- C. Complete system readiness checks and prepare system readiness reports. Verify the following:
 - 1. Permanent electrical power wiring is complete.
 - 2. Automatic temperature-control systems are operational.
 - 3. Equipment and duct access doors are securely closed.
 - 4. Isolating and balancing valves are open and control valves are operational.
 - 5. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 - 6. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.
- B. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.
- C. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts, or use reduced scale contract documents with notations.
- C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
- D. Cut insulation, and drill ducts for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes with neat patches, neoprene plugs, threaded plugs, or threaded twist-on metal caps, and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check dampers for proper position to achieve desired airflow path.
- H. Check for airflow blockages.
- I. Check condensate drains for proper connections and functioning.
- J. Check for proper sealing of air-handling unit components.
- K. Check for proper sealing of air duct system.

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure fan static pressures to determine actual static pressure as follows:
 - a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.

- d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
 - a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
 - 3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.
 - 4. Select required sheave sizes and advise installing contractor to change drive sheaves accordingly. Refer to Division 23 Section "Common Work Results for HVAC" for additional requirements.
 - 5. When existing air handling systems require rebalancing, select required sheave sizes and advise Mechanical Contractor to change drive sheaves accordingly. Refer to Division 23 Section "Common Work Results for HVAC" for additional requirements.
 - 6. Do not recommend fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.
 - B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 - 1. Measure airflow at a point downstream from the balancing damper and adjust volume dampers until the proper airflow is achieved.
 - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 - 2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
 - C. Measure terminal outlets and inlets without making adjustments.
 - 1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
 - D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.
 - 1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 - 2. Adjust patterns of adjustable outlets for proper distribution without drafts.
- 3.6 PROCEDURES FOR CONDENSING UNITS
- A. Verify proper rotation of fans.
 - B. Measure entering- and leaving-air temperatures.
 - C. Record compressor data.

3.7 TOLERANCES

- A. Set HVAC system airflow and water flow rates within the following tolerances:
 - 1. Air handling equipment and outlets: Plus or minus 5 percent.

3.8 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.

3.9 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. Fan 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.
 - 8. Report date.
 - 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. Terminal units.
 3. Balancing stations.
- F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data: Include the following:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - j. Number of belts, make, and size.
 - k. Number of filters, type, and size.
 2. Motor Data:
 - a. Make and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - g. Power factor efficiency.
 3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat coil static-pressure differential in inches wg.
 - g. Cooling coil static-pressure differential in inches wg.
 - h. Heating coil static-pressure differential in inches wg.
 - i. Outside airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outside-air damper position.

- l. Return-air damper position.
- m. Vortex damper position.

G. Apparatus-Coil Test Reports:

1. Coil Data:

- a. System identification.
- b. Location.
- c. Coil type.
- d. Number of rows.
- e. Fin spacing in fins per inch o.c.
- f. Make and model number.
- g. Face area in sq. ft..
- h. Tube size in NPS.
- i. Tube and fin materials.
- j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in cfm.
- b. Average face velocity in fpm.
- c. Air pressure drop in inches wg.
- d. Outside-air, wet- and dry-bulb temperatures in deg F.
- e. Return-air, wet- and dry-bulb temperatures in deg F.
- f. Entering-air, wet- and dry-bulb temperatures in deg F.
- g. Leaving-air, wet- and dry-bulb temperatures in deg F.
- h. Water flow rate in gpm.
- i. Water pressure differential in feet of head or psig.
- j. Entering-water temperature in deg F.
- k. Leaving-water temperature in deg F.

H. Gas- and Oil-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:

- a. System identification.
- b. Location.
- c. Make and type.
- d. Model number and unit size.
- e. Manufacturer's serial number.
- f. Fuel type in input data.
- g. Output capacity in Btuh.
- h. Ignition type.
- i. Burner-control types.
- j. Motor horsepower and rpm.
- k. Motor volts, phase, and hertz.
- l. Motor full-load amperage and service factor.
- m. Sheave make, size in inches, and bore.
- n. Sheave dimensions, center-to-center, and amount of adjustments in inches.

2. Test Data (Indicated and Actual Values):

- a. Total airflow rate in cfm.
- b. Entering-air temperature in deg F.
- c. Leaving-air temperature in deg F.
- d. Air temperature differential in deg F.
- e. Entering-air static pressure in inches wg.

- f. Leaving-air static pressure in inches wg.
 - g. Air static-pressure differential in inches wg.
 - h. Low-fire fuel input in Btuh.
 - i. High-fire fuel input in Btuh.
 - j. Manifold pressure in psig.
 - k. High-temperature-limit setting in deg F.
 - l. Operating set point in Btuh.
 - m. Motor voltage at each connection.
 - n. Motor amperage for each phase.
 - o. Heating value of fuel in Btuh.
- I. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
 - 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Coil identification.
 - d. Capacity in Btuh.
 - e. Number of stages.
 - f. Connected volts, phase, and hertz.
 - g. Rated amperage.
 - h. Airflow rate in cfm.
 - i. Face area in sq. ft..
 - j. Minimum face velocity in fpm.
 - 2. Test Data (Indicated and Actual Values):
 - a. Heat output in Btuh.
 - b. Airflow rate in cfm.
 - c. Air velocity in fpm.
 - d. Entering-air temperature in deg F.
 - e. Leaving-air temperature in deg F.
 - f. Voltage at each connection.
 - g. Amperage for each phase.
- J. Fan Test Reports: For supply, return, and exhaust fans, include the following:
 - 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - 2. Motor Data:
 - a. Make and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
 - g. Number of belts, make, and size.

3. Test Data (Indicated and Actual Values):
 - a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- K. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
 1. Report Data:
 - a. System and air-handling unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft..
 - g. Indicated airflow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual airflow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- L. Air-Terminal-Device Reports:
 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Test apparatus used.
 - d. Area served.
 - e. Air-terminal-device make.
 - f. Air-terminal-device number from system diagram.
 - g. Air-terminal-device type and model number.
 - h. Air-terminal-device size.
 - i. Air-terminal-device effective area in sq. ft..
 2. Test Data (Indicated and Actual Values):
 - a. Airflow rate in cfm.
 - b. Air velocity in fpm.
 - c. Preliminary airflow rate as needed in cfm.
 - d. Preliminary velocity as needed in fpm.
 - e. Final airflow rate in cfm.
 - f. Final velocity in fpm.
 - g. Space temperature in deg F.
- M. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
 1. Unit Data:
 - a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Room or riser served.
 - d. Coil make and size.
 - e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

- a. Airflow rate in cfm.
- b. Entering-water temperature in deg F.
- c. Leaving-water temperature in deg F.
- d. Water pressure drop in feet of head or psig.
- e. Entering-air temperature in deg F.
- f. Leaving-air temperature in deg F.

N. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:

1. Unit Data:

- a. Unit identification.
- b. Location.
- c. Unit make and model number.
- d. Compressor make.
- e. Compressor model and serial numbers.

2. Test Data (Indicated and Actual Values):

- a. Inlet-duct static pressure in inches wg.
- b. Outlet-duct static pressure in inches wg.
- c. Entering-air, dry-bulb temperature in deg F.
- d. Leaving-air, dry-bulb temperature in deg F.
- e. Condenser entering-water temperature in deg F.
- f. Condenser leaving-water temperature in deg F.
- g. Condenser-water temperature differential in deg F.
- h. Condenser entering-water pressure in feet of head or psig.
- i. Condenser leaving-water pressure in feet of head or psig.
- j. Condenser-water pressure differential in feet of head or psig.
- k. Control settings.
- l. Voltage at each connection.
- m. Amperage for each phase.
- n. Kilowatt input.
- o. Crankcase heater kilowatt.
- p. Number of fans.
- q. Condenser fan rpm.
- r. Condenser fan airflow rate in cfm.
- s. Condenser fan motor make, frame size, rpm, and horsepower.
- t. Condenser fan motor voltage at each connection.
- u. Condenser fan motor amperage for each phase.

3.10 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.

3.11 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional testing, inspecting, and adjusting during near-peak summer and winter conditions.

END OF SECTION 23 0593

SECTION 23 0933 - TEMPERATURE CONTROLS

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SUMMARY	2
1.3 DEFINITIONS	2
1.4 SYSTEM DESCRIPTION	2
1.5 SEQUENCE OF OPERATION	2
1.6 SUBMITTALS	2
1.7 REFERENCES	4
1.8 QUALITY ASSURANCE	4
1.9 DELIVERY, STORAGE, AND HANDLING	4
1.10 COORDINATION	4
1.11 WARRANTY	5
1.12 POSTED OPERATING INSTRUCTIONS	5
1.13 SPECIAL TOOLS	5
1.14 PROTECTION OF PROPRIETARY INFORMATION	5
PART 2 - PRODUCTS	6
2.1 DESCRIPTION OF THE HVAC TEMPERATURE CONTROL SYSTEM	6
2.2 DDC CONTROLLERS	6
2.3 DDC CONTROLLER SOFTWARE	6
2.4 DDC INPUT/OUTPUT SENSORS	8
2.5 DAMPERS - AUTOMATED	9
2.6 DAMPERS, INSULATED OUTDOOR AIR / RELIEF AIR / EXHAUST AIR - AUTOMATED	10
2.7 DAMPER OPERATORS - ELECTRIC	10
2.8 LOCAL AND AUXILIARY CONTROL PANELS	11
2.9 THERMOSTATS - ELECTRONIC & ELECTRIC	11
2.10 STATUS SENSORS AND DEVICES - ELECTRIC	12
2.11 ELECTRICAL REQUIREMENTS FOR CONTROLS WORK	12
PART 3 - EXECUTION	13
3.1 INSTALLATION - CONTROL SYSTEMS	13
3.2 TC CONTRACTOR DESIGN & INSTALLATION COORDINATION MEETINGS	13
3.3 IDENTIFICATION AND MARKING	14
3.4 GRAPHIC DISPLAY GENERATION	14
3.5 OWNER INSTRUCTION AND TRAINING	15
3.6 CALIBRATION AND START-UP	15
3.7 ACCEPTANCE PROCEDURE	15

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."
 - 3. Division 23 Section "Testing, Adjusting, and Balancing."
 - 4. Division 26 Section "Electrical General Requirements" and any related Section for power, control, and communication wiring.

1.2 SUMMARY

- A. This Section includes control equipment for HVAC systems and components, including control components for air handling, and heating and cooling units, not supplied with factory-wired controls.

1.3 DEFINITIONS

- A. BACnet: Communications open protocol for building automation system networks and control (developed by ASHRAE and documented per ANSI/ASHRAE Standard 135-2012).
- B. BAS: Building Automation System
- C. CAD: Computer Aided Design.
- D. DDC: Direct-digital controls.
- E. EWIC: Electrical Wiring/Installation Contractor for Controls
- F. TC: Temperature Control.

1.4 SYSTEM DESCRIPTION

- A. Temperature control system consisting of BACnet direct digital control (DDC) system panels, sensors, transducers, relays, switches, data communication network, etc. and all associated control wiring and raceway systems. The new temperature controls shall interface with the existing Siemens BAS located the WSU FP&M Building.
- B. Provide BAS/DDC system programming, database and graphic display generation at the existing operator workstation of the BAS.
- C. Electric control valves, dampers, operators, control wiring, etc.
- D. Electric and electronic control devices, relays, accessories, etc., and other control system instrumentation and devices.
- E. All electrical controls power wiring, conduit, data communication wiring, etc. and all associated control wiring and raceway systems as it relates to the new temperature controls shall interface with the existing Siemens ABC and be wired by the EWIC.

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, 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, automated dampers, and initial phases of work associated with fast-track projects (when required). Early submittals of control valve and automated 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, pumps, coils, dampers, valves, and control devices.
 - 3. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
 - 4. Details of control panel faces and interior, including controls, instruments, terminal blocks and labeling.
 - 5. Written sequence of operation for each controlled system.
 - 6. Schedule of dampers including size, leakage, and flow characteristics (Refer to Design Data).
 - 7. Schedule of valves including leakage and flow characteristics (Refer to Design Data).
 - 8. Complete bill of materials to identify and quantify all control components
 - 9. Overall system schematic showing communication trunk cabling to DDC panels, peripheral devices, modems including component locations and wire termination details.
 - 10. DDC panel layouts showing connected data points and LAN connections. DDC panel terminations including power supply and remote control component termination details shall be provided.
 - 11. Point list for each DDC panel including point descriptions and addresses. This information may be incorporated with DDC panel layouts.
- F. Design Data: Provide indicated component selection and sizing criteria for the following component categories:
 - 1. Dampers:
 - a. Component tag.
 - b. Equipment served/function.
 - c. Overall damper size (inch height x inch width).
 - d. Quantity of damper sections with respective size(s):
 - e. Material and gauge of thickness.
 - f. Mounting orientation (horizontal or vertical).
 - g. Blade configuration (parallel or opposed)
 - h. Pressure drop (in. W.G.).
 - i. Shut-off rating/differential pressure rating (in. W.G.).
 - j. Leakage rating (CFM/sq. ft. at 4 in. W.G.).
 - k. Normal position (normally open, normally closed, floating).
 - l. Actuator spring range (where applicable).
 - m. Actuator power requirement.
 - n. Actuator torque requirement.
 - o. Actuator quantity.
 - p. Damper manufacturer/model number.
 - q. Actuator manufacturer/model number.
- G. Samples: Temperature sensor cover for each color required and guards if required.
- H. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- I. Submit field reports indicating operating conditions after detailed check out of systems at Date of Substantial Completion.
- J. 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.
- K. Software and Firmware Operational Documentation: Include the following:
 - 1. DDC panel keypad operating instructions and DDC panel control override features where applicable.
 - 2. Device address list.
 - 3. Program Software Backup: On a magnetic media or compact disc, complete with data files.

L. 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. Keypad illustrations and step-by-step procedures indexed for each operator function where applicable.
3. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
4. Calibration records and list of set points.

1.7 REFERENCES

- A. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.
- B. ANSI/ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure fittings.
- C. ANSI/ASTM B32 - Solder Metal.
- D. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- E. ANSI/NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
- F. ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- G. ASTM B75 - Seamless Copper Tube for General Engineering Purposes.
- H. ASTM D1693 - Environmental Stress - Cracking of Ethylene Plastics.
- I. NEMA DC 3 - Low-Voltage Room Thermostats.
- J. ASTM E1 - Specification for ASTM Thermometers.
- K. UL 1820 - Fire Test of Pneumatic Tubing for Flame and Smoke Characteristics Only.
- L. ASHRAE 135 - BACNET

1.8 QUALITY ASSURANCE

- A. Electrical Installer Qualifications: Must be an experienced installer who has previously installed the Siemens automatic control system for this Project. Installer shall attend Pre-Bid Walk-through and Post-Bid Interview (when required).
- 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 DELIVERY, STORAGE, AND HANDLING

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated or optional to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

1.10 COORDINATION

- A. Coordinate work under Division 20, 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. Coordinate equipment with Division 28 Section "Fire Alarm" to achieve compatibility with equipment that interfaces with that system.
- G. Ensure control system installation is complete, checked, tested and functioning properly prior to system balancing and Owner/Engineer system checkout.
- H. 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."

1.11 WARRANTY

- A. Provide warranty per Division 20 Section "General Mechanical Requirements" and as supplemented in this section.
- B. Provide 24 hour per day emergency service during warranty period, with maximum response period of four (4) hours. Provide phone number(s) for quick assistance by a Service Engineer regarding hardware or software problems.
- C. Provide scheduled maintenance service during warranty period to inspect, calibrate, and adjust controls. Make a minimum of one eight hour service call every three months. Notify Owner prior to each scheduled inspection trip. Submit written reports upon completion of service.
- D. Provide any software or firmware revisions for controllers provided with project which are released by the DDC system manufacturer during the warranty period, at no additional cost to the Owner.

1.12 POSTED OPERATING INSTRUCTIONS

- A. Provide panel related as-built documents in protective binder or clear plastic display envelope for each control panel. These instructions shall include such items as as-built control diagrams and sequence of operation, simplified narrative instructions and materials necessary to aid in the operation of the equipment at the local control panels.

1.13 SPECIAL TOOLS

- A. Deliver two sets of any special tools required for operation, adjustment, resetting or maintenance, not including PC Laptop.

1.14 PROTECTION OF PROPRIETARY INFORMATION

- A. All proprietary manuals and software non-disclosure agreements, where applicable, shall be submitted by the proprietary equipment manufacturer to the Owner for approval and signature during the warranty period.

PART 2 - PRODUCTS

2.1 DESCRIPTION OF THE HVAC TEMPERATURE CONTROL SYSTEM

- A. This project's controls and controllers shall integrate to the WSU campus-wide BAS at the FP&M Building and be a fully integrated, distributed data processing system incorporating BACnet DDC for the control and monitoring of heating, ventilating and air conditioning (HVAC) equipment and other related systems. Microprocessor based DDC panels shall be directly connected to HVAC equipment sensors and actuators. A data communication network shall allow data exchange between existing and new DDC panels and each building's existing Network Controller (Siemens). Each building's existing Network Controller is connected to the owner's Ethernet and communicates with the owner's existing central BAS.
- B. WSU IT staff shall provide an IP drop for equipment controllers in locations and quantities coordinated with Siemens.
- C. Approved Manufacturer – System / Installer (Location):
 - 1. Siemens Industry, Inc. – Apogee System 600 / Siemens - Building Technologies Division (Plymouth, MI).

2.2 DDC CONTROLLERS

- A. Manufacturer:
 - 1. DDC Controller Models: Siemens PXCC
 - 2. DDC Controller/Network Controller: PXCM
- B. 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.
- C. 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.
- D. Provide fully functional communication interface ports for communication between processor, other processors, existing Building Network Controller, portable operator unit and portable programmer terminal.
- E. 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 CONTROLLER SOFTWARE

- A. Operating system shall work in real time, provide prioritized task scheduling, control time programs, monitor DDC panel to DDC panel as well as DDC panel to existing Building Network Controller communications, scan inputs and outputs, and contain built-in diagnostics.
- B. Input/output point processing shall include the following:
 - 1. Continuous update of input and output values and/or conditions. All connected points are to be updated at least once per second.
 - 2. Assignment of proper engineering units and status condition identifiers to all points.
 - 3. In addition to physical or "hardware" points required, "software" points shall be provided where required for command access and meaningful displays, where required by the "execution" portion of this section or where required on the DDC input/output points lists. "Software" points shall appear identical to physical points in output displays and shall be assignable to text descriptors,

logical groups, reports, etc. in the same manner as physical points. "Software" points shall be assigned alarm limits in the same manner as physical points.

- C. Command control software shall manage the receipt of commands from the existing Building Network Controller and from control programs.
 - 1. Command delay, programmable from 0 to 2 minutes, shall be provided to prevent simultaneous energizing of large loads. Command delays shall be honored throughout the DDC network, not just within the DDC panel. Delays shall be assignable on an individual per point basis.
 - 2. Each command shall be assigned a command and residual priority to manage contentions created by multiple programs having access to the same command point. Only commands with a higher command priority than the existing residual priority shall be permitted to execute. Whenever a command is allowed to execute, its assigned residual priority shall replace the existing residual priority.
 - 3. A "fixed mode" option shall be supported to allow inputs to, and outputs from DDC control programs to be set to a fixed state or value. When in the "fixed mode," inputs and outputs shall be so noted in all reports.
 - 4. A "last user" record is to be maintained to positively identify which program or manual command is in control of a given point. The last user information shall be displayed and printed along with other point data of logical groups.
- D. Provide self-test procedure. Notify existing Building Network Controller for maintenance, performance, software, cable break, or data transmission problems. Identify variables as reliable or unreliable. Variables identified as unreliable shall use default in calculation.
- E. Alarm Processing
 - 1. High/Low Alarm: Analog input alarm comparison with the ability to assign two individual sets of high and low limits (warning and actual alarm) to an input. Each alarm shall be assigned a unique differential to prevent a point from oscillating into and out of alarm. Alarm comparisons are to be made each scan cycle.
 - 2. Floating Alarm: Where analog controlled values are automatically varied by software (such as hot water temperature reset), a single set of alarm limits shall be provided for those varying values. These alarm limits shall then "float" a user definable differential above and below the varying setpoint value.
 - 3. Abnormal Alarm: When a digital input is not in agreement with the commanded state of its associated output point, or when a digital input is not in its normal state, an abnormal alarm shall be generated. Abnormal "on" shall cause an alarm, as well as abnormal "off." Alarm time delay for digital inputs to prevent nuisance alarms shall be provided. Each digital input alarm time delay shall be adjustable from zero to two minutes in one-second increments.
 - 4. Alarm lockout shall be provided to positively lock out alarms when equipment is turned off or when a true alarm is dependent on the condition of an associated point. Lockout points and lockout initiators shall be operator programmable. On initial startup of air handler and other mechanical equipment, a "timed lockout" period shall be assigned to analog points to allow them to reach a stable condition before activating alarm comparison logic. Timed lockout period shall be programmable on a per point basis from 0 to 90 minutes in one-minute increments.
 - 5. The capability of automatically initiating commands upon the occurrence of an alarm.
- F. Totalization
 - 1. Run time shall be accumulated based on the status of digital input points. It shall be possible to totalize either on time or off time up to 10,000 hours with one-minute resolution. Run time counts shall be resident in memory and have DDC panel resident run time limits assignable through the portable programmer's terminal, portable operators unit or the existing Building Network Controller.
 - 2. A transition counter shall be provided to accumulate the number of times a device has been cycled on or off. Counter shall be capable of accumulating 600,000 switching cycles. Limits shall be assignable to counts to provide maintenance alarm printouts.
 - 3. Analog totalization capability shall be provided to allow the totalization of electricity, air, water and steam flow, etc. These flows shall be totalized with respect to time and converted to the appropriate energy unit. It shall be possible to automatically set time intervals for totalization, adjustable from one second to 365 days. The totalization program shall keep track of the maximum and minimum

instantaneous analog value measured during the period, including the date and time at which each occurred.

G. Custom DDC Programs

1. All DDC programs shall be fully custom programmable. DDC panels or systems which require remote or factory programming are not acceptable. DDC panels or systems with programs which may not be custom modified by the user are not acceptable. "Custom" programming shall mean allowing the alteration of actual control logic, and shall not be limited to allowing only the alteration of setpoints, gains, parameters, time constants, etc.
2. Custom DDC programs shall be provided to meet the control strategies as called for in the sequences of operation on the drawings.
3. All DDC setpoints, gains, parameters, time constants, etc., associated with DDC programs shall be available to the operator for display and modification via the existing Building Network Controller and/or portable operators unit.
4. The execution interval of each DDC control loop shall be adjustable from two to 30 seconds.
5. Each DDC panel shall have resident in its memory and available to the programs a full library of DDC algorithms, intrinsic control operators, and arithmetic, logic and relational operators for implementation of control sequences. Functions to be provided shall include, but not be limited to, the following:
 - a. Mathematical: Absolute value, calculate, square root, power, sign, average, totalize.
 - b. Logic: OR, AND, compare, negate.
 - c. Fixed Formula: High and low select, span, rate, ramp, enthalpy, wet bulb, dew point, relative humidity, humidity ratio, and filter.
 - d. Data Manipulation: Store, file and set.
 - e. Control Routines: Real-time based functions, proportional control, proportional-integral control, proportional-integral-derivative control, adaptive control (self tuning), direct-acting, reverse acting, feedforward, fixed setpoint, calculated setpoint, adjustable setpoint, lead lag, hysteresis correction, event initiation/ software interlock.

2.4 DDC INPUT/OUTPUT SENSORS

A. Current Switches:

1. Split-core donut transformer type for monitoring AC current, with digital output signal. Current switches used on motor side of variable frequency drives shall have low frequency detection capability.
2. Current switches with digital output shall have adjustable trip settings. Field-adjust current switches to trip at approximately 90% of normal motor operating amperage.
3. Manufacturers:
 - a. NK Technologies.
 - b. Senva.
 - c. Setra.
 - d. Veris Industries.

B. Temperature Sensors:

1. Resistance temperature detectors (RTD) with platinum, nickel or balco element. Accuracy shall be +/- 0.5 deg F over the entire range. Range shall be as indicated below, or as appropriate to the application.
2. Single point duct mounted sensors shall have 18" minimum, rigid probe and up to 48", rigid, averaging with a calibrated span of 20 - 120° F.
3. Averaging duct mounted sensors shall have 25' long averaging element and calibrated span of 20 - 120° F.
4. Liquid immersion sensors shall have welded stainless steel thermowell for ferrous pipe and brass thermowell for copper pipe. Length of sensor and thermowell shall be selected based on the diameter of the pipe to provide accurate, reliable and homogeneous sensing of the liquid

- temperature. Thermowell pressure rating shall meet or exceed the system minimum pressure rating. Sensors for chilled water application shall have calibrated span of 20 - 120° F.
5. Room sensors shall have locking cover and a minimum span of 40 - 90° F.
 6. Outside air sensors shall have watertight inlet fitting and shall be shielded from direct rays of sun.
 7. Manufacturers:
 - a. Specified BAS product where available.
 - b. TCS.
 - c. Minco.
 - d. ACI.
 - e. MAMAC.

C. Outside Air Temperature/Humidity Combination Transmitters:

1. Dual transmitters housed in a single hinged enclosure with integral probes configured for exterior wall mount application with PVC sun shield. Unit shall provide separate 4-20 mA signals for temperature and humidity measurement.
2. Temperature sensor shall be 1000 OHM thin film platinum resistance temperature detector with matching 4-20 mA transmitter having independent zero and span adjustments. Accuracy shall be ± 0.5 degrees F with a range of -25 degrees F to 125 degrees F.
3. Humidity sensor shall be washable thin film type with matching 4-20 mA transmitter having independent zero and span adjustments and linear output over a span of 0-100% RH. Accuracy shall be $\pm 2.5\%$ RH over the range 0-95% RH at 25 degrees C.
4. Manufacturer:
 - a. GE Industrial, Sensing (formerly General Eastern)
 - b. Veris.

2.5 DAMPERS - AUTOMATED

- A. Performance: Test in accordance with AMCA 500.
- B. Frames: Galvanized steel, minimum 16 gauge, minimum 2 inches in width, welded or riveted with corner reinforcement for 12 gage structural equivalence.
- C. Blades: Galvanized steel, minimum 14 gauge, maximum blade size 8 inches wide, 60 inches long, attached to minimum 1/2 inch shafts. Dampers which are required to have a static pressure rating over 4 inch W.G. shall have minimum 3/4 inch solid shafts.
- D. Blade Seals: Synthetic elastomeric or Neoprene, mechanically attached, field replaceable.
- E. Jackshafts (where required): Minimum 1/2 inch galvanized steel.
- F. Jamb Seals: Stainless steel.
- G. Bearings: Oil impregnated sintered bronze or lubricant free, solid stainless steel. Provide thrust washers at bearings for all dampers which are to be mounted with blades in the vertical position.
- H. Linkages: Accessible for maintenance. Linkages may be located in airstream. Linkages located in damper frame shall be external to the duct, accessible for maintenance. Linkages located in the airstream shall be zinc-plated.
- I. Leakage: Less than 8 CFM per square foot based on 4 inches W.G. pressure differential.
- J. Static Pressure Rating: As scheduled on the drawings, or if not scheduled, minimum 4" W.G.
- K. Maximum Velocity: As scheduled on the drawings, or design for maximum velocity to be encountered in location where installed.
- L. Temperature Limits: -40 to 200 deg F.
- M. Manufacturers:

1. American Warming & Ventilating.
2. Arrow United Industries.
3. Greenheck.
4. Honeywell.
5. Johnson Controls.
6. Louvers & Dampers, Inc.
7. Ruskin.
8. Tamco.
9. Vent Products.

2.6 DAMPERS, INSULATED OUTDOOR AIR / RELIEF AIR / EXHAUST AIR - AUTOMATED

- A. Performance: AMCA certified for Air Performance and Air Leakage.
- B. Frames: Extruded aluminum, .080-inch thickness minimum, 4 inches deep minimum, thermally broken, and insulated with polystyrene or polyurethane foam insulation.
- C. Blades: Extruded aluminum, internally insulated, and thermally broken. Maximum blade size 8 inches wide, 60 inches long.
- D. Shafts: Minimum 7/16 inch hexagonal or square corrosion resistant zinc plated steel.
- E. Blade Seals: Extruded EPDM, silicone, or synthetic elastomeric, mechanically attached.
- F. Jamb Seals: Silicone, or synthetic elastomeric, mechanically attached.
- G. Bearings: Dual bearing assembly of durable synthetic polymer resulting in no metal-to-metal contact. Provide thrust washers at bearings for all dampers which are to be mounted with blades in the vertical position.
- H. Linkage: Linkage shall be installed in the frame side and shall be constructed of aluminum and/or corrosion resistant zinc plated steel.
- I. Leakage: Less than 3 CFM per square foot at 1 inch W.G. pressure differential at minus 40 deg F.
- J. Static Pressure Rating: As scheduled on the drawings, or if not scheduled, minimum 4 inches W.G.
- K. Maximum Velocity: As scheduled on the drawings, or design for maximum velocity to be encountered in location where installed.
- L. Temperature Limits: Minus 40 to 155 deg F.
- M. Manufacturers:
 1. Greenheck ICD-45.
 2. Ruskin CDTI-50BF.
 3. Tamco Series 9000 BF

2.7 DAMPER OPERATORS - ELECTRIC

- A. Electric damper motor shall be 24 or 120 volt two-position or modulating as required with spring return type and sized to operate the damper with sufficient reserve power for smooth operation from full close to full open and tight shut-off. Damper motor shall have "O ring" gaskets for weatherproof operation.
- B. Number: Sufficient to achieve unrestricted movement throughout damper range. Provide sufficient number of operators such that one operator does not operate more than the maximum square footage of damper area as recommended in standard catalog of manufacturer.

C. Manufacturers:

1. Belimo.
2. Delta Control Products.
3. Siemens.

2.8 LOCAL AND AUXILIARY CONTROL PANELS

- A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, pushbuttons and switches flush on cabinet panel face, or as detailed on drawings. Provide panel with locking door.
- B. ANSI/NEMA 250, general purpose utility enclosures with enameled finished face panel, or as indicated on the drawings.
- C. Panels shall be sized for a maximum fill of 50% capacity, and shall not be smaller than 24" X 24".

2.9 THERMOSTATS – ELECTRONIC & ELECTRIC

- A. Electric, solid-state, microcomputer-based room thermostat with remote sensor.
 1. Automatic switching from heating to cooling
 2. Preferential rate control to minimize overshoot and deviation from setpoint
 3. Capable of providing four separate temperatures per day
 4. Instant override of setpoint for continuous or timed period from 1 hour to 31 days.
 5. Short-cycle protection.
 6. Programming based on every day of week.
 7. Selection features include degree F, 12- and 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
 8. Battery replacement without program loss.
 9. LCD features include the following:
 - a. Time of the day
 - b. Actual room temperature
 - c. Programmed temperature setpoints
 - d. Programmed time for occupied/unoccupied
 - e. Duration of timed override
 - f. Day of week
 - g. System mode indications include "occupied", "unoccupied", "cooling", "heating," "off," "fan auto," and "fan on."
- B. Electric Low Limit Duct Thermostat (freezestat): Snap acting, auto-reset switch which trips if temperature sensed across any 12 inches of bulb length is equal to or below setpoint, fixed 5 deg F differential, range 30 deg F to 60 deg F, requiring minimum 20 feet length of bulb. Provide one thermostat for every 20 sq ft of coil surface. Switch shall be UL listed and rated for 10 amps at 120 VAC. Provide additional switch or contacts for connection to monitoring system.
 1. Manufacturers:
 - a. Honeywell.
 - b. Johnson Controls.
 - c. Siemens.
- C. Strap-on Aquastat: UL listed, with a suitable removable spring clip attaching aquastat to pipe and a snap-acting SPDT switch.
 1. Manufacturers:

- a. Honeywell.
- b. Johnson Controls.
- c. Siemens.

2.10 STATUS SENSORS AND DEVICES - ELECTRIC

- A. Control Relay: Monitors or controls AC or DC motors or other equipment (as required), with cover, with visual indicator when energized, and two SPDT contacts rated 120/250 VAC at 8 Amps.
 - 1. Manufacturers:
 - a. Dayton.
 - b. Omron.
 - c. Functional Devices.
- B. Damper End Switch (limit switch):
 - 1. Oil-tight type with operator as required providing function. Limit switches used on dampers should be set at approximately 75% of full stroke.
 - 2. Manufacturers:
 - a. Allen-Bradley.
 - b. General Electric.
 - c. Square D.
 - d. Westinghouse.
 - e. Micro-switch.
- C. Contactor: Electrically operated, mechanically held, relay mounted in NEMA-12 rated enclosure. Six (6) normally closed contacts rated 120/250 VAC at 20 Amps.
 - 1. Manufacturers:
 - a. Allen-Bradley
 - b. Cutler-Hammer
 - c. Square-D

2.11 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. Locate room temperature sensors 48 inches above floor unless noted otherwise.
- C. The location of all control-related items to be mounted on the exterior of the building must be approved by the Architect prior to installation. Indicate proposed locations on the shop drawings.
- D. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. Sensors used for closed loop control must be connected to the same DDC panel as the associated output signal.
- E. Provide conduit and electrical wiring where required.
- F. All wiring in altered and unaltered areas shall be run concealed. "Wiremold" in finished areas shall be allowed when wiring cannot be run concealed in walls or partitions. Minimize "wiremold" routing.
- G. Splicing of DDC sensor cabling at junction boxes shall not be acceptable.
- H. 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.
- I. Coil and conceal excess capillary on remote element instruments.
- J. Locate all control components and accessories such that they are easily accessible for adjustment, service and replacement.
- K. 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.
- L. Locate and size sensing elements in liquid lines so that they are in moving liquid and not in stagnant or turbulent locations. Wells shall not obstruct the flow of the liquid being measured. Pipes one inch and smaller shall be increased at least one pipe size at the point of insertion.
- M. 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.
- N. 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.
- O. 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.
- P. All electric valve and damper operators shall be capable of moving from full closed to full open, or vice versa, within 120 seconds.

3.2 TC CONTRACTOR DESIGN & INSTALLATION COORDINATION MEETINGS

- A. Temperature Controls Shop Drawing Pre-submittal Meeting: TC Contractor's option to schedule a meeting at the Engineer's Office to review project design documentation for clarification purposes to aide in the TC Contractor development of TC/BAS shop drawings. For simple clarification items, TC Contractor may contact Engineer via telephone to discuss. For project scope questioning items, TC Contractor shall utilize the formal Request of Information (RFI) process.

- B. Temperature Controls Shop Drawing Submittal Meeting: Project Design Engineer's option to schedule a meeting at the Engineer's Office to review the TC Contractor's formally submitted drawings to address Engineer's comments and concerns that indicate TC Contractor's shop drawings vary from project design intent. This meeting can be avoided if TC Contractor's shop drawing submittal is complete and Engineer is confident that documents are going to lead to an installation that meets project design intent.
- C. Temperature Controls Installation Technician Meeting: Project Design Engineer's option to schedule a meeting at the project site to meet and discuss project expectations with the TC Contractor's field installation technician and/or project manager. Discussion may include
 - 1. Shop drawing review comments to ensure installation technician has the most up-to-date TC submittal.
 - 2. Graphics generation requirements including special Owner requirements and schedule for completion.
 - 3. Owner training agenda and scheduling.
 - 4. TC/BAS system acceptance procedures.

3.3 IDENTIFICATION AND MARKING

- A. All 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.
- D. All control panels and auxiliary enclosures shall be supplied with engraved phenolic nameplate permanently attached identifying it as control panel number, system served, area served, fed from receptacle panel number, circuit number, etc.

3.4 GRAPHIC DISPLAY GENERATION

- A. Provide the following graphic displays as a minimum for operator interface, arranged in logical penetration paths. Modify, copy, or expand the existing graphics associated with building as required to allow operator interface to newly installed equipment. Remove graphics associated with equipment that may have been eliminated with project scope of work:
 - 1. Floor plans for each floor within each building, with display of present values of space conditions sensed by connected space sensors, display of the name of the air handler associated with each space sensor, display of the room number in which the sensor is located and color coding to indicate whether the sensed space condition is within the acceptable range, is too high, or is too low. TC Contractor shall confirm Owner desired room names prior to graphics generation which may differ from the room names indicated on construction documents.
 - 2. Schematic diagram for each HVAC system. Each system schematic display shall include at least the following:
 - a. Schematic arrangement of ductwork, fans, dampers, coils, valves, piping, pumps, equipment etc.
 - b. System name.
 - c. Area served.
 - d. Present value or status of all inputs, along with present setpoint.
 - e. Present percent open for each damper, valve, etc. based on commanded position.
 - f. Reset schedule parameters for all points, where applicable.
 - g. Present occupancy mode.
 - h. Present economizer mode, where applicable.
 - i. Present outside air temperature.

- j. Associated space conditions and setpoints, where applicable.
 - k. Status of application programs (e.g., warm-up, night cycle, duty cycle, etc.).
 - l. Color coding to indicate normal and abnormal values, alarms, etc.
- 3. Manual override capability for each on/off or open/closed controlled digital output (for fans, pumps, 2-position dampers and valves, etc.) and each modulating analog output (for dampers, valves, VFC speed modulation type points, etc) shall be provided. Graphic display of output point auto or manual override status shall be provided.
 - 4. Sequence of operation in written (text) format for each HVAC system.
 - 5. Overall BAS system schematic.
 - 6. System management graphic for each network device and/or DDC panel.

3.5 OWNER INSTRUCTION AND TRAINING

- A. Provide a minimum of four (4) hours of on-site instruction and training to the Owner for each building on the operation of the control systems for the initial installation.
- B. Instruction and training shall be performed by a competent Contractor representative familiar with the control systems operation, maintenance and calibration.
- C. Training shall take place after check, test, start-up of temperature controls system at a time mutually agreed upon by the Owner and Contractor.

3.6 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.

3.7 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 1123 - FUEL GAS PIPING

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SUMMARY	1
1.3 DEFINITIONS	2
1.4 PERFORMANCE REQUIREMENTS	2
1.5 SYSTEMS DESCRIPTIONS	2
1.6 SUBMITTALS	2
1.7 QUALITY ASSURANCE	2
1.8 DELIVERY, STORAGE, AND HANDLING	3
1.9 PROJECT CONDITIONS	3
1.10 COORDINATION	3
PART 2 - PRODUCTS	3
2.1 MANUFACTURERS	3
2.2 BLACK STEEL PIPE AND FITTINGS	3
2.3 PIPING SPECIALTIES	4
2.4 JOINING MATERIALS	4
2.5 SPECIALTY VALVES	4
2.6 SERVICE METERS	ERROR! BOOKMARK NOT DEFINED.
2.7 PRESSURE REGULATORS	4
PART 3 - EXECUTION	5
3.1 EXAMINATION	5
3.2 PREPARATION	5
3.3 SERVICE-METER ASSEMBLY INSTALLATION	5
3.4 PIPING SYSTEM INSTALLATION	5
3.5 JOINT CONSTRUCTION	6
3.6 HANGER AND SUPPORT INSTALLATION	7
3.7 CONNECTIONS	7
3.8 PAINTING	7
3.9 CONCRETE BASES	7
3.10 FIELD QUALITY CONTROL	8

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 20 Section "Mechanical General Requirements."
 - 2. Division 20 Section "Basic Mechanical Materials and Methods."

1.2 SUMMARY

- A. This Section includes facility fuel gas piping and service meter assemblies.
- B. Service meter assemblies will be furnished by utility company for installation by Contractor.

1.3 DEFINITIONS

- A. Gas Main: Utility's natural gas piping.
- B. Gas Distribution: Piping from gas main to individual service-meter assemblies.
- C. Service-Meter Assembly: Piping, valves, service regulator, service meter, and specialties.
- D. Point of Delivery: Piping outlet from service-meter assembly.
- E. Fuel Gas Piping: Piping that conveys fuel gas from point of delivery to fuel gas utilization devices inside the building.
- F. PE: Polyethylene.

1.4 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. Piping and Valves: Performance requirements are scheduled on the Drawings.
 - 2. Exception: Fuel Gas Piping Installed within Ceilings Used as Plenums: 150 psig.

1.5 SYSTEMS DESCRIPTIONS

- A. Fuel gas piping system materials are scheduled on the Drawing.

1.6 SUBMITTALS

- A. Product Data: For the following:
 - 1. Specialty valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 2. Service meters. Include pressure rating and capacity of selected models.
 - 3. Pressure regulators. Include pressure rating, capacity, and settings of selected models.
- B. Welding certificates.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For natural gas specialties and accessories to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. NFPA Standard: Comply with NFPA 54, "National Fuel Gas Code."

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

1.9 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Gas System Pressure: Not more than 5.0 psig.
- C. Design values of fuel gas supplied for these systems are as follows:
 - 1. Nominal Heating Value: 1000 Btu/cu. ft.
 - 2. Nominal Specific Gravity: 0.6.

1.10 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 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 BLACK STEEL PIPE AND FITTINGS

- A. Black Steel Pipe: ASTM A 53/A 53M; Type E or S; Grade B; Schedule 40. Wall thickness of wrought-steel pipe shall comply with ASME B36.10M.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
 - 2. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
 - 3. Steel Welding Fittings: ASME B16.9, wrought steel or ASME B16.11, forged steel.
 - 4. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
 - 5. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
 - 6. Joint Compound and Tape: Suitable for natural gas.
 - 7. Steel Flanges and Flanged Fittings: ASME B16.5.
 - 8. Gasket Material: Thickness, material, and type suitable for natural gas.

2.3 PIPING SPECIALTIES

- A. Flexible Connectors: ANSI Z21.24, copper alloy.
- B. Y-Pattern Strainers:
 - 1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
 - 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
 - 3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
 - 4. CWP Rating: 125 psig.
- C. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.4 JOINING MATERIALS

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

2.5 SPECIALTY VALVES

- A. Valves, NPS 3 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
- B. Natural Gas Valves, NPS 3 and Smaller: Use the following:
 - 1. Ball Valves: Bronze or brass body with AGA or CSA stamp, UL listed or FM approved for service, with chrome-plated brass ball and lever handle; 125-psig minimum pressure rating.
 - a. Manufacturers:
 - 1) Apollo Valve; Conbraco Industries, Inc.
 - 2) Jomar International Ltd.
 - 3) Legend Valve and Fitting, Inc.
 - 4) NIBCO INC.
 - 5) Watts Water Technologies, Inc.; Watts Regulator Co.
 - b. Tamperproof Feature: Include design for locking.

2.6 PRESSURE REGULATORS

- A. Description: Single stage and suitable for fuel gas service. Include steel jacket and corrosion-resistant components, elevation compensator, and atmospheric vent.
 - 1. Manufacturers:
 - a. Line Pressure Regulators:
 - 1) Elster Gas North America; Elster American Meter.
 - 2) Fisher Controls International, Inc.; Division of Emerson Process Management.
 - 3) Itron Gas.
 - 2. NPS 2 and Smaller: Threaded ends according to ASME B1.20.1 for pipe threads.
 - 3. NPS 2-1/2 and Larger: Flanged ends according to ASME B16.5 for steel flanges.
 - 4. Service Pressure Regulators: ANSI Z21.80. Include 100-psig- minimum inlet pressure rating.

5. Line Pressure Regulators: ANSI Z21.80/GCA 6.22 or ANSI B109.4/CGA 6.18, with inlet pressure rating as scheduled on the Drawings.
 6. Appliance Pressure Regulators: ANSI Z21.18. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
- B. Pressure Regulator Vents: Factory- or field-installed, corrosion-resistant screen in opening if not connected to vent piping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for fuel gas piping system to verify actual locations of piping connections before equipment installation.
1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Inspect natural-gas piping according to NFPA 54 and the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- B. Comply with NFPA 54 and the International Fuel Gas Code requirements for prevention of accidental ignition.

3.3 SERVICE-METER ASSEMBLY INSTALLATION

- A. Install service-meter assemblies aboveground.
1. Service meters shall be installed in strict accordance with the utility company's requirements.
- B. Include gas valve or plug valve, strainer, service pressure regulator, service-meter bar for service meter with connections NPS 1 and smaller, and service meter for each assembly.
- C. Install gas valve and strainer upstream from each service pressure regulator.
- D. Install service pressure regulators with vent outlet turned down and with corrosion-resistant-metal insect screen.
- E. Install service meters downstream from service pressure regulators.
1. Service meters with connections larger than NPS 1 supported from piping or set on concrete bases.

3.4 PIPING SYSTEM INSTALLATION

- A. Comply with NFPA 54 and the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and

other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

- C. Basic piping installation requirements are specified in Division 20 Section "Basic Mechanical Materials and Methods."
- D. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels, unless indicated to be exposed to view.
- E. Concealed Locations:
 - 1. Above Accessible Ceiling Locations: Gas piping with welded joints may be installed in accessible ceiling spaces, subject to approval of authorities having jurisdiction, whether or not such spaces are used as plenums. Do not locate valves or unions above ceilings used as plenums.
 - 2. In Partitions: Do not install concealed piping in partitions.
 - a. Exception: Piping passing through partitions or walls.
 - 3. Prohibited Locations: Do not install gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
- F. Drips and Sediment Traps: Install drips at points where condensate may collect. Include outlets of service meters. Locate where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use minimum-length nipple of 3 pipe diameters, but not less than 3 inches long, and same size as connected pipe. Install with space between bottom of drip and floor for removal of plug or cap.
- G. Install fuel gas piping at uniform grade of 0.1 percent slope upward toward risers.
- H. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- I. Connect branch piping from top or side of horizontal piping.
- J. Install strainer on inlet of each automatic and electrically operated valve.
- K. Locate valves for easy access.
- L. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.
- M. Install gas valve or plug valve and strainer upstream from each line pressure regulator or appliance pressure regulator.
- N. Install vent piping for gas pressure regulators and gas trains, extend outside building, and vent to atmosphere. Terminate vents with turned-down, reducing-elbow fittings with corrosion-resistant insect screens in large end.

3.5 JOINT CONSTRUCTION

- A. Basic piping joint construction is specified in Division 20 Section "Basic Mechanical Materials and Methods."
- B. Use materials suitable for fuel gas.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Pipe hanger and support and equipment support materials and installation requirements are specified in Division 20 Section "Hangers and Supports."
- B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
 - 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
 - 4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
 - 5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.
- C. Support vertical steel pipe at each floor and at spacing not greater than 15 feet.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of fuel gas piping, fittings, and specialties.
- B. Install piping adjacent to appliances to allow service and maintenance.
- C. Connect piping to appliances using gas with shutoff valves and unions. Install valve upstream from and within 72 inches of each appliance. Install union downstream from valve.
- D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance using gas.

3.8 PAINTING

- A. Use materials and procedures in Division 09 painting Sections.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
 - 1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel (semigloss).
 - d. Color: Gray.
- C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.9 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base.
 - 1. Construct concrete bases of dimensions indicated, 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. Use 3000-psig, 28-day, compressive-strength concrete and reinforcement as specified in Division 03.

3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections during business hours.
- B. Allow Owner access to field quality-control testing of fuel gas system. Notify Owner 7 days in advance of testing.
- C. Tests and Inspections:
 1. Test, inspect, and purge natural gas according to NFPA 54 and the International Fuel Gas Code and authorities having jurisdiction.
- D. Additional Testing: Subject welded fuel gas piping installed within ceiling spaces used as plenums to test pressure of 150 psig for a minimum of 2 hours.
- E. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION 23 1123

SECTION 23 3113 - METAL DUCTS

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SUMMARY	1
1.3 DEFINITIONS	1
1.4 SYSTEM DESCRIPTION	2
1.5 PERFORMANCE REQUIREMENTS	2
1.6 SUBMITTALS	2
1.7 QUALITY ASSURANCE	3
1.8 COORDINATION	3
PART 2 - PRODUCTS	3
2.1 MANUFACTURERS	3
2.2 SHEET METAL MATERIALS	3
2.3 SEALANTS AND GASKETS	4
2.4 HANGERS AND SUPPORTS	4
2.5 RECTANGULAR DUCT FABRICATION	5
2.6 ROUND AND FLAT-OVAL DUCT AND FITTING FABRICATION	5
PART 3 - EXECUTION	8
3.1 DUCT INSTALLATION	8
3.2 DUCT SEALING	9
3.3 HANGING AND SUPPORTING	9
3.4 CONNECTIONS	9
3.5 PAINTING	9
3.6 FIELD QUALITY CONTROL	9
3.7 START UP	9

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 20 Section "Mechanical General Requirements."
 - 2. Division 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.2 SUMMARY

- A. This Section includes metal ducts for supply, return, outside, relief air, and exhaust air-distribution systems in pressure classes from minus 6- to plus 6-inch wg.

1.3 DEFINITIONS

- A. Duct Sizes: Inside clear dimensions. For lined ducts, maintain sizes inside lining.
- B. Low Pressure: Up to 2 inch WG and velocities less than 1,500 fpm. Construct for 2 inch WG positive or negative static pressure.

- C. Medium Pressure: Greater than 2 inch WG to 6 inch WG and velocities greater than 1,500 fpm and less than 2,500 fpm. Construct for 6 inch WG positive or negative static pressure.
- D. High Pressure: Greater than 6 inch WG to 12 inch WG and velocities greater than 2,500 fpm. Construct for 12 inch WG positive or negative static pressure.

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. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Other systems installed in same space as ducts.
 - 3. Ceiling- and wall-mounting access doors and panels required to provide access to dampers and other operating devices.
 - 4. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

- D. Welding certificates.
- E. Field quality-control test reports.

1.7 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
 - 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- 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.
- B. Sheet metal trades shall participate in the above ceiling coordination program. Refer to Division 01 requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METAL MATERIALS

- A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.
- C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.

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. Water-Based Joint and Seam Sealant:
 - 1. Manufacturers:
 - a. Hardcast; Flex-Grip 550 and Versa-Grip 181.
 - b. Polymer Adhesives; No. 11.
 - c. United McGill.
 - 2. Application Method: Brush on.
 - 3. Solids Content: Minimum 65 percent.
 - 4. Shore A Hardness: Minimum 20.
 - 5. Water resistant.
 - 6. Mold and mildew resistant.
 - 7. VOC: Maximum 75 g/L (less water).
 - 8. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
 - 9. Service: Indoor or outdoor.
 - 10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- C. Gaskets: Chloroprene elastomer, 40 durometer, 1/8 inch thick, full face, one piece vulcanized or dovetailed at joints.
- D. Round Duct Joint O-Ring Seals:
 - 1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
 - 2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
 - 3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.4 HANGERS AND SUPPORTS

- A. Building Attachments: Structural-steel fasteners appropriate for construction materials to which hangers are being attached.
- B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
 - 1. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
 - 2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."
- C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials. Attachments for stainless steel and PVC-coated duct shall be stainless steel.
- D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.
 - 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 - 2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.
 - 3. Supports for Aluminum Ducts: Aluminum support materials unless materials are electrolytically separated from ducts.

- E. Load Rated Cable Suspension System for Noncorrosive Environments: Tested to five times the Safe Working Loads and verified by the SMACNA Testing and Research Institute.
1. Cable: Aircraft quality 7 x 7 and 7 x 19 wire rope.
 - a. Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
 - b. Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
 2. Fastener: One-piece, die-cast zinc housing with Type 302 S26 stainless steel hardened and tempered springs, and oil impregnated, sintered, hardened and tempered steel locking wedges.
 3. End Fixings: Loop, stud or toggle; or plain end suitable for wire rope beam clamp.
 4. Manufacturers:
 - a. Ductmate Industries, Inc.; Clutcher and EZ-Lock.
 - b. Duro Dyne Corp.; Dyna-Tite System.
 - c. Gripple Inc.; Hang-Fast System.
- F. Welded Supports: Structural steel shapes with zinc rich paint. Equivalent, proprietary design, rolled steel structural support systems may be used in lieu of mill rolled structural steel.

2.5 RECTANGULAR DUCT FABRICATION

- A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
 2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- 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.
 - d. McGill AirFlow Corporation.

- 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.
 - 3. Ducts Larger Than 72 Inches in Diameter: Companion angle flanged joints per SMACNA "HVAC Duct Construction Standards--Metal and Flexible," Figure 3-2.
 - 4. Bolts and fasteners for galvanized steel duct shall be carbon steel, zinc coated per ASTM A153. Bolts and fasteners for stainless steel and polyvinyl chloride coated steel duct shall be stainless steel.
 - 5. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.
 - a. Manufacturers:
 - 1) AccuDuct Mfg. Inc.
 - 2) Ductmate Industries, Inc.
 - 3) Eastern Sheet Metal (ESM).
 - 4) Lindab Inc.
 - 5) Universal Spiral Air.
 - 6. Flat-Oval Ducts: Prefabricated connection system consisting of two flanges and one synthetic rubber gasket.
 - a. Manufacturers:
 - 1) AccuDuct Mfg. Inc.
 - 2) Ductmate Industries, Inc.
 - 3) Eastern Sheet Metal (ESM).
 - 4) McGill AirFlow Corporation.
 - 5) SEMCO Incorporated.
 - 6) Universal Spiral Air.
- F. Low Pressure Ductwork (plus or minus 2 inches W.G. Static Pressure Class)
- 1. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible provide single thickness turning vanes.

2. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible. Divergence upstream of equipment shall not exceed 30 degrees; convergence downstream shall not exceed 45 degrees.
- G. 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.
- H. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.
- 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. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.
- M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.
- N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, and sleeves. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories."
- O. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.
- P. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."
 - 1. Basic level.

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 upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.
- E. Use load rated cable suspension system for round duct in exposed locations.

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 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.6 FIELD QUALITY CONTROL

- A. Duct System Cleanliness Tests:
 - 1. Visually inspect duct system to ensure that no visible contaminants are present.
- B. Duct system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.7 START UP

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing."
- END OF SECTION 23 3113

SECTION 23 3300 - DUCT ACCESSORIES

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 DEFINITIONS	1
1.3 SUBMITTALS	1
1.4 QUALITY ASSURANCE	2
PART 2 - PRODUCTS	2
2.1 MANUFACTURERS	2
2.2 SHEET METAL MATERIALS	2
2.3 LOW PRESSURE MANUAL VOLUME DAMPERS	3
2.4 MOTORIZED CONTROL DAMPERS	3
2.5 DUCT SILENCERS (FIBERGLASS FILL)	4
2.6 TURNING VANES	5
2.7 FLEXIBLE CONNECTORS	5
2.8 FLEXIBLE DUCTS, LOW AND MEDIUM PRESSURE	6
2.9 FLEXIBLE DUCT ELBOW SUPPORTS	6
PART 3 - EXECUTION	7
3.1 APPLICATION AND INSTALLATION	7
3.2 FIELD QUALITY CONTROL	7
3.3 ADJUSTING	8

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. Include breakout noise calculations for high transmission loss casings.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control damper installations.
- 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. Source quality-control reports.
- E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.
- 1.4 QUALITY ASSURANCE
- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and NFPA 90B, "Installation of Warm Air Heating and Air Conditioning 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 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. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

2.3 LOW PRESSURE MANUAL VOLUME DAMPERS

A. Manufacturers:

1. American Warming and Ventilating.
2. Arrow United Industries.
3. Greenheck.
4. Krueger.
5. Louvers and Dampers.
6. Nailor Industries Inc.
7. Ruskin Company.
8. Vent Products Company, Inc.
9. Young Regulator Company.

B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

1. Except for dampers in round ductwork sized 12 inches and smaller, provide end bearings.

C. Rectangular Volume Dampers: Multiple-opposed-blade design, AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications.

D. Round Volume Dampers 16-inch Diameter and Smaller: Single-blade design, AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications.

E. Round Volume Dampers Larger than 16-inch Diameter: Multiple-opposed-blade design AMCA certified for maximum leakage of 2 percent of total fan volume at shutoff, and suitable for horizontal or vertical applications.

F. Damper Materials:

1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized sheet steel.
3. Blade Axles: Galvanized steel.
4. Bearings: Oil-impregnated bronze, molded synthetic, or stainless-steel sleeve type.
5. Tie Bars and Brackets: Galvanized steel.

G. Jackshaft: 1-inch- diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.

H. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch- thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.4 MOTORIZED CONTROL DAMPERS

A. Refer to Division 23 Section "Temperature Controls."

2.5 DUCT SILENCERS (FIBERGLASS FILL)

A. Manufacturers:

1. Industrial Acoustics Co. Inc.
2. Price Industries.
3. Ruskin Company.
4. VAW Systems Ltd.
5. Vibro-Acoustics.

B. General Requirements:

1. Factory fabricated.
2. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E 84.

C. Rectangular Units: Unless otherwise scheduled on the Drawings, fabricate casings with a minimum of 20 gage, solid galvanized sheet metal for outer casing and 22 gage, ASTM A 653/A 653M, G90, perforated galvanized sheet metal for inner casing.

D. Round Units: Unless otherwise scheduled on the Drawings:

1. Outer Casings:

- a. ASTM A 653/A 653M, G90, galvanized sheet steel.
- b. Up to 8 Inches in Diameter: 24 gage.
- c. 9 through 22 Inches in Diameter: 22 gage.
- d. 24 through 36 Inches in Diameter: 20 gage.
- e. 38 through 50 Inches in Diameter: 18 gage.
- f. 52 through 60 Inches in Diameter: 16 gage.
- g. Casings fabricated of spiral lock-seam duct may be one gage thinner than that indicated.

2. Interior Casing, Partitions, and Baffles:

- a. ASTM A 653/A 653M, G90, galvanized sheet steel.
- b. At least 24 gage thick and designed for minimum aerodynamic losses.

E. Sheet Metal Perforations: 1/8-inch diameter for inner casing and baffle sheet metal.

F. Fill Material: Inert and vermin-proof fibrous glass material, packed under not less than 5 percent compression.

1. Erosion Barrier: Mylar film with 1/4-inch standoff.

- a. Return fan inlet and outlet silencer fill shall not be encapsulated in Mylar.

G. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations.

1. Do not use nuts, bolts, or sheet metal screws for unit assemblies.
2. Lock form and seal or continuously weld joints.
3. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
4. Reinforcement: Cross or trapeze angles for rigid suspension.

H. Source Quality Control:

1. Acoustic Performance: Test according to ASTM E 477.
 - a. Tests performed in NVLAP accredited laboratory.
 - b. Include accreditation certificate with submittals.
 - c. Submittals from non-NVLAP accredited facilities will not be accepted.
2. Record acoustic ratings, including dynamic insertion loss and self-noise power levels with an airflow of at least 2000-fpm face velocity.
3. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg static pressure, whichever is greater.

2.6 TURNING VANES

A. Manufactured Turning Vanes:

1. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.
2. Double-vane or airfoil-shaped, curved blades of galvanized sheet steel set into vane runners suitable for duct mounting.
3. Generated sound power level shall not exceed 54 decibels in octave band 4 at 2000 fpm in a 24-inch by 24-inch duct.
4. Manufacturers:
 - a. Aero/Dyne Company; H-E-P Turning Vanes.
 - b. Ductmate Industries, Inc.
 - c. Duro Dyne Corp.
 - d. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

2.7 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 minimum 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.

D. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd..
2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
3. Service Temperature: Minus 20 to plus 200 deg F.
4. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
5. Service Temperature: Minus 50 to plus 250 deg F.
6. Service Temperature: Minus 67 to plus 500 deg F.

2.8 FLEXIBLE DUCTS, LOW AND MEDIUM PRESSURE

A. Manufacturers:

1. Flexmaster Type 1M, UL 181, Class 1.
2. Automation Industries Thermaflex.
3. Hart & Cooley.

B. Flexible Ducts: Interlocking spiral of galvanized steel or aluminum construction or fabric supported by helically wound spring steel wire or flat steel bands; rated to 6 inches WG positive and 4 inches WG negative for low and medium pressure ducts.

C. Insulated Flexible Ducts: Flexible duct wrapped with flexible glass fiber insulation, enclosed by a fire retardant polyethylene vapor barrier jacket; maximum 0.23 K value at 75 deg F.

D. Acoustical performance tested in accordance with the Air Diffusion Council's *Flexible Air Duct Test Code FD 72-R1, Section 3.0, Sound Properties* shall be as follows:

The insertion loss (dB) of a 10 foot length of straight duct when tested in accordance with ASTM E477, at a velocity of 2500 feet per minute, shall be minimum:

Octave Band Hz.	2 125	3 250	4 500	5 1000	6 2000	7 4000
6" diameter	8	32	38	35	39	25
8" diameter	13	32	36	35	36	21
12" diameter	15	29	28	33	26	14

The radiated noise reduction (dB) of a 10 foot length of straight duct when tested in accordance with ASTM E477, at a velocity of 2500 feet per minute, shall be minimum:

Octave Band Hz.	2 125	3 250	4 500	5 1000	6 2000	7 4000
6" diameter	6	8	7	8	9	13
8" diameter	9	6	6	7	8	10
12" diameter	9	7	6	6	8	11

The self generated sound power levels (LW) dB are 10-12 Watt of a 10 foot length of straight duct for an empty sheet metal duct when tested in accordance with ASTM E477, at a velocity of 1000 feet per minute, shall not exceed:

Octave Band Hz.	2 125	3 250	4 500	5 1000	6 2000	7 4000
6" diameter	42	31	23	18	17	21
8" diameter	41	34	27	19	18	21
12" diameter	53	44	36	27	21	22

E. Flexible Duct Fittings: Galvanized steel, twist-in design with damper. Size as indicated.

F. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 through 18 inches to suit duct size.

2.9 FLEXIBLE DUCT ELBOW SUPPORTS

A. Manufacturer:

1. Automation Industries Thermaflex; FlexFlow Elbow.
2. Smart Air & Energy Solutions; SMART Flow Elbow.

- B. Elbow supports shall be constructed of durable composite material and be fully adjustable to support flexible duct diameters 6 inches through 16 inches.
- C. Elbow supports shall be UL listed for use in return air plenum spaces.

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 control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install duct silencers rigidly to ducts.
- G. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.
- H. Connect diffusers or light troffer boots to low pressure ducts flexible duct clamped or strapped in place.
- I. Connect flexible ducts to metal ducts with draw bands.
- J. Install flexible duct elbow supports at each diffuser, grille, or register, and elsewhere as indicated.
- K. Install turning vanes in rectangular duct elbows in excess of 45 degrees, and where indicated:
 - 1. Use manufactured double-vane turning vanes unless otherwise specified.
 - 2. Seat outboard-most vane in heel of duct elbow.
 - 3. Provide vanes for all runner punchings, practice of eliminating every other vane is prohibited.
 - 4. Use single-vane turning vanes in low pressure square elbows.

3.2 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Operate dampers to verify full range of movement.
 - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
 - 3. Inspect turning vanes for proper and secure installation.
 - 4. Operate remote damper operators to verify full range of movement of operator and damper.

3.3 ADJUSTING

- A. Adjust duct accessories for proper settings.
- B. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION 23 3300

SECTION 23 3423 - POWER VENTILATORS

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 PERFORMANCE REQUIREMENTS	1
1.3 SUBMITTALS	1
1.4 QUALITY ASSURANCE	2
1.5 DELIVERY, STORAGE, AND HANDLING	2
1.6 COORDINATION	2
1.7 EXTRA MATERIALS	3
PART 2 - PRODUCTS	3
2.1 UPBLAST CENTRIFUGAL ROOF VENTILATORS	3
2.2 ROOF CURBS AND ACCESSORIES	3
2.3 SOURCE QUALITY CONTROL	4
PART 3 - EXECUTION	4
3.1 INSTALLATION	4
3.2 CONNECTIONS	4
3.3 FIELD QUALITY CONTROL	5
3.4 ADJUSTING	5

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. Classify according to AMCA 99.

1.3 SUBMITTALS

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
 - 1. Certified fan performance curves with system operating conditions indicated.
 - 2. Certified fan sound-power ratings.
 - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
 - 4. Material thickness and finishes, including color charts.
 - 5. Dampers, including housings, linkages, and operators.
 - 6. Roof curbs.
 - 7. Fan speed controllers.

- 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.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
 - 2. Design Calculations: Calculate requirements for selecting vibration isolators 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. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Roof framing and support members relative to duct penetrations.
 - 2. Ceiling suspension assembly members.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For power ventilators to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
- B. 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 units, 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 size and location of structural-steel support members.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- C. Coordinate delivery and placement of roof curbs, and equipment supports. Installation of roof curbs, equipment supports, and roof penetrations is specified in Division 07 Section "Roof Accessories."

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-drive unit.

PART 2 - PRODUCTS

2.1 UPBLAST CENTRIFUGAL ROOF VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Acme Engineering & Mfg. Corp.
 2. Aerovent; a Twin City Fan Company.
 3. Greenheck; CUBE Series.
 4. Loren Cook Company.
 5. Moffitt Corporation, Inc.
 6. PennBarry; a unit of Tomkins PLC; Fumex.
- B. Description: Direct- or belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.
- C. Housing: Spun-aluminum construction with square, one-piece, aluminum base with venturi inlet cone. Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
- D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
 2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
 3. Sheaves: Cast-iron, adjustable-pitch motor sheave.
 4. Fan and motor isolated from exhaust airstream.
 5. Refer to Division 23 Section "Common Work Results for HVAC" for additional requirements.
- F. Accessories:
1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
 2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
 3. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
- G. Provide prefabricated roof curbs for each fan.
- H. Capacities and Characteristics: Refer to schedule(s) on Drawings.

2.2 ROOF CURBS AND ACCESSORIES

- A. Construction: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch chemically treated wood nailer. Size as required to suit roof opening and fan base.

1. Manufacturers: Roof curbs shall be provided by the fan manufacturer, or one of the following:
 - a. Creative Metals.
 - b. Pate.
 - c. Roof Products & Systems.
 - d. ThyCurb.
 - e. Any of the approved roof mounted exhaust fan manufacturers.
2. Configuration: Self-flashing without a cant strip, with mounting flange, and suitable for flat roofs with tapered insulation.
3. Height: Curb shall extend a minimum 12 inches above top surface of roof insulation.
4. Sound Curb: Curb with sound-absorbing insulation matrix.
5. Metal Liner: Galvanized steel.
6. Burglar Bars: Minimum 1/2-inch- thick steel bars welded in place to form 6-inch squares.
7. Mounting Pedestal: Galvanized steel with removable access panel.

2.3 SOURCE QUALITY CONTROL

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.
- C. Install units with clearances for service and maintenance.
- D. 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. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Duct Accessories."
- B. Install ducts adjacent to power ventilators 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. 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.
- B. 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. Adjust belt tension.
- C. Refer to Division 23 Section "Testing, Adjusting, and Balancing" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor sheaves as required to achieve design airflow.
- E. Lubricate bearings.

END OF SECTION 23 3423

SECTION 23 3713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SUBMITTALS	1
PART 2 - PRODUCTS	2
2.1 AIR DIFFUSION DEVICES	2
2.2 SOURCE QUALITY CONTROL	2
PART 3 - EXECUTION	2
3.1 EXAMINATION	2
3.2 INSTALLATION	2
3.3 ADJUSTING	3

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 10 Section "Louvers and Vents" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
 - 2. Division 20 Section "Mechanical General Requirements."
 - 3. Division 23 Section "Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.2 SUBMITTALS

- A. Product Data: For each product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate Drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.
 - 4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 - 5. Duct access panels.

PART 2 - PRODUCTS

2.1 AIR DIFFUSION DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
 - 1. Krueger; Tomkins PLC.
 - 2. Nailor Industries of Texas Inc.
 - 3. Price Industries.
 - 4. Titus; Tomkins PLC.
- B. Terminal air diffusion devices have been chosen in terms of specific air distribution requirements, spacing, and sound characteristics.
- C. Provide plaster frames for units installed in plaster ceilings.
- D. Provide gaskets for supply terminal air devices mounted in finished surfaces.
- E. Finish:
 - 1. Air Diffusion Device Face and Visible Trim: Standard off white baked enamel finish unless noted otherwise.
 - 2. Air Diffusion Device Interior Surfaces, Including Blank-Offs: Black matte finish.
- F. Air pattern adjustments shall be made from the face of the device.
- G. Refer to drawings and schedules for quantities, types, and finishes.
- H. Coordinate frame types with Architectural Reflected Ceiling Plan.

2.2 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."
- B. Acoustical Applications and Sound Evaluation: Based on ARI Standard 885-98, "Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.

- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Wall-Mounted Supply Registers: Install 6 inches below finished ceiling unless otherwise indicated.
- D. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 3713

SECTION 23 8120 – UNITARY ROOFTOP AIR CONDITIONERS

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 COORDINATION	2
1.7 EXTRA MATERIALS	2
PART 2 - PRODUCTS	3
2.1 MANUFACTURERS	3
2.2 UNITARY ROOFTOP AIR CONDITIONERS 7-1/2 TO 20 TONS	3
2.3 MOTORS	5
PART 3 - EXECUTION	5
3.1 INSTALLATION	5
3.2 CONNECTIONS	6
3.3 FIELD QUALITY CONTROL	6
3.4 STARTUP SERVICE	7
3.5 ADJUSTING	8
3.6 DEMONSTRATION	8

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 20 Section “Mechanical General Requirements.”
 - 2. Division 20 Section “Basic Mechanical Materials and Methods.”
 - 3. Division 20 Section “Mechanical Vibration Controls.”
 - 4. Division 23 Section “Common Work Results for HVAC” for common mechanical drive requirements for fans and air handling equipment.

1.2 SUMMARY

- A. This Section includes outdoor-mounted unitary air conditioning units smaller than 20 tons.
- B. Products supplied but not installed under this Section:
 - 1. Roof curbs and equipment rails.

1.3 DEFINITIONS

- A. DDC: Direct-digital controls.
- B. BAS: Building Automation System.

1.4 SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Design Calculations: Calculate requirements for selecting vibration isolators and for designing vibration isolation bases.
 - 2. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.
 - 3. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For rooftop air conditioners to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. AHRI Compliance:
 - 1. Comply with AHRI 210/240 and AHRI 340/360 for testing and rating energy efficiencies for RTUs.
 - 2. Comply with AHRI 270 for testing and rating sound performance for RTUs.
- B. ASHRAE Compliance:
 - 1. Comply with ASHRAE 15 for refrigeration system safety.
 - 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
- C. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
- D. UL Compliance: Comply with UL 1995.
- E. 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.

1.6 COORDINATION

- A. Coordinate size and locations of roof curbs, equipment supports, and roof penetrations. Framing, flashing, and attachment to roof structure are specified under Division 07.

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. Fan Belts: One set for each belt-drive fan.
 - 2. Filters: One set of filters for each unit.

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 UNITARY ROOFTOP AIR CONDITIONERS 7-1/2 TO 20 TONS

- A. Manufacturers:
1. Carrier Corp.; United Technologies Corporation.
 2. Johnson Controls Incorporated/YORK; Engineered Systems Group; Series 10 and Series 20.
 3. Lennox Industries Inc.; K Series/L Series.
 4. Trane Company; a Division of Ingersoll Rand; Precedent and Voyager Light Commercial.
- B. Description: Factory assembled and tested; designed for exterior installation; consisting of compressor, condenser coil, direct expansion cooling coil, supply-air fan, condenser coil fan, refrigeration controls, filters, dampers, and temperature controls or interface specified for unit controls.
- C. Maximum Temperature Distribution Across Supply Air Outlet:
1. 10 deg F Heating.
 2. 5 deg F Cooling.
- D. Casing: Galvanized-steel single-wall construction with enamel paint finish, hinged access doors with neoprene gaskets for inspection and access to internal parts, minimum 1/2-inch- thick thermal insulation, knockouts for electrical and piping connections, exterior condensate drain connection, and lifting lugs.
- E. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.1.
1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
 2. Drain Connections: Threaded nipple.
 3. Pan-Top Surface Coating: Corrosion-resistant compound.
- F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- G. Supply-Air Fan: Forward curved, centrifugal, belt driven with adjustable motor sheaves, grease-lubricated ball bearings, and motor.
- H. Condenser Coil Fan: Propeller type, directly driven by permanently lubricated motor.
- I. Direct Expansion Cooling Coils: Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
- J. Compressor(s): Number as scheduled. Hermetic reciprocating or scroll compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief, and crankcase heater(s).
- K. Refrigeration System:

1. Compressor(s).
 2. Condenser coil and fan.
 3. Direct expansion cooling coil and supply-air fan.
 4. Expansion valves with replaceable thermostatic elements.
 5. Check valves.
 6. Refrigerant dryers.
 7. High-pressure switches.
 8. Low-pressure switches.
 9. Thermostats for coil freeze-up protection during low-ambient temperature operation or loss of air.
 10. Low ambient switch.
 11. Brass service valves installed in discharge and liquid lines.
 12. Independent refrigerant circuits.
 13. Refrigerant: R-407C or R-410A.
 14. Compressor Motor Overload Protection: Manual reset.
 15. Anti-recycling Timing Device: Prevents compressor restart for five minutes after shutdown.
 16. Oil-Pressure Switch: Designed to shut down compressors on low oil pressure.
- L. Filters: 2-inch- thick, fiberglass, pleated, throwaway filters in filter rack.
- M. Heat Exchanger: Aluminized-steel or stainless-steel construction for natural-gas-fired burners. Include the following controls:
1. Redundant dual gas valve with manual shutoff.
 2. Direct-spark pilot ignition.
 3. Electronic flame sensor.
 4. Induced-draft blower.
 5. Flame rollout switch.
- N. Economizer: Return- and outside-air dampers with neoprene seals, bird screen, and hood.
1. Damper Motor: Fully modulating spring return with adjustable minimum position.
 2. Control: Electronic-control system uses return-air and outside-air temperature to adjust mixing dampers.
 3. Relief Damper: Gravity actuated with bird screen and hood.
- O. Electrical:
1. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection.
 2. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.
 3. Wiring shall be numbered and color-coded to match wiring diagram.
 4. Field power interface shall be to NEMA KS 1, heavy-duty, nonfused disconnect switch. Minimum SCCR according to UL 508 shall be as required by electrical power distribution system.
 5. Each motor shall have branch power circuit and controls with one of the following disconnecting means having SCCR to match main disconnecting means:
 - a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
 - b. NEMA KS 1, heavy-duty, nonfusible switch.
 - c. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
 6. Each motor shall have overcurrent protection.
- P. Unit Controls: Refer to below and details and sequences on temperature controls drawings for requirements.
- Q. Solid-state control board and components contain at least the following features:

1. Supply-air fan control relay.
2. Default control to ensure proper operation after power interruption.
3. Field-adjustable control parameters.
4. Economizer control.
5. Electric heat staging.
6. Gas valve delay between first- and second-stage firing.
7. Night setback mode (outside air damper lockout).
8. Low-refrigerant pressure control.
9. Control interface for BAS communication link.

- R. BAS Communication Link (with or without manufacturer provided thermostat): Install stand-alone control module providing link between unit controls and BAS. Control module shall be compatible with temperature-control system specified in Division 23 Section "Temperature Controls." Interface shall communicate the following:

1. Occupied (continuous) mode control.
2. Unoccupied cycle mode control.
3. Economizer mode activated.
4. Supply-air fan status.
5. Relief/Exhaust fan status.
6. Dirty filter alarm.
7. Specific unit alarms system diagnostics.
8. Occupied space heating and cooling setpoints.
9. Unoccupied space heating and cooling setpoints.
10. Unit monitored temperatures.
11. Control signal feedback (on/off or modulating signals).

- S. Accessories:

1. Cold-Weather Kit: Electric heater maintains temperature in gas burner compartment.
2. Service Outlets: 115-V, ground-fault, circuit-interrupter type, field wired such that outlet remains energized even if the unit main disconnect is open.
3. Dirty-filter switch.
4. Hail guards of steel, painted to match casing.
5. Power Exhaust Fan.
6. Vertical vent extension.

- T. Roof Curb: Steel with corrosion-protection coating, gasketing, and factory-installed wood nailer; complying with NRCA standards. Top of curb shall be level and height shall be as scheduled.

2.3 MOTORS

- A. Comply with requirements in Division 20 Section "Motors."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Hoist, transport, and rig air conditioning units or their shipping sections into position following procedures recommended by the manufacturer.
- B. Install units level and plumb, maintaining manufacturer's recommended clearances. Install according to AHRI Guideline B.

- C. Deliver roof curbs and equipment supports to site for installation under Division 07. Install rooftop air conditioners on equipment curbs and supports specified and as scheduled. Secure units to curb support with anchor bolts.
- D. Unit Support: Install unit level on structural [curbs] [pilings]. Coordinate wall penetrations and flashing with wall construction. Secure units to structural support with anchor bolts.
- E. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions [and according to seismic codes at Project]. Refer to Division 20 Section "Basic Mechanical Materials and Methods" for base requirements. Coordinate wall penetrations and flashing with wall construction.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 20 and 23 Sections.
- B. Install piping adjacent to machine to allow service and maintenance.
 - 1. Gas Piping: Comply with applicable requirements in Division 23 Section "Fuel Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.
- C. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
 - 1. Install ducts to termination in roof curb.
 - 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
 - 3. Connect supply ducts to rooftop unit with flexible duct connectors specified in Division 23 Section "Duct Accessories."
 - 4. Terminate return-air duct through roof structure and insulate space between roof and bottom of unit with 2-inch- thick, acoustic duct liner.
- D. Electrical System Connections: Comply with applicable requirements in Division 26 Sections for power wiring, switches, and motor controls.
- E. Ground equipment according to Division 26 Section "Grounding and Bonding."
- F. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 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 quality-control tests and inspections and prepare test reports:
 - 1. After installing rooftop air conditioners and after electrical circuitry has been energized, test units for compliance with requirements.
 - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- C. Repair malfunctioning units and retest as specified above; or remove malfunctioning units, replace with new units and retest as specified.

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
 - 1. Inspect for visible damage to unit casing.
 - 2. Inspect for visible damage to furnace combustion chamber.
 - 3. Inspect for visible damage to compressor, air-cooled outside coil, and fans.
 - 4. Inspect internal insulation.
 - 5. Verify that labels are clearly visible.
 - 6. Verify that clearances have been provided for servicing.
 - 7. Verify that controls are connected and operable.
 - 8. Verify that filters are installed.
 - 9. Clean outside coil and inspect for construction debris.
 - 10. Clean furnace flue and inspect for construction debris.
 - 11. Connect and purge gas line.
 - 12. Adjust vibration isolators.
 - 13. Inspect operation of barometric dampers.
 - 14. Lubricate bearings on fan.
 - 15. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
 - 16. Adjust fan belts to proper alignment and tension.
 - 17. Start unit according to manufacturer's written instructions.
 - a. Start refrigeration system in summer only.
 - b. Complete startup sheets and attach copy with Contractor's startup report.
 - 18. Inspect and record performance of interlocks and protective devices; verify sequences.
 - 19. Operate unit for an initial period as recommended or required by manufacturer.
 - 20. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency. Adjust pilot to stable flame.
 - a. Measure gas pressure on manifold.
 - b. Measure combustion-air temperature at inlet to combustion chamber.
 - c. Measure flue-gas temperature at furnace discharge.
 - d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
 - e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
 - 21. Check control interface wiring.
 - 22. Adjust and inspect high-temperature limits.
 - 23. Inspect outside-air dampers for proper stroke and interlock with return-air dampers.
 - 24. Start refrigeration system and measure and record the following:
 - a. Coil leaving-air, dry- and wet-bulb temperatures.
 - b. Coil entering-air, dry- and wet-bulb temperatures.
 - c. Outside-air, dry-bulb temperature.
 - d. Outside-air-coil, discharge-air, dry-bulb temperature.
 - 25. Inspect and verify operation of controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
 - 26. Measure and record the following minimum and maximum airflows.

- a. Supply-air volume.
- b. Return-air volume.
- c. Relief-air volume.
- d. Outside-air intake volume.

27. Simulate maximum cooling demand and inspect the following:

- a. Compressor refrigerant suction and hot-gas pressures.
- b. Short circuiting of air through outside coil or from outside coil to outside-air intake.

28. Record all final adjustment and control settings.

29. After startup and performance testing, change filters, vacuum heat exchanger and cooling and outside coils, lubricate bearings, adjust belt tension, and inspect operation of power vents.

3.5 ADJUSTING

- A. Adjust initial temperature [and humidity] set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain rooftop air conditioners.

END OF SECTION 23 8120

SECTION 23 8244 – CENTRIFUGAL FAN CABINET UNIT HEATERS (ELECTRIC)

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SUBMITTALS	1
1.3 QUALITY ASSURANCE	2
1.4 EXTRA MATERIALS	2
PART 2 - PRODUCTS	2
2.1 MANUFACTURED UNITS	2
2.2 UNIT CONTROLS	3
PART 3 - EXECUTION	3
3.1 EXAMINATION	3
3.2 INSTALLATION	4
3.3 CONNECTIONS	4
3.4 FIELD QUALITY CONTROL	4
3.5 DEMONSTRATION	4

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 20 Section "Mechanical General Requirements."
 - 2. Division 20 Section "Basic Mechanical Materials and Methods."

1.2 SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each 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.
 - 1. Plans, elevations, sections, and details.
 - 2. Location and size of each field connection.
 - 3. Location and arrangement of integral controls.
 - 4. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Structural members to which cabinet unit heaters will be attached.
 - 3. Method of attaching hangers to building structure.
 - 4. Size and location of initial access modules for acoustical tile.
 - 5. Items penetrating finished ceiling, including the following:
 - a. Lighting fixtures.

- b. Air outlets and inlets.
- c. Speakers.
- d. Sprinklers.
- e. Access panels.

6. Perimeter moldings for exposed or partially exposed cabinets.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For cabinet unit heaters to include in operation and maintenance manuals.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by an NRTL acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

1.4 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. Cabinet Unit Heater Filters: Furnish spare filter for each filter installed.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

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

- 1. Berko Electric Heating; a division of Marley Engineered Products.
- 2. Brasch Manufacturing Co., Inc.
- 3. Chromalox, Inc.; a division of Emerson Electric Company.
- 4. Indeeco.
- 5. Markel Products; a division of TPI Corporation.
- 6. QMark Electric Heating; a division of Marley Engineered Products.
- 7. Sterling Radiator; a Mestek Company.

B. Description: A factory-assembled and -tested unit complying with AHRI 440.

- 1. Comply with UL 2021.

A. Coil Section Insulation: ASTM C 1071; surfaces exposed to airstream shall have erosion-resistant coating to prevent erosion of glass fibers.

- 1. Thickness: Minimum 1/2 inch.
- 2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F mean temperature.
- 3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
- 4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.

5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
 - B. Cabinet: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect.
 1. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0528-inch- thick, sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
 2. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch- thick, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
 3. Recessing Flanges for Units That Are Semirecessed or Fully Recessed: Steel, finished to match cabinet.
 4. Control Access Door: Key operated.
 5. Base for Surface, Vertical, Wall-Mounting Units: Minimum 0.0528-inch- thick steel, finished to match cabinet, 6 inches high with leveling bolts.
 - C. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
 1. Glass Fiber Treated with Adhesive: Throw-away type 80 percent arrestance and 5 MERV.
 - D. Electric-Resistance Heating Coil: Non-glowing type. Steel fins brazed to high temperature resistance wire enclosed in incoloy sheath; with fuses in terminal box for overcurrent protection and limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
 - E. Fan and Motor Board: Removable.
 1. Fan: Forward curved, double-width centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
 2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 20 Section "Motors."
 3. Wiring Terminations: Connect motor to chassis wiring with plug connection.
 - F. Electrical Connection: Factory wire motors and controls for a single field connection.
 - G. Capacities and Characteristics: Refer to Schedule on Drawings.
- 2.2 UNIT CONTROLS
- A. Control devices are specified in Division 23 Section "Temperature Controls," and operational sequences are indicated on the Drawings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive cabinet unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for electrical connections to verify actual locations before cabinet unit heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install cabinet unit heaters to comply with NFPA 90A.
- B. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
- C. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

- A. Comply with safety requirements in UL 1995.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding."
- C. Connect wiring according to Division 26 Section "Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters.

END OF SECTION 23 8244

SECTION 26 0010 - ELECTRICAL GENERAL REQUIREMENTS

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	3
1.7 MATERIAL AND EQUIPMENT MANUFACTURERS	3
1.8 INSPECTION OF SITE	3
1.9 ITEMS REQUIRING PRIOR APPROVAL	4
1.10 SHOP DRAWINGS/SUBMITTALS	4
1.11 COORDINATION DRAWINGS	4
1.12 OPERATION AND MAINTENANCE INSTRUCTIONAL MANUALS	5
1.13 RECORD DRAWINGS	5
1.14 INSTRUCTION OF OWNER PERSONNEL	5
1.15 WARRANTY	5
1.16 USE OF EQUIPMENT	6
1.17 COORDINATION	6
PART 2 - PRODUCTS (NOT APPLICABLE)	6
PART 3 - EXECUTION	6
3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION	6
3.2 INSTALLATION OF EQUIPMENT	7
3.3 WORK IN EXISTING BUILDINGS	7
3.4 TEMPORARY SERVICES	7
3.5 CHASES AND RECESSES	7
3.6 CUTTING, PATCHING AND DAMAGE TO OTHER WORK	8
3.7 EXCAVATION AND BACKFILLING	8
3.8 EQUIPMENT CONNECTIONS	8
3.9 CLEANING	8
3.10 PROTECTION AND HANDLING OF EQUIPMENT AND MATERIALS	8
3.11 EXTRA WORK	9
3.12 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. A.N.S.I. - American National Standards Institute
2. A.S.T.M. - American Society for Testing Materials
3. I.C.E.A. - Insulated Cable Engineers Association
4. I.E.E.E. - Institute of Electrical and Electronics Engineers
5. N.E.C. - National Electrical Code
6. N.E.C.A. - National Electrical Contractors Association
7. N.E.M.A. - National Electrical Manufacturer's Association
8. U.L. - Underwriters Laboratories, Inc.
9. N.E.C.A. 1-2000, "Practices for Good Workmanship in Electrical Contracting (ANSI)."

1.4 QUALITY ASSURANCE

- A. Scope of Work: Furnish all labor, material, equipment, technical supervision, and incidental services required to complete, test and leave ready for operation the electrical systems as specified in the Division 26 Sections and as indicated on Drawings.
1. Contract Documents are complimentary, and what is required by one shall be as binding as if required by all. In the event of inconsistencies or disagreements within the Construction Documents bids shall be based on the most expensive combination of quality and quantity of the work indicated.
 2. The Contractor understands that the work herein described shall be complete in every detail.
- B. Ordinances and Codes: Perform all Work in accordance with applicable Federal, State and local ordinances and regulations, the Rules and Regulations of NFPA, NECA, and UL, unless otherwise indicated.
1. Notify the Architect/Engineer before submitting a proposal should any changes in Drawings or Specifications be required to conform to the above codes, rules or regulations. After entering into Contract, make all changes required to conform to above ordinances, rules and regulations without additional expense to the Owner.
- C. Source Limitations: All equipment of the same or similar systems shall be by the same manufacturer.
- D. Tests and Inspections: Perform all tests required by state, city, county and/or other agencies having jurisdiction. Provide all materials, equipment, etc., and labor required for tests.
- E. Performance Requirements: Perform all work in a first class and workmanlike manner, in accordance with the latest accepted standards and practices for the trades involved.
- F. Sequence and Schedule: Work so as to avoid interference with the work of other trades. Be responsible for removing and relocating any work which in the opinion of the Owner's Representatives causes interference.

1.5 CODES, PERMITS AND FEES

- A. Unless otherwise indicated, all required permits, licenses, inspections, approvals and fees for electrical work shall be secured and paid for by the Contractor. All work shall conform to all applicable codes, rules and regulations.
- B. All work shall be executed in accordance with the rules and regulations set forth in local and state codes. Prepare any detailed Drawings or diagrams which may be required by the governing authorities. Where the Drawings and/or Specifications indicate materials or construction in excess of code requirements, the Drawings and/or Specifications shall govern.

1.6 DRAWINGS

- A. The Drawings show the location and general arrangement of equipment, electrical systems and related items. They shall be followed as closely as elements of the construction will permit.
- B. Examine the Drawings of other trades and verify the conditions governing the work on the job site. Arrange work accordingly, providing such fittings, conduit, junction boxes and accessories as may be required to meet such conditions.
- C. Deviations from the Drawings, with the exception of minor changes in routing and other such incidental changes that do not affect the functioning or serviceability of the systems, shall not be made without the written approval of the Architect/Engineer.
- D. The architectural and structural Drawings take precedence in all matters pertaining to the building structure, mechanical Drawings in all matters pertaining to mechanical trades and electrical Drawings in all matters pertaining to electrical trades. Where there are conflicts or differences between the Drawings for the various trades, report such conflicts or differences to the Architect/Engineer for resolution.
- 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. Wiring Devices
 - 2. Lighting Control Devices
 - 3. Enclosed Switches and Circuit Breakers
 - 4. Enclosed Controllers
 - 5. Switchboards
 - 6. Panelboards
 - 7. Dry Type Transformers (600 V and Less)
 - 8. Fuses
 - 9. Interior Lighting
 - 10. Communications Backbone Cabling
 - 11. Communications Horizontal Cabling
 - 12. Fire Alarm

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.
 - 4. Submittals.
 - 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 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.

3.3 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 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 and remove upon completion of the project, in accordance with the general conditions and as described in Division 1, a complete temporary electrical and telephone service during construction.

3.5 CHASES AND RECESSES

- 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 EXCAVATION AND BACKFILLING

- A. Provide all excavation, trenching, tunneling, dewatering and backfilling required for the electrical work. Coordinate the work with other excavating and backfilling in the same area.
- B. Where conduit is installed less than 2'6" below the surface of pavement, provide concrete encasement, 4" minimum coverage, all around or as shown on the electrical Drawings.
- C. Backfill all excavations with well-tamped granular material. Backfill all excavations under wall footings with lean mix concrete up to underside of footings and extend concrete within excavation a minimum of four (4) feet each side of footing. Granular backfill shall be placed in layers not more than 8 inches in thickness, 95 percent compaction throughout with approved compaction equipment. Tamp, roll as required. Excavated material shall not be used.
- D. Backfill all excavations inside building, under drives and parking areas with well-tamped granular material. Granular backfill shall be placed in layers not more than 8 inches in thickness, 95 percent compaction throughout with approved compaction equipment. Tamp, roll as required. Excavated material shall not be used.
- E. Backfill outside building with granular material to a height 12 inches over top of pipe compacted to 95 percent compaction as specified above. Backfill remainder of excavation with unfrozen, excavated material in such a way to prevent settling.

3.8 EQUIPMENT CONNECTIONS

- A. Make connections to equipment, motors, lighting fixtures, and other items included in the work in accordance with the approved shop Drawings and rough-in measurements furnished by the manufacturers of the particular equipment furnished. All additional connections not shown on the Drawings, but called out by the equipment manufacturer's shop Drawings shall be provided.

3.9 CLEANING

- A. All debris shall be removed daily as required to maintain the work area in a neat, orderly condition.
- B. Final cleanup shall include, but not be limited to, washing of fixture lenses or louvers, switchboards, substations, motor control centers, panels, etc. Fixture reflectors and lenses or louvers shall be left with no water marks or cleaning streaks.

3.10 PROTECTION AND HANDLING OF EQUIPMENT AND MATERIALS

- A. Equipment and materials shall be protected from theft, injury or damage.
- B. Protect conduit openings with temporary plugs or caps.

- C. Provide adequate storage for all equipment and materials delivered to the job site. Location of the space will be designated by the Owner's representative or Architect/Engineer. Equipment set in place in unprotected areas must be provided with temporary protection.

3.11 EXTRA WORK

- A. For any extra electrical work which may be proposed, this Contractor shall furnish to the General Contractor, an itemized breakdown of the estimated cost of the materials and labor required to complete this work. The Contractor shall proceed only after receiving a written order from the General Contractor establishing the agreed price and describing the work to be done. Prior to any extra work which may be proposed, the Electrical Contractor shall submit unit prices (same prices for increase/decrease of work) for the following items: 3/4", 1", 1-1/2" conduit; #12, #10, #8, #6, #2 wire; receptacle, I.G. receptacle, data box, fire alarm combination visual/audible notification appliance, fire alarm visual notification appliance, or other devices which may be required for any proposed extra work.

3.12 DRAWINGS AND MEASUREMENTS

- A. The Drawings are not intended to be scaled for rough-in measurements nor to serve as Shop Drawings. Field measurements necessary for ordering materials and fitting the installation to the building construction and arrangement are the Contractor's responsibility. The Contractor shall check latest Architectural Drawings and locate light switches from same where door swings are different from Electrical Drawings.

END OF SECTION 26 0010

SECTION 26 0519 - CONDUCTORS AND CABLES

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SUMMARY	1
1.3 SUBMITTALS	1
1.4 QUALITY ASSURANCE	1
PART 2 - PRODUCTS	2
2.1 CONDUCTORS AND CABLES	2
2.2 CONNECTORS AND SPLICES	2
PART 3 - EXECUTION	2
3.1 CONDUCTOR MATERIAL APPLICATIONS	2
3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS	3
3.3 INSTALLATION OF CONDUCTORS AND CABLES	3
3.4 CONNECTIONS	4
3.5 IDENTIFICATION	4
3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS	5
3.7 FIRESTOPPING	5
3.8 FIELD QUALITY CONTROL	5

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes:
 - 1. Building wires and cables rated 600V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.
- B. Related Sections include the following:
 - 1. Division 27 Section "Communications Horizontal Cabling" for cabling used for voice and data circuits.

1.3 SUBMITTALS

- A. Field Quality-Control Test Reports

1.4 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Testing agency as defined by OSHA in 29 CFR 1910.7 or a member company of the InterNational Electrical Testing Association and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.
- B. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for types THHN/THWN-2.
- C. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for Metal-clad cable, Type MC with ground wire.
- D. Power Cable for Variable Frequency Controlled Motors: 600V and 2000V, three conductor, XLPE cable with three symmetrical positioned ground conductors and a continuous impervious corrugated aluminum armor and overall PVC jacket. Cable shield transfer impedance shall be less than 10 ohms per meter up to 30 MHZ when tested in accordance with NEMA WC 61.
 1. Approved manufacturers for VFC power cables:
 - a. Southwire Armor-x
 - b. Draka USA

2.2 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger, except VFC cable, which shall be extra flexible stranded.
- C. Each feeder shall be of the same conductor and insulation material (phase, neutral, and parallel).
- D. Use conductor not smaller than 12 AWG for power and lighting circuits. Unless indicated otherwise, all circuits shall be 2#12, 1#12G, $\frac{3}{4}$ "C.
- E. Use conductor not smaller than 14 AWG for control circuits, provided by Electrical Contractor.

- F. Where equipment is listed for use with copper conductors only, splice from aluminum to copper prior to entering equipment or use copper conductors for the entire length of feeder.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN/THWN-2, single conductors in raceway.
- B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and in Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- E. Exposed Branch Circuits, including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Metal-clad cable, Type MC.
- G. Branch Circuits Concealed in Concrete and below Slabs-on-Grade: Type THHN/THWN-2, single conductors in raceway.
- H. Fire Alarm Circuits: Type THHN/THWN-2, in raceway.
- I. Class 1 Control Circuits: Type THHN/THWN-2, in raceway.
- J. Connection between Variable Frequency Controllers and Motors: Use 600V rated VFC power cable for circuit lengths less than 50 feet and 2000V rated VFC power cable for circuit lengths 50 feet and greater. Support 5' on center, minimum. Terminate according to cable manufacturer's recommendations.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."
- G. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.
- H. Support communication cables above accessible ceiling, using spring metal clips or plastic cable ties to support cables from structure. Do not rest cable on ceiling panels.

- I. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- J. Branch circuits may be combined up to 3 circuits in a homerun conduit.
- K. Provide a separate neutral conductor for each circuit.
- L. Electrical Contractor shall be responsible for de-rating of conductors as required by N.E.C. when more than three current carrying conductors are installed in a single raceway or cable.
- M. Type MC cable shall be supported and secured at intervals not exceeding 4'-0".
- N. AC/MC cable shall not be used for home runs to receptacle or distribution panels.
- O. Where AC/MC cable is permitted by the specifications, MC cable shall not be bundled
- P. Between support, hangers and termination no more than 3" deflection from the bottom of the cable to a horizontal line between the support/hanger or termination.
- Q. Do not route conductors across roof without prior approval from engineer. Where approved, conductors shall be installed in rigid steel conduit and shall be de-rated for ambient temperature per the NEC.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors.
 - 1. Use oxide inhibitor in each splice and tap conductor for aluminum conductors.
 - 2. Use compression type terminations for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.
- D. Clean conductor surfaces before installing lugs and connectors.
- E. Make splices, taps, and terminations to carry full ampacity of conductors with no perceptible temperature rise.
- F. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, 8 AWG and larger.
- G. Use Sta-Kon connectors to terminate stranded conductors #10 AWG and smaller to screw terminals.
- H. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260533 "Raceways and Boxes."

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping".

3.8 FIELD QUALITY CONTROL

- A. 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
1.1 RELATED DOCUMENTS	1
1.2 SUMMARY	1
1.3 REFERENCES	1
1.4 SUBMITTALS	2
1.5 PROJECT RECORD DOCUMENTS	2
1.6 QUALITY ASSURANCE	2
PART 2 - PRODUCTS	3
2.1 MANUFACTURERS	3
2.2 GROUNDING CONDUCTORS	3
2.3 CONNECTOR PRODUCTS	4
2.4 GROUNDING ELECTRODES	4
PART 3 - EXECUTION	4
3.1 EQUIPMENT GROUNDING	4
3.2 CONNECTIONS	5
3.3 INSTALLATION	6
3.4 TELECOMMUNICATIONS GROUNDING	6
3.5 FIELD QUALITY CONTROL	7
3.6 GRADING AND PLANTING	8

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.
- D. ASTM B 187: Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes.
- E. IEEE 81: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

- F. IEEE 142: Grounding of Industrial and Commercial Power Systems.
- G. IEEE 837: Qualifying Permanent Connections Used in Substation Grounding.
- H. IEEE 1100 – 1992: Recommended Practice for Powering and Grounding Sensitive Electronic Equipment.
- I. IEEE C2: National Electrical Safety Code.
- J. NETA MTS – 2001: Maintenance Testing Specifications.
- K. NFPA 70: National Electrical Code.
- 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.
- P. UL 486B: Wire Connectors for Use with Aluminum 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 NFPA 70; for overhead-line construction and medium-voltage underground construction, comply with IEEE C2.
- D. Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system.
- E. Comply with ANSI/TIA/EIA-607 "Standard for Commercial Building Grounding and Bonding Requirements for Telecommunications".
- F. Comply with ANSI/IEEE 1100 -1992 "Powering and Grounding Sensitive Electronic Equipment".

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. American Electric-Blackburn.
 - b. Apache Grounding/Erico Inc.
 - c. Chance/Hubbell.
 3. Mechanical Connectors:
 - a. American Electric-Blackburn.
 - b. Burndy.
 - c. Chance/Hubbell.
 4. Exothermic Connections:
 - a. Cadweld.

2.2 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 Section "Conductors and Cables."
- B. Material: Aluminum, copper-clad aluminum, and copper.
- C. Equipment Grounding Conductors: Insulated with green-colored insulation.
- D. 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.
- E. Grounding Electrode Conductors: Stranded cable.
- F. Underground Conductors: Bare, stranded, copper unless otherwise indicated.

G. Bare Copper Conductors: Comply with the following:

1. Solid Conductors: ASTM B 3.
2. Assembly of Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.

H. Copper Bonding Conductors: As follows:

1. Bonding Conductor: Stranded copper conductor; size per the NEC.
2. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; size per the NEC.
3. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; size per the NEC.

I. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

1. 24" (min) x 4" x 1/4" tin plated, copper busbar with three rows of 1/4 x 20 tapped holes 3" on center.

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.
 1. Size: 3/4 in diameter.
 2. Length: 120 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. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
- G. 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.
 - 3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
 - 4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 - 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. Connections at Test Wells: Use compression-type connectors on conductors and make bolted- and clamped-type connections between conductors and ground rods.
- F. 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.
- G. 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.
- H. 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. 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.
- B. 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.
- C. 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.
- D. Metal Water Service Pipe: Provide insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
- E. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding clamp connectors.
- F. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.
- G. Grounding Bus:
 - 1. Install grounding bus in the locations listed below and elsewhere as indicated:
 - a. Electrical equipment rooms.
 - b. Telephone equipment rooms.
 - 2. Use insulated spacer; space 1 inch from wall and support from wall 6 inches above finished floor, unless otherwise indicated.
- H. 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.
- I. Bond together metal building elements not attached to grounded structure; bond to ground.
- J. Provide a flexible braid bonding jumper at each set of columns at expansion joints.

3.4 TELECOMMUNICATIONS GROUNDING

- A. Telecommunications Grounding System: The telecommunications grounding system shall consist of:

1. Telecommunications Main Grounding Busbar (TMGB) located in the main telecommunications room near the telecommunications service entrance. Bond to the main building electrical grounding electrode system via a No. 3/0 AWG copper ground conductor.
 2. Bonding of all equipment racks, raceways, non-current carrying metallic equipment and surge protection devices within the telecommunications room to the TGB's or TMGB using approved bonding conductors. Each piece of equipment shall be bonded individually directly to the ground bus.
- B. All bonding connections shall be installed at an accessible location for inspection and maintenance.
- C. All telecommunications bonding connections shall be of an approved mechanical type connection. Do not use exothermic welds unless specifically indicated on the Drawings.
- D. The physical routing shall, in general, follow the same path as the backbone cable system.
- E. All bonding connectors and conductors shall be UL listed for the purpose intended.
- F. Mount TMGB and TGB bus to backboard or wall using 2" standoff insulators.
- G. Individually bond each piece of non-current carrying metallic equipment in the Telecommunications Room to the TGB.

3.5 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. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - c. 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.
 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.
 - d. Substations and Pad-Mounted Switching Equipment: 5 ohms.
 - e. Manhole Grounds: 10 ohms.
 - f. The telecommunications grounding system shall have a maximum resistance of 1 ohm as measured from the TMGB ground to earth ground.

4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

3.6 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. Comply with Division 2 Section "Landscaping." Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION 26 0526

SECTION 26 0529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SUMMARY	1
1.3 DEFINITIONS	1
1.4 PERFORMANCE REQUIREMENTS	2
1.5 SUBMITTALS	2
1.6 QUALITY ASSURANCE	2
1.7 COORDINATION	2
PART 2 - PRODUCTS	2
2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS	2
2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES	3
2.3 ROOF MOUNTED CONDUIT AND EQUIPMENT SUPPORTS	4
PART 3 - EXECUTION	5
3.1 APPLICATION	5
3.2 SUPPORT INSTALLATION	5
3.3 INSTALLATION OF FABRICATED METAL SUPPORTS	6
3.4 INSTALLATION OF ROOF MOUNTED SUPPORTS	6
3.5 CONCRETE BASES	6
3.6 PAINTING	7

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.

- B. Related Sections include the following:

1. Division 26 Section "Vibration and Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.5 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.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

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. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 2. 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.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

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.

2.3 ROOF MOUNTED CONDUIT AND EQUIPMENT SUPPORTS

- A. General: Shop- or field- fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted conduit and equipment.
- B. Adjustable Compact Stand: Recycled rubber base unit with integral threaded coupling capable of accepting 3/8-16 threaded rod, or 1-5/8 inch by 1-5/8 inch metal strut and various supporting elements.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. B-Line Systems, Inc.; a division of Cooper Industries; Dura-Blok.
 - b. ERICO International Corp.; Caddy Pyramid.
 - c. Tolco; a brand of Nibco; Pipe Piers.
- C. Low-Type, Single-Conduit Stand: Assembly of base and horizontal members, and support, for roof installation without membrane penetration.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. B-Line Systems, Inc.; a division of Cooper Industries; Dura-Blok.
 - b. ERICO International Corp.; Caddy Pyramid.
 - c. Tolco; a brand of Nibco; Pipe Piers.
 - 2. Base: Plastic, Recycled rubber.
 - 3. Horizontal Member: Cadmium-plated-steel or galvanized-steel strut designed for use with standard strut clamps and accessories.
- D. Low-Type, Multiple-Conduit Stand: Assembly of two or more bases and horizontal members, and supports, for roof installation without membrane penetration.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. B-Line Systems, Inc.; a division of Cooper Industries; Dura-Blok.
 - b. ERICO International Corp.; Caddy Pyramid.
 - c. Tolco; a brand of Nibco; Pipe Piers.
 - 2. Base: Plastic, Recycled rubber.
 - 3. Horizontal Member: Cadmium-plated-steel or galvanized-steel strut designed for use with threaded rod, standard strut clamps, and accessories.
- E. High-Type, Multiple-Conduit and Equipment Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. B-Line Systems, Inc.; a division of Cooper Industries; Dura-Blok.
 - b. ERICO International Corp.; Caddy Pyramid.
 - c. Tolco; a brand of Nibco; Pipe Piers.
 - 2. Bases: One or more recycled rubber.
 - 3. Vertical Members: Two or more protective-coated-steel channels.
 - 4. Horizontal Member: Protective-coated-steel channel.
 - 5. Supports: Standard strut clamps, hangers, and accessories.

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. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with:
 - a. Two-bolt conduit clamps
 - b. Single-bolt conduit clamps
 - c. Single-bolt conduit clamps using spring friction action for retention in support channel.
- D. Support single runs of MC cable using spring-steel clamps from suspended ceiling hangers, hanger wire or building structure at intervals not to exceed three feet. Do not support MC cable from ceiling grid.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 6. 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.
 - 7. To Light Steel: Sheet metal screws.
 - 8. 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
- 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. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 INSTALLATION OF ROOF MOUNTED SUPPORTS

- A. Install in accordance with manufacturer's instructions.
- B. If gravel top roof, gravel must be removed around and under support.
- C. Consult roofing manufacturer for roof membrane compression capacities. If required, a compatible sheet of roofing material (rubber pad) may be required under rooftop support to disperse concentrated loads and add further membrane protection.
- D. Utilize properly sized clamps and accessories to suit conduit sizes.

3.5 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.

3.6 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide 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
1.1 RELATED DOCUMENTS	1
1.2 SUMMARY	1
1.3 DEFINITIONS	2
1.4 SUBMITTALS	2
1.5 QUALITY ASSURANCE	2
1.6 COORDINATION	2
PART 2 - PRODUCTS	2
2.1 METAL CONDUIT AND TUBING	2
2.2 FIRE ALARM EMT	3
2.3 NONMETALLIC CONDUIT AND TUBING	3
2.4 METAL WIREWAYS	4
2.5 BOXES, ENCLOSURES, AND CABINETS	4
2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING	4
2.7 SLEEVES FOR RACEWAYS	5
2.8 SLEEVE SEALS	5
2.9 GROUT	6
2.10 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES	6
PART 3 - EXECUTION	6
3.1 RACEWAY APPLICATION	6
3.2 INSTALLATION	7
3.3 INSTALLATION OF UNDERGROUND CONDUIT	10
3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES	10
3.5 SLEEVE INSTALLATION FOR ELECTRICAL AND COMMUNICATIONS PENETRATIONS	11
3.6 SLEEVE-SEAL INSTALLATION	11
3.7 FIRESTOPPING	12
3.8 PROTECTION	12
3.9 CLEANING	12

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 26 Section, "Underground Ducts and Raceways for Electrical Systems" for exterior duct banks, manholes and underground utility construction.
 2. Division 07 Section, "Penetration Firestopping" for firestopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
 3. 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. AFC Cable Systems, Inc.
 - 2. Alflec Inc.
 - 3. Allied Tube Triangle Century.
 - 4. Anamet Electrical, Inc.; Anaconda Metal Hose.

5. International Metal Hose.
6. Electri-Flex Co
7. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
8. LTV Steel Tubular Products Company – Manhattan/CDT/Cole-Flex.
9. Maverick.
10. O-Z Gedney; unit of General Signal.
11. Wheatland.

B. Rigid Steel Conduit: ANSI C80.1.

C. EMT: ANSI C80.3.

D. FMC: Zinc-coated steel.

E. LFMC: Flexible steel conduit with PVC jacket.

F. 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.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
2. Fittings for EMT: Steel, set-screw type.
3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch, with overlapping sleeves protecting threaded joints.

2.2 FIRE ALARM EMT

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

1. Allied Tube Triangle Century.

B. EMT conduit with bright red topcoat; Fire Alarm EMT.

C. EMT and Fittings: ANSI C80.3.

2.3 NONMETALLIC CONDUIT AND TUBING

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

1. American International.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corp.
4. Cantex Inc.
5. Certainteed Corp.; Pipe and Plastics Group.
6. Condux International.
7. ElecSys, Inc.
8. Electri-Flex Co.
9. Integral.
10. Kor-Kap.
11. Lamson and Sessions: Carlon Electrical Products.
12. Manhattan/CDT/Cole-Flex.
13. RACO; Division of Hubbell, Inc.
14. Scepter.
15. Spiraldut, Inc./AFC Cable Systems, Inc.
16. Thomas & Betts Corporation.

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.
- F. HDPE: UL 651, ASTM D 3350, ASTM D 1248 Schedule 40.

2.4 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.

2.5 BOXES, ENCLOSURES, AND CABINETS

- A. Sheet Metal Outlet and Device Boxes: NEMA OS 1. Shall be used within walls or ceiling.
- B. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover. Shall be used in all exposed, non-recessed, locations.
- C. Nonmetallic Outlet and Device Boxes: NEMA OS 2. Shall be used in corrosive areas.
- D. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- E. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover. Shall be used in areas exposed to water.
- F. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
- G. 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.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. Description: Comply with ANSI/SCTE 77.

1. Color of Frame and Cover: Gray.
2. Configuration: Units shall be designed for flush burial and have open bottom, unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC", "COMMUNICATIONS" or as indicated for each system service.
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
7. Handholes 12 inches wide by 24 inches long and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or a combination of the two.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell: Quazite
 - b. Armorcast Products Company.
 - c. Carson Industries LLC.
 - d. CDR Systems Corporation.
 - e. NewBasis.
 - f. Christy Concrete Products.

2.7 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."

2.8 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 of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.9 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.

2.10 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
 1. Tests of materials shall be performed by a independent testing agency.
 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

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, Enclosures, and Handholes:
 1. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.
 2. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate Loading by Vehicles: Polymer-concrete units, SCTE 77, Tier 8 structural load rating.
- D. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.
- E. Minimum Raceway Size: 3/4-inch trade size.
- F. 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. EMT: Use setscrew, fittings. Comply with NEMA FB 2.10.
 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

- G. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- H. Do not install aluminum conduits in contact with concrete.
- I. Install surface raceways only where indicated on Drawings.
- J. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- E. Install temporary closures to prevent foreign matter from entering raceways.
- F. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
- G. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
- H. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- I. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
 - 1. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
- J. Support conduit within 12 inches of enclosures to which attached.
- K. Raceways Embedded in Slabs:
 - 1. Raceways embedded in slabs shall be limited to above grade concrete decks. Embedded conduit shall be limited to servicing floor boxes and equipment located in open spaces away from accessible walls.
 - 2. Install in middle 1/3 of slab thickness where practical and leave at least 2 inches (50 mm) of concrete cover.
 - 3. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - 4. Space raceways laterally to prevent voids in concrete.
 - 5. Run conduit larger than 1-inch trade size (DN 27) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - 6. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 7. Conduits shall run flat. Do not allow conduits to cross.
 - 8. Change from non-metallic raceway to EMT before turning up out of the concrete and rising above the floor.

- L. 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.
- M. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
- N. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- O. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- Q. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- R. 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.
- S. 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.
- T. 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.
- U. Provide pull string and 25% spare capacity in every branch circuit conduit.
- V. Telephone and Signal System Raceways, 2-Inch Trade Size and Smaller: In addition to above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.
 - 1. Electrical conduit (LB's) are not permitted.
 - 2. Conduits shall have no more than two 90 degree bends between pull points or pull boxes.
 - 3. Conduits shall contain no continuous sections longer than 100 ft. without a pull point/box.
 - 4. The bend radius of conduit must be at least 6 times the internal diameter for a conduit 2 inches or less and a radius of 10 times the diameter for a conduit greater than two inches.
 - 5. All conduit ends shall have an insulated bushing.
- W. 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.
- X. 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.
- Y. Expansion-Joint Fittings:
 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- Z. Flexible Conduit Connections: Comply with NEMA RV3. Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.
- AA. 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.
- BB. 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.
- CC. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- DD. Locate boxes so that cover or plate will not span different building finishes.
- EE. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- FF. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- GG. Set floor boxes level and flush with finished floor surface. Trim non-metallic boxes after installation to fit flush with finished floor surface.
- HH. Install hinged-cover enclosures and cabinets plumb. Support at each corner.
- II. Do not route feeders across roof.

- JJ. 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.
- KK. Route conduits in finished areas with exposed ceilings at underside of structural deck or as high as possible.
- LL. 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 stub-ups at poles and 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.
5. Warning Planks: Bury warning planks approximately 12 inches above direct-buried conduits, placing them 24 inches o.c. Align planks along the width and along the centerline of conduit.

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install handholes and boxes with bottom below the frost line, 42" below grade.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
- F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE INSTALLATION FOR ELECTRICAL AND COMMUNICATIONS PENETRATIONS

- A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Through-Penetration Firestop Systems."
- B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
- C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- D. Rectangular Sleeve Minimum Metal Thickness:
 - 1. For sleeve cross-section rectangle perimeter less than 50 inches and no side greater than 16 inches, thickness shall be 0.052 inch.
 - 2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches and 1 or more sides equal to, or greater than, 16 inches, thickness shall be 0.138 inch.
- E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- F. Cut sleeves to length for mounting flush with both surfaces of walls.
- G. Extend sleeves installed in floors 2 inches above finished floor level.
- H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway unless sleeve seal is to be installed.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.
- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 7 Section "Joint Sealants" for materials and installation.
- K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 7 Section "Through-Penetration Firestop Systems."
- L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.
- M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.6 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.

3.7 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."

3.8 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.

3.9 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
1.1 RELATED DOCUMENTS	1
1.2 SUMMARY	1
1.3 QUALITY ASSURANCE	1
1.4 COORDINATION	1
PART 2 - PRODUCTS	2
2.1 RACEWAY AND METAL-CLAD CABLE IDENTIFICATION MATERIALS	2
2.2 CONDUCTOR, COMMUNICATION AND CONTROL CABLE IDENTIFICATION MATERIALS	2
2.3 UNDERGROUND-LINE WARNING TAPE	2
2.4 EQUIPMENT IDENTIFICATION LABELS	2
2.5 MISCELLANEOUS IDENTIFICATION PRODUCTS	2
2.6 WIRING DEVICE IDENTIFICATION	3
PART 3 - EXECUTION	3
3.1 APPLICATION	3
3.2 INSTALLATION	4

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
1. Identification for raceway and metal-clad cable.
 2. Identification for conductors and communication and control cable.
 3. Underground-line warning tape.
 4. Equipment identification labels.
 5. Miscellaneous identification products.

1.3 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and ANSI C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.145.

1.4 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual, and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. 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 UNDERGROUND-LINE WARNING TAPE

- A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
 - 1. Not less than 6 inches wide by 4 mils thick.
 - 2. Compounded for permanent direct-burial service.
 - 3. Embedded continuous metallic strip or core.
 - 4. Printed legend shall indicate type of underground line.

2.4 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.
- B. Outdoor Equipment Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.5 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch.
2. Tensile Strength: 50 lb, minimum.
3. Temperature Range: Minus 40 to plus 185 deg F.
4. Color: Black, except where used for color-coding.

- 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.

2.6 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 More Than 600 V: Identify with "DANGER-HIGH VOLTAGE" in black letters at least 2 inches high, with self-adhesive vinyl labels. Repeat legend at 10-foot maximum intervals.
- B. 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.
- C. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:
1. Fire Alarm System: Red.
 2. Security System: Blue and yellow.
 3. Telecommunication System: Green and yellow.
 4. Control Wiring: Green and red.
- D. 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.
- E. 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.
- F. Branch-Circuit Conductor Identification: Mark junction box covers in indelible ink with the panel and breaker numbers of other circuits contained within.
- G. Conductor Identification: Locate at each conductor at panelboard gutters, pull boxes, outlet and junction boxes, and each load connection or termination point.
- H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
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.
 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.
- I. 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.
- J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and apply self-adhesive warning labels. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
1. Equipment with Multiple Power or Control Sources: Apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
 2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.
- K. 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. Panelboards, electrical cabinets, and enclosures.
 - b. Electrical switchgear and switchboards.
 - c. Transformers.
 - d. Disconnect switches.
 - e. Motor starters.
 - f. Breakers or switches at distribution panels.
- L. 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:
 - a. Phase A: Brown.
 - 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:

RP-1A FED FROM DP-1A ELECTRICAL ROOM A100 VIA T-1A	EF-1 FED FROM MCC-1A MECHANICAL ROOM F101	LP-1A LOCATED IN ELECTRICAL ROOM A100

- 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.
- R. Paint red colored band on each fire alarm conduit and junction box.
- S. Paint bands 10 feet on center, and 4 inches minimum in width.

END OF SECTION 26 0553

SECTION 26 0573 – OVERCURRENT DEVICE COORDINATION STUDY/ARC FLASH HAZARD ANALYSIS

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SCOPE	1
1.3 REFERENCES	1
1.4 SUBMITTALS FOR REVIEW/APPROVAL	2
1.5 SUBMITTALS FOR CONSTRUCTION	2
1.6 QUALIFICATIONS	2
1.7 COMPUTER SOFTWARE PROGRAMS	3
PART 2 - PRODUCTS	3
2.1 STUDIES	3
2.2 DATA COLLECTION	3
2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY	3
2.4 PROTECTIVE DEVICE COORDINATION STUDY	4
2.5 ARC FLASH HAZARD ANALYSIS	5
2.6 REPORT SECTIONS	6
PART 3 - EXECUTION	7
3.1 FIELD ADJUSTMENT	7
3.2 ARC FLASH WARNING LABELS	7

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 SCOPE

- A. The contractor shall furnish short-circuit and protective device coordination studies as prepared by the electrical equipment manufacturer.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in NFPA 70E -Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D prepared by the electrical equipment manufacturer.

1.3 REFERENCES

- A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
 - 1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems
 - 2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems
 - 3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis
 - 4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings
 - 5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
 - 6. IEEE 1584 -Guide for Performing Arc-Flash Hazard Calculations

B. American National Standards Institute (ANSI):

1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers
2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures
3. ANSI C37.010 – Standard Application Guide for AC High Voltage Circuit Breakers Rated on a Symmetrical Current Basis
4. ANSI C 37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

C. The National Fire Protection Association (NFPA)

1. NFPA 70 -National Electrical Code, latest edition
2. NFPA 70E – Standard for Electrical Safety in the Workplace

1.4 SUBMITTALS FOR REVIEW/APPROVAL

- A. The short-circuit and protective device coordination studies shall be submitted to the design engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.

1.5 SUBMITTALS FOR CONSTRUCTION

- A. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. Five (5) bound copies of the complete final report shall be submitted. Additional copies of the short-circuit input and output data, where required, shall be provided on CD in PDF format.
- B. The report shall include the following sections:
1. Executive Summary.
 2. Descriptions, purpose, basis and scope of the study.
 3. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties.
 4. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip unit settings, fuse selection.
 5. Fault current calculations including a definition of terms and guide for interpretation of the computer printout.
 6. Details of the incident energy and flash protection boundary calculations.
 7. Recommendations for system improvements, where needed.
 8. One-line diagram.
- C. Arc flash labels shall be provided in hard copy and a copy of the computer analysis software viewer program is required to provide arc flash labels in electronic format.

1.6 QUALIFICATIONS

- A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the supervision and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.
- B. The Registered Professional Electrical Engineer shall be a full-time employee of the equipment manufacturer.

- C. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.
- D. The equipment manufacturer shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analysis it has performed in the past year.

1.7 COMPUTER SOFTWARE PROGRAMS

- A. Computer Software Programs: Subject to compliance with requirements, provide products by one of the following:
 - 1. EDSA Micro Corporation.
 - 2. SKM Systems Analysis, Inc.
 - 3. ESA Inc.
 - 4. CGI CYME.
 - 5. Operation Technology, Inc.

PART 2 - PRODUCTS

2.1 STUDIES

- A. Contractor to furnish short-circuit and protective device coordination studies as prepared by equipment manufacturer.
- B. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E -Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D prepared by the equipment manufacturer.

2.2 DATA COLLECTION

- A. Contractor shall furnish all data as required by the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.
- B. Source combination may include present and future motors and generators.
- C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner.
- D. If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data to satisfy the study requirements.

2.3 SHORT-CIRCUIT AND PROTECTIVE DEVICE EVALUATION STUDY

- A. Use actual conductor impedances if known. If unknown, use typical conductor impedances based on IEEE Standard 141-1993.
- B. Transformer design impedances shall be used when test impedances are not available.
- C. Provide the following:

1. Calculation methods and assumptions
2. Selected base per unit quantities
3. One-line diagram of the system being evaluated
4. Source impedance data, including electric utility system and motor fault contribution characteristics
5. Tabulations of calculated quantities
6. Results, conclusions, and recommendations.

D. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault at each:

1. Electric utility's supply termination point
2. Incoming switchgear
3. Unit substation primary and secondary terminals
4. Low voltage switchgear
5. Motor control centers
6. Standby generators and automatic transfer switches
7. Branch circuit panelboards
8. Other significant locations throughout the system.

E. For grounded systems, provide a bolted line-to-ground fault current study for areas as defined for the three-phase bolted fault short-circuit study.

F. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short circuit ratings
2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses
3. Notify design engineer in writing, of existing, circuit protective devices improperly rated for the calculated available fault current.

2.4 PROTECTIVE DEVICE COORDINATION STUDY

- A. Proposed protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.
- B. Include on each TCC graph, a complete title and one-line diagram with legend identifying the specific portion of the system covered.
- C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
- D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
- E. Plot the following characteristics on the TCC graphs, where applicable:
 1. Electric utility's overcurrent protective device
 2. Medium voltage equipment overcurrent relays
 3. Medium and low voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands
 4. Low voltage equipment circuit breaker trip devices, including manufacturer's tolerance bands
 5. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves
 6. Conductor damage curves
 7. Ground fault protective devices, as applicable
 8. Pertinent motor starting characteristics and motor damage points, where applicable
 9. Pertinent generator short-circuit decrement curve and generator damage point
 10. The largest feeder circuit breaker in each motor control center and applicable panelboard.

- F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

2.5 ARC FLASH HAZARD ANALYSIS

- A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA70E-2004, Annex D.
- B. The flash protection boundary and the incident energy shall be calculated at all significant locations in the electrical distribution system (switchboards, switchgear, motor-control centers, panelboards, busway and splitters) where work could be performed on energized parts.
- C. The Arc-Flash Hazard Analysis shall include all significant locations in 240 volt and 208 volt systems fed from transformers equal to or greater than 125 kVA where work could be performed on energized parts.
- D. Safe working distances shall be based upon the calculated arc flash boundary considering an incident energy of 1.2 cal/cm².
- E. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations
- F. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for all normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum and will assume a minimum motor contribution (all motors off). Conversely, the maximum calculation will assume a maximum contribution from the utility and will assume the maximum amount of motors to be operating. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable.
- G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators should be decremented as follows:
 - 1. Fault contribution from induction motors should not be considered beyond 3-5 cycles.
 - 2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g. contributions from permanent magnet generators will typically decay from 10 per unit to 3 per unit after 10 cycles).
- H. For each equipment location with a separately enclosed main device (where there is adequate separation between the line side terminals of the main protective device and the work location), calculations for incident energy and flash protection boundary shall include both the line and load side of the main breaker.
- I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.
- J. Mis-coordination should be checked amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.
- K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. Maximum clearing time will be capped at 2 seconds based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

2.6 REPORT SECTIONS

- A. Input data shall include, but not be limited to the following:
1. Feeder input data including feeder type (cable or bus), size, length, number per phase, conduit type (magnetic or non-magnetic) and conductor material (copper or aluminum).
 2. Transformer input data, including winding connections, secondary neutral-ground connection, primary and secondary voltage ratings, kVA rating, impedance, % taps and phase shift.
 3. Generation contribution data, (synchronous generators and Utility), including short-circuit reactance ($X''d$), rated MVA, rated voltage, three-phase and single line-ground contribution (for Utility sources) and X/R ratio.
 4. Motor contribution data (induction motors and synchronous motors), including short-circuit reactance, rated horsepower or kVA, rated voltage, and X/R ratio.
- B. Short-Circuit Output Data shall include, but not be limited to the following reports:
1. Low Voltage Fault Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
 - a. Voltage
 - b. Calculated fault current magnitude and angle
 - c. Fault point X/R ratio
 - d. Equivalent impedance
 2. Momentary Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
 - a. Voltage
 - b. Calculated symmetrical fault current magnitude and angle
 - c. Fault point X/R ratio
 - d. Calculated asymmetrical fault currents
 - 1) Based on fault point X/R ratio
 - 2) Based on calculated symmetrical value multiplied by 1.6
 - 3) Based on calculated symmetrical value multiplied by 2.7
 - e. Equivalent impedance
 3. Interrupting Duty Report shall include a section for three-phase and unbalanced fault calculations and shall show the following information for each applicable location:
 - a. Voltage
 - b. Calculated symmetrical fault current magnitude and angle
 - c. Fault point X/R ratio
 - d. No AC Decrement (NACD) Ratio
 - e. Equivalent impedance
 - f. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a symmetrical basis
 - g. Multiplying factors for 2, 3, 5 and 8 cycle circuit breakers rated on a total basis
- C. Recommended Protective Device Settings:
1. Phase and Ground Relays:
 - a. Current transformer ratio
 - b. Current setting
 - c. Time setting
 - d. Instantaneous setting
 - e. Recommendations on improved relaying systems, if applicable.

- 2. Circuit Breakers:
 - a. Adjustable pickups and time delays (long time, short time, ground)
 - b. Adjustable time-current characteristic
 - c. Adjustable instantaneous pickup
 - d. Recommendations on improved trip systems, if applicable.

D. Incident energy and flash protection boundary calculations

- 1. Arcing fault magnitude
- 2. Protective device clearing time
- 3. Duration of arc
- 4. Arc flash boundary
- 5. Working distance
- 6. Incident energy
- 7. Hazard Risk Category
- 8. Recommendations for arc flash energy reduction

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

- A. The contractor shall adjust relay and protective device settings according to the recommended settings table provided by the coordination study.
- B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.
- C. Notify design engineer in writing of any required major equipment modifications.

3.2 ARC FLASH WARNING LABELS

- A. The contractor shall provide a 3.5 in. x 5 in. thermal transfer type label of high adhesion polyester for each work location analyzed.
- B. All labels will be based on recommended overcurrent device settings and will be provided after the results of the analysis have been presented to the owner and after any system changes, upgrades or modifications have been incorporated in the system.
- C. The label shall include the following information, at a minimum:
 - 1. Location designation
 - 2. Nominal voltage
 - 3. Flash protection boundary
 - 4. Hazard risk category
 - 5. Incident energy
 - 6. Working distance
 - 7. Engineering report number, revision number and issue date.
- D. Labels shall be machine printed, with no field markings.
- E. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
 - 1. For each 480 and applicable 208 volt panelboard, one arc flash label shall be provided.

2. For each motor control center, one arc flash label shall be provided.
3. For each low voltage switchboard, one arc flash label shall be provided.
4. For each switchgear, one flash label shall be provided.
5. For medium voltage switches one arc flash label shall be provided

F. Labels shall be field installed by the contractor.

END OF SECTION 26 0573

SECTION 26 0923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SUMMARY	1
1.3 REFERENCES	1
1.4 DEFINITIONS	2
1.5 SUBMITTALS	2
1.6 QUALITY ASSURANCE	3
1.7 COORDINATION	3
1.8 DELIVERY, STORAGE, AND HANDLING	3
PART 2 - PRODUCTS	3
2.1 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS	3
2.2 TIME CONTROLLERS	3
2.3 OUTDOOR PHOTOELECTRIC CONTROL	4
2.4 OCCUPANCY SENSORS	4
2.5 LIGHTING CONTACTORS	6
PART 3 - EXECUTION	6
3.1 LIGHTING CONTACTOR INSTALLATION	6
3.2 OUTDOOR PHOTOELECTRIC CONTROL INSTALLATION	6
3.3 TIME CONTROLLER INSTALLATION	7
3.4 OCCUPANCY SENSOR INSTALLATION	7
3.5 WIRING INSTALLATION	7
3.6 IDENTIFICATION	7
3.7 FIELD QUALITY CONTROL	8
3.8 ADJUSTING	8

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following lighting control devices:

1. Time controllers.
2. Outdoor photoelectric control.
3. Occupancy sensors.
4. Outdoor motion sensors.
5. Lighting contactors.

- B. Related Sections include the following:

1. Division 26 Section "Electrical General Requirements".
2. Division 26 Section "Wiring Devices" for wall-box dimmers and manual light switches.

1.3 REFERENCES

- A. IEEE C62.41: Guide for Surge Voltages in Low-Voltage AC Power Circuits.

- B. IEEE C136.10: Standard for Roadway Lighting Equipment Locking-Type Photocontrol Devices and Mating Receptacle Physical and Electrical Interchangeability and Testing.
- C. NEMA ICS 2: Industrial Control and Systems Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC Part 8: Disconnect Devices for Use in Industrial Control Equipment.
- D. NFPA 70: National Electrical Code.
- E. UL 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.
- F. UL 486B: Wire Connectors for Use with Aluminum Conductors.
- G. UL 773: Plug-in, Locking Photocontrols for Use with Area Lighting.
- H. UL 773A: Nonindustrial Photoelectric Switches for Lighting Control.
- I. UL 917: Clock Operated Switches.
- J. UL 1449: Transient Voltage Surge Suppressors.
- K. UL 1598: Luminaires.
- L. NECA 130-2010: Installing and Maintaining Wiring Devices.

1.4 DEFINITIONS

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.
- C. ULTRASONIC: Active emission of at least 35 kHz sound waves, using Doppler reflectance to detect motion.
- D. MICROPHONIC: Passive reception to listen for continued occupancy, with circuitry to filter out white noise.
- E. MULTI-Tech: Using PIR and ultrasonic or microphonic technologies in one sensor.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated including physical data and electrical performance.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
 - 1. Lighting plan showing location, orientation, and coverage area of each sensor.
 - 2. Interconnection diagrams showing field-installed wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. Include the following:
 - 1. Description of operation and servicing procedures.
 - 2. List of major components.
 - 3. Recommended spare parts.

4. Programming instructions and system operation procedures.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.7 COORDINATION

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
- B. Coordinate interface of lighting control devices with temperature controls specified in Division 23

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the site under provisions of Division 26 Section "Electrical General Requirements".
- B. Store and protect products under provisions of Division 26 Section "Electrical General Requirements".

PART 2 - PRODUCTS

2.1 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS

- A. Line-Voltage Surge Protection: An integral part of the devices for 120- and 277-V solid-state equipment. For devices without integral line-voltage surge protection, field-mounting surge protection shall comply with IEEE C62.41 and with UL 1449.

2.2 TIME CONTROLLERS

- A. Manufacturers:
 1. Intermatic, Inc.
 2. TORK.
- B. General
 1. Provide NEMA Type 1-general purpose steel enclosure with corrosion-resistant primer and baked enamel finish in manufacturer's standard color.
 2. Provide enclosure suitable for surface mounting with hinged front; padlock hasp; and side, bottom, and back knockouts for conduit connections.
 3. Provide heavy-duty pressure terminals suitable for wire sizes up to no. 8 AWG.
- C. Electromechanical-Dial Time Controller: Type complying with UL 917.
 1. Contact Configuration: SPST.
 2. Contact Rating: 40 amperes tungsten, 120-277 V ac.
 3. Input Voltage: As indicated.

4. Program: 24 hour dial, which can perform a minimum of 10 On/Off operations within a 24-hour period. Provide a minimum of 1 hour setting for ON or OFF operations and maximum ON time of 20 hours.

- a. Circuitry: Allow connection of a photoelectric relay as substitute for on and off function of a program.

2.3 OUTDOOR PHOTOELECTRIC CONTROL

A. Manufacturers:

1. Intermatic, Inc.
2. Square D.
3. TORK.

B. General

1. Provide fully-gasketed, weathertight enclosure constructed of die cast zinc, with one-half inch conduit nipple for mounting purposes, and with positioning lug to permit full 360-degree adjustable orientation of photocell.
2. Provide hermetically-sealed, one-inch-diameter, cadmium sulphide photoelectric cell with manual, light level selector.
3. Provide photoelectric control suitable for an operating temperature range of minus 40 degrees F to plus 140 degrees F.

C. Description: Solid state, with SPST dry contacts rated for load, to operate connected load, relay, contactor coils, or microprocessor input, and complying with UL 773A.

1. Light-Level Monitoring Range: Adjustable turn-on range of 1 to 5 fc (11 to 54 lux) and adjustable turn-off range of 3 to 15 fc (32 to 1662 lux).
2. Time Delay: Adjustable delay up to two minutes to prevent false operation.
3. Contacts: Normally closed, fail on.
4. Electrical: Provide photocell with operating voltage rated to switch the load directly unless otherwise indicated.
5. Surge Protection: Metal-oxide varistor type, complying with IEEE C62.41 for Category A1 locations.
6. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the North sky exposure.
7. Provide hermetically-sealed, one inch diameter, cadmium sulphide photoelectric cell with manual, 2 to 50 footcandle, light level selector.

2.4 OCCUPANCY SENSORS

A. General

1. Coordinate occupancy sensor locations, coverages and required quantities with manufacturer's recommendations. Coverage areas indicated on the Drawings are for minor motion (6 to 8 inches of hand movement). Provide additional occupancy sensors and control units as required to achieve complete minor motion coverage of the space indicated.
2. Adjust occupancy sensors and test that complete minor motion coverage is obtained in accordance with Part 3. Provide written confirmation of testing to owner, architect and engineer.
3. Provide occupancy sensors with a bypass switch to override the "ON" function in the event of sensor failure.
4. Provide occupancy sensors with an LED indicator indicating when motion is being detected during testing and normal operation of the sensor.
5. Provide occupancy sensors and occupancy sensor control units from single manufacturer.

B. Wall Switch Passive Infrared Occupancy Sensor

1. Manufacturers:
 - a. Perfect Sense – PS-PWS
 - b. Wattstopper PW-100.
 - c. Hubbell Building Automation SOM 101.
 - d. Greengate OSW-P-0451-W.
 - e. Sensorswitch WSD.
 - f. Philips LRS2210.
 - g. Leviton ODS10-IDW.
2. Description: Wall mounted, 180° coverage, passive infrared sensing occupancy sensor.
 - a. Electrical Characteristics: Capable of switching up to 800W fluorescent or incandescent lighting loads at 120V and 1200 watts fluorescent loads at 277V.
 - b. Functions: Automatic ON/Automatic OFF, or Manual ON/Automatic OFF operation, field selectable. Integral manual override pushbutton switch.
 - c. Adjustments: User adjustable sensitivity and time delay. Time delay shall be adjustable from 30 seconds to 30 minutes.
 - d. Device Body: White, plastic with momentary on/off override pushbutton designed to mount in a standard switch box with “decora” style switch plate.
3. Dual Level Switching: Provide occupancy sensor capable of controlling two switch legs independently where dual level switching is indicated.
 - a. Manufacturers:
 - 1) Perfect Sense PWD.
 - 2) Wattstopper PW-200.
 - 3) Hubbell Building Automation SOM-102.
 - 4) Greengate OSW-P-0451-DMV.
 - 5) Sensorswitch WSD-2P.
 - 6) Philips LRS2215.
 - 7) Leviton ODSOD-IDW.

C. 360° Ceiling Mounted Dual Technology Occupancy Sensor

1. Manufacturers:
 - a. Perfect Sense CDS.
 - b. Wattstopper DT 300
 - c. Hubbell Building Automation “OMNI-DT” Series.
 - d. Greengate OMC-DT-2000-R.
 - e. Sensorswitch CM-PDT-R.
 - f. Philips LRM2255.
 - g. Leviton OSC10-M0W.

D. Occupancy Sensor Control Units:

1. Description: Transformer and relay combined in single unit to provide 24DC power to sensors and provide 20A contact(s) for control of lighting loads at 120 or 277V. Control unit input power shall be from unswitched leg of lighting circuit it is controlling.
 - a. Control units shall be provided as required to power ceiling mounted occupancy sensors, control lighting loads and provide a minimum of one auxiliary contact.
 - b. Occupancy sensor control units shall mount external to 4” sq junction box in the ceiling space. Wiring between control unit and occupancy sensor shall be plenum rated.

- c. Locate control unit in accessible location in gyp-board ceilings, adjacent to return air grilles, or provide access panel.
- d. Additional auxiliary relay modules shall be provided as required to provide control of all lighting circuits and additional auxiliary contacts as required.
- e. It is acceptable to provide controls and auxiliary contacts as required integral to the ceiling sensor, provided all required contacts are provided.
- f. Maximum of 3 sensors per power pack. Verify exact quantities required with manufacturer.

2.5 LIGHTING CONTACTORS

A. Manufacturers:

- 1. Cutler-Hammer; Eaton Corporation.
- 2. Square D Co.
- 3. General Electric.
- 4. Siemens.
- 5. Square D Co; class 8903.

B. Contactor

- 1. Electrically-operated mechanically-held, per NEMA ICS2, with 120 volt, 60 hertz coil and 240 volt, 60 hertz, 30 ampere contacts with number of poles indicated.
- 2. Provide contacts to be 100 percent, continuously rated for all types of ballast and tungsten lighting and resistance loads without the need for in-rush current derating.
- 3. Provide NEMA type 1 enclosure unless otherwise indicated.
- 4. Provide NEMA type 1 hinged cover cabinet enclosure sized as required for contactors as indicated on drawings. Mount switches and indicating lights required on front of enclosure. Install terminal strips for connection of all external control wiring connections.
- 5. Provide solderless pressure wire terminals.
- 6. Provide corrosion-resistant primer treatment with light gray baked acrylic enamel finish.
- 7. Provide the following control and indicating devices:
 - a. Auxiliary contacts: One field convertible.
 - b. Auxiliary relay to convert maintained-contact type control circuit to momentary-contact type control circuit necessary for contactor control.
 - c. Green pilot light to indicate "power on" condition. Mount on front cover with legend plate.

PART 3 - EXECUTION

3.1 LIGHTING CONTACTOR INSTALLATION

- A. Install lighting contactors as indicated on plan. Install at accessible locations. Switch controls where provided shall be no higher than 54" or lower than 48".
- B. Demonstrate proper operation of all lighting control functions to the Owner and Engineer.

3.2 OUTDOOR PHOTOELECTRIC CONTROL INSTALLATION

- A. Mount photocell on roof or parapet to ½" GRS conduit, supported to building structure below. Coordinate roof penetration with roofing contractor.
- B. Install photoelectric control oriented in the northeast direction and not within any potential shadows.

- C. Adjust photocell sensitivity and delay to meet owner's requirements. Multiple adjustments may be required, as needed.

3.3 TIME CONTROLLER INSTALLATION

- A. Install time controller, near contactor control equipment or as indicated on plan. Install at accessible location.
- B. Program time controller as directed by the owner. Train owner in time clock programming.

3.4 OCCUPANCY SENSOR INSTALLATION

- A. Install wall mounted occupancy sensors as noted on plan. Arrange occupancy sensors with adjacent switch devices so that device plates line-up and are equally spaced.
- B. Install ceiling mounted sensors at approximate locations as indicated on plan. Sensor manufacturer shall provide quantity of sensors as required to provide complete coverage for rooms.
- C. Locate sensors such that motion through open doors will not falsely activate sensors.
- D. Do not locate ultrasonic sensors within six feet of supply air diffusers.
- E. Locate infrared sensors to avoid obstructions.
- F. Provide the services of a manufacturer's representative for commissioning of occupancy sensor installation. This shall include consultation on layout and location prior to installing sensors, testing of each sensor for compliance with Contract Documents and field adjustment and fine tuning after installation is complete. Provide written confirmation of testing to the Owner, Architect and Engineer.
- G. Field adjustments shall take place in the presence of the owner and the engineer. This shall include owner training on adjustment techniques for the occupancy sensors.

3.5 WIRING INSTALLATION

- A. Wiring Method: Comply with Division 26 Section "Conductors and Cables".
- B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.6 IDENTIFICATION

- A. Identify components and power and control wiring according to Division 26 Section "Electrical Identification."

- B. Label time switches and contactors with a unique designation.

3.7 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
 - 2. Operational Test: Verify actuation of each sensor and adjust time delays.
- B. Remove and replace lighting control devices where test results indicate that they do not comply with specified requirements.
- C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.8 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose.

END OF SECTION 26 0923

SECTION 26 0999 - ELECTRICAL TESTING

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SECTION INCLUDES	1
1.3 REFERENCES	2
1.4 QUALIFICATIONS	2
1.5 PERFORMANCE REQUIREMENTS	2
1.6 TEST INSTRUMENT CALIBRATION	3
1.7 TEST REPORTS	4
PART 2 - PRODUCTS	4
PART 3 - EXECUTION	4
3.1 THERMOGRAPHIC SURVEY	4

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. Section 019100- Commissioning
 - 2. Section 017823 - Operation and Maintenance Manual
 - 3. Division 26 Section "Electrical General Requirements."
 - 4. Division 26 Section "Conductors and Cables."
 - 5. Division 26 Section "Grounding and Bonding."
 - 6. Division 26 Section "Enclosed Switches."
 - 7. Division 26 Section "Enclosed Controllers."
 - 8. Division 26 Section "Surge Protective Devices."
 - 9. Division 26 Section "Switchgear."
 - 10. Division 26 Section "Switchboards."
 - 11. Division 26 Section "Panelboards."
 - 12. Division 26 Section "Dry Type Transformers (600V and Less)."
 - 13. Division 26 Section "Fuses."

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
 2. American Society for Testing and Materials - ASTM
 3. Institute of Electrical and Electronic Engineers - IEEE
 4. InterNational Electrical Testing Association - NETA Acceptance Testing Specifications - ATS-1996
 5. InterNational Electrical Testing Association - NETA Maintenance Testing Specifications-MTS-1997
 6. American National Standards Institute - ANSI C2: National Electrical Safety Code
 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
 - d. ANSI/NFPA 101: Life Safety Code

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.
 6. Power Plus Engineering, Inc. Phone (248) 344-0200.

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.
 - b. Accident Prevention Manual for Industrial Operations, National Safety Council.
 - c. Applicable state and local safety operating procedures.
 - d. NETA Safety/Accident Prevention Program.
 - e. Owner's safety practices.
 - f. National Fire Protection Association - NFPA 70E.
 - g. American National Standards for Personnel Protection.
 - 2. All tests shall be performed with apparatus de-energized except where otherwise specifically required.
 - 3. The testing organization shall have a designated safety representative on the project to supervise operations with respect to safety.

1.6 TEST INSTRUMENT CALIBRATION

- A. Test Instrument Calibration
 - 1. The testing firm shall have a calibration program, which assures that all applicable test instruments are maintained within rated accuracy.
 - 2. The accuracy shall be directly traceable to the National Institute of Standards and Technology.
 - 3. Instruments shall be calibrated in accordance with the following frequency schedule:
 - a. Field instruments: Analog - 6 months maximum Digital - 12 months maximum
 - b. Laboratory instruments: 12 months
 - c. Leased specialty equipment: 12 months
(Where accuracy is guaranteed by Lessor)
 - 4. Dated calibration labels shall be visible on all test equipment.
 - 5. Records must be kept up-to-date which show date and results of instruments calibrated or tested.
 - 6. An up-to-date instrument calibration instruction and procedures shall be maintained for each test instrument.
 - 7. Calibrating standard shall be of higher accuracy than that of the instrument tested.
- B. Field Test Instrument Standards
 - 1. All equipment used for testing and calibration procedures shall exhibit the following characteristics:
 - a. Maintained in good visual and mechanical condition.
 - b. Maintained in safe, operating condition.
- C. Suitability of Test Equipment

1. All test equipment shall be in good mechanical and electrical condition.
2. Selection of metering equipment should be based on knowledge of the waveform of the variable being measured. Digital multi-meters may be average of RMS sensing and may include or exclude the dc component. When the variable contains harmonics of dc offset and, in general, any deviation from a pure sine wave, average sensing, average measuring RMS scaled meters may be misleading. Use of RMS measuring meters is recommended.
3. Field test metering used to check power system meter calibration must have any accuracy higher than that of the instrument being checked.
4. Accuracy of metering in test equipment shall be appropriate for the test being performed.
5. Waveshape and frequency of test equipment output waveforms shall be appropriate for the test and tested equipment.

1.7 TEST REPORTS

- A. A test report shall be generated for each piece of major equipment or groups of equipment and shall include the following:
 1. A list of visual and mechanical inspections required by Division 26 Specification Sections in a checklist or similar format.
 2. Test reports, including test values where applicable, for all required electrical tests. Clearly indicate where test values fall outside of the limits of recommended values.
 3. Summary and interpretation of test results detailing problems located and recommended corrective measures.
 4. Record of infrared scan and photos showing potential problem locations.
 5. Signed and dated by the testing firm field superintendent stating that all required tests have been completed.
- B. Test reports shall be furnished to the Architect/Engineer within 14 days of the completion each test on an ongoing basis. Original copies of the reports shall be furnished directly to the Architect/Engineer by the testing company prior to formal submittal via the Contractors.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 THERMOGRAPHIC SURVEY

- A. Visual and Mechanical Inspection
 1. Remove all necessary covers prior to scanning.
 2. Inspect for physical, electrical, and mechanical condition.
- B. Equipment to be Scanned
 1. All components of the distribution system down to and including branch circuit panelboards and motor control centers. Return 3 months after equipment has been energized and loaded to do a final scan of all equipment.
- C. Provide report indicating the following:
 1. Problem area (location of "hot spot").
 2. Temperature rise between "hot spot" and normal or reference area.

3. Cause of heat rise.
4. Phase unbalance, if present.
5. Areas scanned.

D. Test Parameters

1. Scanning distribution system with ability to detect 1°C between subject area and reference at 30°C.
2. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
3. Infrared surveys should be performed during periods of maximum possible loading but not less than twenty percent (20%) of rated load of the electrical equipment being inspected.

E. Test Results

1. Interpretation of temperature gradients requires an experienced technician. Some general guidelines are:
 - a. Temperature gradients of 37°F to 44.6°F indicate possible deficiency and warrant investigation.
 - b. Temperature gradients of 37°F to 59°F indicate deficiency; repair as time permits.
 - c. Temperature gradients of 61°F and above indicate major deficiency; repair immediately.

END OF SECTION 26 0999

SECTION 26 2200 - DRY-TYPE TRANSFORMERS (600 V AND LESS)

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SUMMARY	1
1.3 REFERENCES	1
1.4 SUBMITTALS	2
1.5 QUALITY ASSURANCE	3
1.6 DELIVERY, STORAGE, AND HANDLING	3
1.7 COORDINATION	3
PART 2 - PRODUCTS	4
2.1 MANUFACTURERS	4
2.2 MATERIALS	4
2.3 DISTRIBUTION TRANSFORMERS	4
2.4 CONTROL AND SIGNAL TRANSFORMERS	5
2.5 SOURCE QUALITY CONTROL	5
PART 3 - EXECUTION	5
3.1 EXAMINATION	5
3.2 INSTALLATION	6
3.3 CONNECTIONS	6
3.4 FIELD QUALITY CONTROL	6
3.5 ADJUSTING	7

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 750 kVA:
1. Distribution transformers.
 2. Control and signal transformers.
- B. Related Section includes the following:
1. Division 26 Section "Electrical General Requirements."
 2. Division 26 Section "Grounding and Bonding."
 3. Division 26 Section "Conductors and Cables."
 4. Division 26 Section "Raceways and Boxes."

1.3 REFERENCES

- A. ANSI/IEEE C57.12.9: Test Code for Dry-Type Distribution and Power Transformers
- B. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum)
- C. NEMA ST 1: Specialty Transformers

- D. NEMA ST 20: Dry Type Transformers for General Applications
- E. NEMA TP 1: Guide for Determining Energy Efficiency for Distribution Transformers
- F. NEMA TP 2: Standard Test Method for Measuring the Energy Consumption of Distribution Transformers
- G. NETA ATS: Acceptable Testing Specifications for Electrical Power Distribution Equipment and Systems
- H. NFPA 70: National Electrical Code
- I. UL 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors
- J. UL 486B: Wire Connectors for Use with Aluminum Conductors
- K. UL 506: Specialty Transformers
- L. UL 1561: Dry-Type General Purpose and Power Transformers

1.4 SUBMITTALS

- A. Product Data Include rated nameplate data, capacities, weights, dimensions, utility or manufacturer's anchorage and base recommendations, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.
 - 1. Transformer Inrush: Provide time-current coordination curves demonstrating transformer inrush and ANSI damage curves with primary overcurrent device selections to clear inrush yet still protecting damage curve.
- B. Shop Drawings: Wiring and connection diagrams.
- C. Manufacturer Seismic Qualification Certification: Submit certification that transformer assembly and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems " Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Qualification Data: Testing agency.
- E. Source quality-control test reports. Include loss data, efficiency at 25, 50, 75 and 100 percent rated load, and sound level.
- F. Output Settings Reports: Record of tap adjustments specified in Part 3.

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 or is a nationally recognized testing laboratory (NRTL) as defined in OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Transformer Inrush: Provide time-current coordination curves demonstrating transformer inrush and ANSI damage curves with primary overcurrent device selections to clear inrush yet still protecting damage curve.
 - 2. 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 onsite testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with IEEE C 57.12.91.
- D. Comply with NFPA 70.
- E. Energy-Efficient Transformers Rated 15 kVA and Larger: Certified as meeting NEMA TP 1, Class 1 efficiency levels when tested according to NEMA TP 2.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.
- B. Store, protect, and handle products to site under provisions of Division 26 section "Electrical General Requirements."
- C. Deliver transformers individually wrapped for protection and mounted on shipping skids.
- D. Accept transformers on site. Inspect for damage.
- E. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- F. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to transformer internal components, enclosure, and finish.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork shall meet load requirements. Requirements for concrete bases for electrical equipment are specified in Division 26 "Hangers and Supports for Electrical Systems."
- B. Coordinate installation of wall-mounting and structure-hanging supports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cutler-Hammer.
2. GE Electrical Distribution & Control.
3. Siemens Industries, Inc.
4. Square D/Groupe Schneider NA.

2.2 MATERIALS

- A. Cores: Grain-oriented, non-aging silicon steel.
- B. Coils: Continuous windings without splices, except for taps.
1. Internal Coil Connections: Brazed or pressure type.
 2. Coil Material: Copper.
- C. Vibration Isolation: Isolate core and coil from enclosure using vibration-absorbing mounts.
- D. Grounding: Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

2.3 DISTRIBUTION TRANSFORMERS

- A. Description: Factory-assembled and tested, air cooled, dry-type transformer rated for 60 Hz operation. Comply with NEMA ST 20, and list and label as complying with UL 1561.
- B. Provide transformers with base KVA as indicated without the use of internal cooling fans.
- C. Provide transformers that are internally braced to withstand seismic forces specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems".
- D. Cores: One leg per phase.
- E. Indoor Enclosure: Ventilated, NEMA 250, Type 2. Provide lifting eyes or brackets.
- F. Indoor Transformer Enclosure Finish: Comply with NEMA 250 for "[Indoor] [Outdoor] Corrosion Protection."
1. Finish Color: Gray.
- G. Insulation Class (15 kVA and larger): 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature TP-1 compliant.
- H. Insulation Class (less than 15 kVA): 185 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- I. Basic Impulse Level: 10 kV.
- J. Taps for Transformers Smaller Than 3 kVA: None.

- K. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.
- L. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.
- M. Case Temperature: Do not exceed 35 degrees C rise above ambient at warmest point.
- N. Mounting: Suitable for mounting as indicated.
- O. Wall Brackets: Manufacturer's standard brackets.
- P. Nameplate: Include transformer connection data and overload capacity based on rated allowable temperature rise.

2.4 CONTROL AND SIGNAL TRANSFORMERS

- A. Description: Factory-assembled and tested, self-cooled, two-winding dry type, rated for continuous duty, and 60 Hz operation, complying with NEMA ST 1, and listed and labeled as complying with UL 506.
- B. Ratings: Continuous duty. If rating is not indicated, provide at least 50 percent spare capacity above connected peak load.

2.5 SOURCE QUALITY CONTROL

- A. Test and inspect transformers according to IEEE C57.12.91.
- B. Provide the following factory tests on each unit provided in accordance with NEMA ST 20:
 - 1. Voltage ratio.
 - 2. Polarity and phase relation.
 - 3. No load losses.
 - 4. Impedance (501 kVA and larger).
 - 5. Applied and induced potential.
- C. Provide the factory tests on the actual transformers provided or on similar units identical to those provided in accordance with NEMA ST 20:
 - 1. Impedance (less than 501 kVA).
 - 2. Temperature rise.
 - 3. Audible sound level.
 - 4. Full load losses.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

- C. Examine walls and floors for suitable mounting conditions where transformers will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install Products in accordance with manufacturer's instructions.
- B. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
 - 1. Brace wall-mounting transformers as specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- C. Install floor mounted transformers on and anchor to concrete bases according to manufacturer's recommendations, seismic codes at Project, and requirements in Division 26 section "Vibration and Seismic Controls for Electrical Systems."
 - 1. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.
- D. Identification: Engraved metal or laminated-plastic nameplate mounted with corrosion resistant screws. Provide nameplate according to Division 26 Section "Electrical Identification" indicating the following:
 - 1. Transformer designation (e.g. "T-1").
 - 2. Primary power characteristics (e.g. "480V, 3PH, 3W").
 - 3. Secondary power characteristics (e.g. "208Y/120V, 3PH, 4W").
 - 4. Power rating (e.g. "75 kVA").
 - 5. Power source (e.g. "Fed from DP-1).

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."
- C. Provide conduit according to Division 26 Section "Raceways and Boxes" for connections to transformer case. Make conduit connections to side panel of enclosure.
- D. 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.
- E. Check for damage and tighten connections prior to energizing transformer.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.
 - 1. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. Testing: Perform the following field quality control tests in accordance with Division 26 section "Electrical Testing" for transformers 75KVA and above:

1. Visual and Mechanical Inspection

- a. Inspect for physical damage, cracked insulators, tightness of connections, defective wiring and general mechanical and electrical conditions.
- b. Verify proper core grounding.
- c. Verify proper equipment grounding.
- d. Compare equipment nameplate with single line diagram and report discrepancies.

2. Electrical Tests

- a. Perform insulation resistance tests, winding-to-winding and windings-to-ground, utilizing a meg-ohmmeter with test voltage output in accordance with N.E.T.A. Acceptance Testing Specifications, Table 10.5. Test duration shall be for 10 minutes with resistance values tabulated at 30 seconds, 1 minute, and 10 minutes. Calculate Polarization index.
- b. Perform a turns ratio test between windings at every tap position. The final tap setting is to be set at the secondary system rated voltage at full load or as directed by the Architect/Engineer.
- c. Verify proper secondary voltage phase-to-phase and phase-to-neutral after energization and prior to loading.
- d. Test mounting and anchorage devices according to requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

3. Test Values

- a. Perform insulation resistance tests in accordance with N.E.T.A. Acceptance Testing Specifications, Table 10.5. Results to be temperature corrected in accordance with Table 10.14.
- b. The polarization index should be above 1.2 unless an extremely high value is obtained initially, such that when doubled will not yield a meaningful value.
- c. Turns ratio test results shall not deviate more than one half percent (0.5%) from either the adjacent coils or the calculated ratio.

3.5 ADJUSTING

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 5 percent. Submit recording and tap settings as test results.
- B. Adjust buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.
- C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

END OF SECTION 26 2200

SECTION 26 2413 - SWITCHBOARDS

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 DELIVERY, STORAGE, AND HANDLING	3
1.7 PROJECT CONDITIONS	3
1.8 COORDINATION	3
1.9 EXTRA MATERIALS	4
PART 2 - PRODUCTS	4
2.1 MANUFACTURERS	4
2.2 MANUFACTURED UNITS	4
2.3 SURGE PROTECTIVE DEVICES	5
2.4 OVERCURRENT PROTECTIVE DEVICES	5
2.5 INSTRUMENTATION	6
2.6 ACCESSORY COMPONENTS AND FEATURES	6
PART 3 - EXECUTION	7
3.1 PROTECTION	7
3.2 EXAMINATION	7
3.3 INSTALLATION	7
3.4 ADJUSTING	7
3.5 IDENTIFICATION	7
3.6 FIELD QUALITY CONTROL	7
3.7 CLEANING	8
3.8 DEMONSTRATION	8

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 service and distribution switchboards rated 600 V and less.

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 switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions, utility or manufacturer's anchorage and base recommendations, 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 switchboard and related equipment.
 - 1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. 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 switchboards and overcurrent protective devices.
 - d. Descriptive documentation of optional barriers specified for electrical insulation and isolation if specified.
 - e. Utility company's metering provisions with indication of approval by utility company if called out.
 - f. 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. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1, include the following:
 - 1. Routine maintenance requirements for switchboards and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 3. 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 to supervise on-site testing specified in Part 3.
- B. Source Limitations: Obtain switchboards through one source from a single manufacturer.

- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- 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 2, "Deadfront Distribution Switchboards."
- F. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver in sections or lengths that can be moved past obstructions in delivery path.
- B. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- C. Handle switchboards according to NEMA PB 2.1 and NECA 400.

1.7 PROJECT CONDITIONS

- A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.
- B. 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.
- 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 Construction Manager no fewer than seven days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without Construction Manager's written permission.

1.8 COORDINATION

- A. Coordinate layout and installation of switchboards and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork shall meet load requirements. Requirements for concrete bases for electrical equipment are specified in Division 26 "Hangers and Supports for Electrical Systems."

1.9 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. Potential Transformer Fuses: 2 of each size and type.
 - 2. Control-Power Fuses: 2 of each size and type.
 - 3. Fuses for Fused Switches: Equal to 10 percent of amount installed for each size and type, but no fewer than 3 of each size and type.
 - 4. Indicating Lights: 3 of each size and type.

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 MANUFACTURED UNITS

- A. Manufacturers:
 - 1. Eaton Corporation; Cutler-Hammer Products.
 - 2. General Electric Co.; Electrical Distribution & Protection Div.
 - 3. Siemens Industries, Inc.
 - 4. Square D.
- B. Front-Connected, Front-Accessible Switchboard:
 - 1. Main devices over 1200A: Fixed, individually mounted.
 - 2. Main devices below 1200A, panel mounted.
 - 3. Branch Devices: panel-mounted.
 - 4. Sections rear aligned.
- C. Nominal System Voltage: As noted on Drawings.
- D. Main-Bus Continuous: As noted on Drawings.
- E. Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- F. Enclosure: Steel, NEMA 250, Type 1 not over 102 in height.
- G. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray, finish over a rust-inhibiting primer on treated metal surface.
- H. Insulation and isolation for main and vertical buses of feeder sections.
- I. Utility Metering Compartment: Fabricated compartment and section complying with utility company's requirements. If separate vertical section is required for utility metering, match and align with basic switchboard.

- J. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.
- K. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.
- L. Buses and Connections: Three phase, four wire, unless otherwise indicated.
 - 1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity with feeder circuit-breaker line connections.
 - 2. Phase- and Neutral-Bus Material: Tin-plated, high-strength, electrical-grade aluminum alloy with copper- or tin-plated, aluminum circuit-breaker line connections.
 - a. If bus is aluminum, use copper- or tin-plated aluminum for circuit-breaker line connections.
 - b. If bus is copper, use copper for feeder circuit-breaker line connections.
 - 3. Ground Bus: 1/4-by-2-inch- minimum-size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
 - 4. Contact Surfaces of Buses: Silver plated.
 - 5. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
 - 6. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
 - 7. Neutral Buses: 100 percent of the ampacity of phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.
- M. Future Devices: Equip compartments with mounting brackets, supports, bus connections, and appurtenances at full rating of circuit-breaker compartment.

2.3 SURGE PROTECTIVE DEVICES

- A. Direct bus connected type as specified in Division 26 Section "Surge Protective Devices."
- B. Provide Surge Protective Device for switchboards that are part of the emergency distribution system.
- C. Provide Surge Protective Device for switchboards elsewhere where indicated on the drawings.

2.4 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: NEMA AB 3, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits.
 - 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 material.
 - 2. Application Listing: Appropriate for application; Type HACR for heating, air-conditioning, and refrigerating equipment.
 - 3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

C. Circuit breaker selection for transformer primary protection:

1. Circuit Breaker Selection for Transformer Primary Protection: Provide circuit breakers with time-current characteristics to clear transformer inrush currents while still providing protection for the ANSI through-fault protection curve. Provide circuit breakers with adjustable magnetic trip or electronic trip units as necessary to provide time-current curve shaping to achieve long time trip indicated on drawings, inrush coordination and damage protection.

2.5 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:

1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
2. Current Transformers: Ratios shall be as indicated with accuracy class and burden suitable for connected relays, meters, and instruments.
3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kV.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:
 - a. Phase Currents, Each Phase: Plus or minus 1 percent.
 - b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
 - c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
 - d. Megawatts: Plus or minus 2 percent.
 - e. Megavars: Plus or minus 2 percent.
 - f. Power Factor: Plus or minus 2 percent.
 - g. Frequency: Plus or minus 0.5 percent.
 - h. Megawatt Demand: Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.
 - i. Accumulated Energy, Megawatt Hours: Plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.
2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

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.
- B. Furnish portable test set to test functions of solid-state trip devices without removal from switchboard. Include relay and meter test plugs suitable for testing switchboard meters and switchboard class relays.
- C. Spare-Fuse Cabinet: Suitably identified, wall-mounted, lockable, compartmented steel box or cabinet. Arrange for wall mounting.

PART 3 - EXECUTION

3.1 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.2 EXAMINATION

- A. Examine elements and surfaces to receive switchboards for compliance with installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

- A. Install switchboards and accessories according to NEMA PB 2.1 and NECA 40.
- B. Install switchboards and anchor to concrete bases according to utility or manufacturer's recommendations, seismic codes at Project, and requirements in Division 26 Section "Hangers and Supports for Electrical Systems."
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.
- D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.
- E. Install overcurrent protective devices, transient voltage suppression devices, and instrumentation.
 - 1. Set field-adjustable switches and circuit-breaker trip ranges.

3.4 ADJUSTING

- A. Adjust circuit breaker trip and time delay settings to values as instructed by the Engineer.

3.5 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."
- B. Switchboard Nameplates: Label each switchboard compartment with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.6 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:

1. Test insulation resistance for each switchboard 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, Sections 7.1, 7.5, 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate. Certify compliance with test parameters.
 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Instruments, Equipment, and Reports:
 - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 2) Prepare a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.7 CLEANING

- A. On completion of installation, inspect interior and exterior of switchboards. 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.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION 26 2413

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	5
2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS	5
2.5 OVERCURRENT PROTECTIVE DEVICES	5
2.6 ACCESSORY COMPONENTS AND FEATURES	5
PART 3 - EXECUTION	5
3.1 INSTALLATION	5
3.2 IDENTIFICATION	6
3.3 CONNECTIONS	6
3.4 FIELD QUALITY CONTROL	6
3.5 CLEANING	7

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

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. GFEP: Ground-fault equipment protection.
- D. AFCI: Arc-fault circuit interrupter.
- E. RFI: Radio-frequency interference.

- F. RMS: Root mean square.
- G. 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 Construction Manager no fewer than seven days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Construction Manager'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.
- b. General Electric Co.; Electrical Distribution & Protection Div.
- c. Siemens Industries, Inc.
- d. Square D.

2.2 MANUFACTURED UNITS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- B. Enclosures: Mounting as noted on panel schedules. NEMA PB 1, Type 1.
 1. Rated for environmental conditions at installed location.
 - a. Outdoor Locations: NEMA 250, Type 3R.
 - b. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 2. Cabinet Front: Flush or surface cabinet as noted on the Drawings.
 - a. Eaton – LT Trim with Door in Door Design, piano hinge on outer door.
 - b. Siemens – Figure 4 hinge to box w/piano hinge.
 - c. GE – FGB (front hinge to box).
 - d. Square D – Continuous piano hinge trim.
 3. Finish: Manufacturer's standard enamel finish over corrosion-resistant treatment or primer coat.
 4. Directory Card: With transparent protective cover, mounted in metal frame, inside panelboard door.
- C. Phase and Ground Buses:
 1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
- D. Conductor Connectors: Suitable for use with conductor material.
 1. Main and Neutral Lugs: Mechanical type.
 2. Ground Lugs and Bus Configured Terminators: Compression type.
 3. Feed-Through Lugs: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 4. Double Lugs: Mechanical type mounted at location of main incoming lugs.
- E. Service Equipment Label: UL labeled for use as service equipment for panelboards with main service disconnect switches.
- F. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.
- G. Surge Protective Devices: Where indicated, provide manufactured units with direct bus connected type as specified in Division 26 Section "Surge Protective Devices."
 1. Provide Surge Protective Device for all Distribution and Branch Circuit Panelboards that are part of the Emergency Distribution System.
 2. Provide Surge Protective Devices elsewhere where indicated on the drawings.

2.3 PANELBOARD SHORT-CIRCUIT RATING

- A. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Main bus bars, neutral and ground, shall be sized in accordance with U.L. Standards to limit temperature rise on any current carrying part to the maximums as indicated in UL67.
- B. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

2.5 OVERCURRENT PROTECTIVE DEVICES

- A. Molded-Case Circuit Breaker: NEMA AB 3, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits.
 - 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. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.
 - 3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - 4. Do not use tandem circuit breakers.
 - 5. Provide lock on devices for circuit breakers when called out on panel schedules with "LOD" designation.
- C. Circuit Breaker Selection for Transformer Primary Protection:
 - 1. Circuit Breaker Selection for Transformer Primary Protection: Provide circuit breakers with time-current characteristics to clear transformer inrush currents while still providing protection for the ANSI through-fault protection curve. Provide circuit breakers with adjustable magnetic trip or electronic trip units as necessary to provide time-current curve shaping to achieve long time trip indicated on drawings, inrush coordination and damage protection.

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. Stub four 1-inch empty conduits from recessed panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- H. 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 2726 - WIRING DEVICES

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SUMMARY	1
1.3 DEFINITIONS	1
1.4 REFERENCES	2
1.5 SUBMITTALS	2
1.6 QUALITY ASSURANCE	2
1.7 COORDINATION	2
PART 2 - PRODUCTS	3
2.1 RECEPTACLES	3
2.2 WALL SWITCHES	3
2.3 WALL PLATES	4
2.4 FLOOR SERVICE FITTINGS	4
2.5 FINISHES	4
PART 3 - EXECUTION	5
3.1 INSTALLATION	5
3.2 IDENTIFICATION	6
3.3 CONNECTIONS	6
3.4 FIELD QUALITY CONTROL	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. Single and duplex receptacles
 2. Ground-fault circuit interrupter receptacles
 3. Device wall plates.
 4. Access floor boxes

1.3 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. PVC: Polyvinyl chloride.
- D. RFI: Radio-frequency interference.
- E. SPD: Surge protective devices.
- F. UTP: Unshielded twisted pair.

- G. USB: Universal serial bus.

1.4 REFERENCES

- A. DSCC W-C-596G: Federal Specification Connector, Electrical, Power, General Specification.
- B. DSCC W-C-896F: Federal Specification Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).
- C. IEC 309-1, Part 1: General Requirements: Plugs, Socket-Outlets and Couplers for Industrial Purposes
- D. NEMA FB 11: Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations.
- E. NEMA WD 1: General Requirements for Wiring Devices.
- F. NEMA WD 6: Wiring Device – Dimensional Requirements.
- G. UL 20: General-Use Snap Switches.
- H. UL 486A: Wire Connectors and Soldering Lugs for Use with Copper Conductors.
- I. UL 486B: Wire Connectors for Use with Aluminum Conductors.
- J. UL 498: Electrical Attachment Plugs and Receptacles.
- K. UL 943: Ground Fault Circuit Interrupters.
- L. NECA 130-2010: Installing and Maintaining Wiring Devices.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations for each type of product indicated.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of wiring device through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and source.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.

1.7 COORDINATION

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.1 RECEPTACLES

- A. Straight-Blade-Type Receptacles: Comply with NEMA WD 1, NEMA WD 6, DSCC W-C-596G, and UL 498. Configuration 5-20R duplex receptacle.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell: 5352.
 - b. Arrowhart: 5352.
 - c. Bryant: 5362.
 - d. Pass & Seymour/Legrand; wiring Devices Division: 5362, PT5362 (use with PTR6STRNA prewired pigtail connector).
- B. GFCI Receptacles: Straight blade, non-feed-through type, with integral NEMA WD 6, Configuration 5-20R duplex receptacle; complying with UL 498 and UL 943. Design units for installation in a 2-3/4-inch- (70-mm-) deep outlet box without an adapter.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Incorporated; Wiring Device-Kellems GF20-LA.
 - b. Arrowhart Wiring Devices VGFB20.
 - c. Leviton 7899.
 - d. Pass & Seymour/Legrand; Wiring Devices Division 2095, PT2095 (use with PTR6STRNA prewired pigtail connector).

2.2 WALL SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Incorporated; Wiring Device-Kellems 1220 Series.
 2. ArrowHart Wiring Devices AH1220 Series.
 3. Leviton 1220 Series.
 4. Bryant 4900 Series.
 5. Pass & Seymour/Legrand; Wiring Devices Division PS20AC Series.
- B. Device body: Plastic handle.
- C. Single- and Double-Pole Switches: Comply with DSCC W-C-896F and UL 20.
- D. Snap Switches: Heavy Duty specification grade, quiet type; rated 20A., 120-277 V AC.
- E. Provide single-pole, two-pole, three-way and four-way switches as indicated.
- F. Provide pilot light where indicated.
- G. Provide key type where indicated. Furnish four keys to Owner.
- H. Combination Switch and Receptacle: Both devices in a single gang unit with plaster ears and removable tab connector that permit separate or common feed connection.
1. Switch: 20 A, 120/277-V ac.
 2. Receptacle: NEMA WD 6, Configuration 5-20R.

2.3 WALL PLATES

A. Manufacturers:

1. Provide wall plates and corresponding wiring devices from same manufacturer.

B. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces:
 - a. 0.035-inch- (1-mm-) thick, satin-finished stainless steel
 - b. 0.05-inch- (1.2-mm-) thick anodized aluminum
3. Material for Unfinished Spaces:
 - a. Galvanized steel
4. Material for Wet Locations: Gasketed Cast aluminum with spring-loaded cover, and listed and labeled for use in "wet locations."
 - a. Manufacturers:
 - 1) Red Dot Model CKSUV, Thomas & Betts.
 - 2) ArrowHart WIUM-Series.
 - 3) Pass & Seymour: WIUCAST1 (single gang), WIUCAST2 (2 gang)

2.4 FLOOR SERVICE FITTINGS

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

1. Hubbell Incorporated; Wiring Device-Kellems.
2. Wiremold.
3. Square D.
4. Mono-Systems, Inc.

B. Type: Modular, flush-type, with services indicated suitable for wiring method used.

C. Compartments: Provide barrier separating power from telecommunications cabling. Provide recessed-type floor service fittings with independent compartments and feed through wiring capability.

D. Service Plate: Provide service plate type as indicated. Provide protective ring for flush service plates.

E. Power Receptacle(s): NEMA WD 6, Configuration 5-20R, heavy-duty grade duplex receptacle, gray finish, unless otherwise indicated.

F. Telecommunications Outlet: Quantity and type as indicated.

2.5 FINISHES

A. Color:

1. Wiring Devices Connected to Normal Power System: As selected by Architect, unless otherwise indicated or required by NFPA 70.
2. Wall Switches: As selected by Architect, unless otherwise indicated.

3. Dimmer Switches: As selected by Architect, unless otherwise indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Prior to installation of devices, verify wall openings are neatly cut and will be completely covered by wall plates, clean debris from outlet boxes and provide extension rings to bring outlet boxes flush with finished surface.
- C. Install devices and assemblies level, plumb, and square with building lines.
- D. Install wall dimmers to achieve full rating specified and indicated after derating for ganging according to manufacturer's written instructions.
- E. Install unshared neutral conductors on load side of dimmers according to manufacturers' written instructions.
- F. Arrangement of Devices:
 1. Coordinate locations of outlet boxes provided under Division 26 Section "Raceways and Boxes" to obtain mounting heights indicated on Drawings.
 2. Unless otherwise indicated, mount flush, with long dimension vertical, and with grounding terminal of receptacles on top.
 3. Where multiple switches, dimmers, and/or occupancy sensors are adjacent to each other, provide a single cover plate. Custom fabricate, if required, for all combinations. Provide separate boxes or barriers as required for the application.
 4. Install horizontally mounted receptacles with grounding pole on the left.
 5. Install GFCI receptacles so that the "Push To Test" and "Reset" designations can be read correctly. If printed in both directions, install with ground pole on top.
 6. Install switches with OFF position down.
- G. Install cover plates on switch, receptacle, and blank outlets in finished areas.
- H. Use oversized plates for outlets installed in masonry walls.
- I. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.
- J. Remove wall plates and protect devices and assemblies during painting.
- K. Coordinate installation of access floor boxes with access floor system provided by Architectural trades.
- L. Install properly oriented access floor boxes into cutouts in access floor tiles and secure to tiles per Manufacturer's instructions.
- M. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.
- N. Adjust devices and wall plates to be flush and level. Three corners of wall plates must be in contact with wall surfaces. Devices shall be solidly mounted against the box.

3.2 IDENTIFICATION

- A. Comply with Division 26 Section "Electrical Identification."
 - 1. Receptacles: Identify panelboard and circuit number from which served. Use adhesive label as specified in Division 26 Section "Electrical Identification" with black-filled lettering on face of wall plate, and durable wire markers or tags inside outlet boxes.

3.3 CONNECTIONS

- A. Ground equipment according to Division 26 Section "Grounding and Bonding." Connect wiring device grounding terminal to outlet box with bonding jumper. Use of quick ground strap or screw is not acceptable.
- B. Connect wiring according to Division 26 Section "Conductors and Cables." Connect wiring devices by wrapping conductor around screw terminal or by using back wiring and tightening the screw securely.
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
 - 1. Inspect each wiring device for defects.
 - 2. Operate each wall switch with circuit energized and verify proper operation.
 - 3. After installing wiring devices and after electrical circuitry has been energized, test each receptacle for proper polarity, ground continuity, and compliance with requirements.
 - 4. Test each GFCI receptacle for proper operation with both local and remote fault simulations according to manufacturer's written instructions.
- B. Remove malfunctioning units, replace with new units, and retest as specified above.

END OF SECTION 26 2726

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
1.7 EXTRA MATERIALS	2
PART 2 - PRODUCTS	2
2.1 MANUFACTURERS	2
2.2 CARTRIDGE FUSES	3
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 switches and 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.
4. Fuse size for elevator feeders and elevator disconnect switches.

- 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.

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. Fuses: Quantity equal to 10% percent of each fuse type and size, but no fewer than 3 of each type and size.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Cooper Bussmann, Inc.
 2. Eagle Electric Mfg. Co., Inc.; Cooper Industries, Inc.
 3. Ferraz Shawmut, Inc.
 4. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.
 - 1. Service Entrance: Class L, fast acting.
 - 2. Feeders: Class L, fast acting.
 - 3. Motor Branch Circuits: Class RK5, time delay.
 - 4. 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.
- C. Install spare-fuse cabinet(s).

3.3 IDENTIFICATION

- A. Install labels indicating fuse rating and type on outside of the door on each fused switch.

END OF SECTION 26 2813

SECTION 26 2816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SUMMARY	1
1.3 DEFINITIONS	1
1.4 REFERENCES	2
1.5 SUBMITTALS	2
1.6 QUALITY ASSURANCE	3
1.7 COORDINATION	3
1.8 EXTRA MATERIALS	3
PART 2 - PRODUCTS	4
2.1 MANUFACTURERS	4
2.2 FUSIBLE AND NONFUSIBLE SWITCHES	4
2.3 TOGGLE DISCONNECT SWITCH	4
2.4 ENCLOSURES	5
PART 3 - EXECUTION	5
3.1 EXAMINATION	5
3.2 CONCRETE BASES	5
3.3 INSTALLATION	5
3.4 IDENTIFICATION	6
3.5 ADJUSTING	6
3.6 CLEANING	6

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 26 Section "Fuses".

1.2 SUMMARY

- A. This Section includes the following individually mounted, enclosed switches and circuit breakers:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Molded-case circuit breakers.
 - 4. Molded-case switches.
 - 5. Enclosures.

1.3 DEFINITIONS

- A. GD: General duty.
- B. GFCI: Ground-fault circuit interrupter.

- C. HD: Heavy duty.
- D. RMS: Root mean square.
- E. SPDT: Single pole, double throw.

1.4 REFERENCES

- A. NECA 1: Practices for Good Workmanship in Electrical Contracting.
- B. NETA ATS: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- C. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum).
- D. NEMA AB 1: Molded Case Circuit Breakers and Molded Case Switches.
- E. NEMA FU 1: Low Voltage Cartridge Fuses.
- F. NEMA KS 1: Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- G. NEMA PB1.1: General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.
- H. NEMA PB2.1: General Instructions for Proper Installation, Operation, and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.
- I. NFPA 70: National Electrical Code.

1.5 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current rating.
 - 4. UL listing for series rating of installed devices.
 - 5. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Qualification Data: For testing agency.
- D. Field quality-control test reports including the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
- E. Manufacturer's field service report.

- F. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures," include the following:

1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
2. Time-current curves, including selectable ranges for each type of circuit breaker.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NFPA 70.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.7 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

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. Spares: For the following:
 - a. Potential Transformer Fuses: 2 of each size and type.
 - b. Control-Power Fuses: 2 of each size and type
 - c. Fuses for Fusible Switches: Equal to 10 percent of amount installed for each size and type, but no fewer than 3 of each size and type.
 2. Spare Indicating Lights: Six of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FUSIBLE AND NONFUSIBLE SWITCHES

- A. Manufacturers:
1. Eaton Corporation; Cutler-Hammer Products.
 2. General Electric Co.; Electrical Distribution & Control Division.
 3. Siemens Industries, Inc.
 4. Square D/Group Schneider.
- B. Fusible Switch: NEMA KS 1, quick make, quick-break load interrupter enclosed knife switch Type HD, with clips or bolt pads to accommodate specified fuses, externally operable lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Nonfusible Switch: NEMA KS 1, quick make, quick-break load interrupter enclosed knife switch Type HD, externally operable lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- D. Accessories:
1. Provide early break auxiliary contacts in motor disconnect switches for motors that are fed from variable frequency controllers.
 2. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 3. Neutral Kit: Internally mounted; insulated, capable of being grounded, and bonded; and labeled for copper and aluminum neutral conductors.
 4. Auxiliary Contact Kit: Auxiliary set of contacts arranged to open before switch blades open.

2.3 TOGGLE DISCONNECT SWITCH

- A. Manufacturers:
1. Double Pole:
 - a. Hubbell 1372.
 - b. Leviton 6808G-DAC.
 - c. Pass & Seymour 7812.
 - d. Bryant 30102.
 2. Three Pole:
 - a. Hubbell 1379.
 - b. Leviton 7810GD.

- c. Pass & Seymour 7813.
- d. Bryant 30103.

- B. Description: Heavy duty, 30A, 600 volt, double or three pole as required, single throw, motor rated switch without overload protection. Provide NEMA 1 enclosure and padlock attachment.

2.4 ENCLOSURES

- A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.

- 1. Indoor Dry Locations: NEMA 250, Type 1.
- 2. Outdoor Locations: NEMA 250, Type 3R.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

- A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.
- B. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 3.

3.3 INSTALLATION

- A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.
- B. Mount individual wall-mounting switches and circuit breakers with tops at uniform height, unless otherwise indicated. Anchor floor-mounting switches to concrete base.
- C. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- D. Install switches with off position down.
- E. Install NEMA KS 1 enclosed switch where indicated for motor loads $\frac{1}{2}$ HP and larger and equipment loads greater than 30A.
- F. Install toggle disconnect switch, surface mounted, where indicated for motor loads less than $\frac{1}{2}$ HP and equipment loads 30A. and less.
- G. Install fuses in fusible disconnect switches.

- H. Install flexible liquid tight conduit from toggle disconnect switch to portable equipment. Leave a 6'-0" (1830 mm) whip.
- I. Install flexible liquid tight conduit from toggle disconnect switch to stationary equipment.
- J. Install control wiring from early break contacts in motor disconnect switch to variable frequency controllers to shut down controller when switch is open.
- K. Install equipment on exterior foundation walls at least one inch (25 mm) from wall to permit vertical flow of air behind breaker and switch enclosures.
- L. Support enclosures independent of connecting conduit or raceway system.
- M. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."
- B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate as specified in Division 26 Section "Electrical Identification."
- C. Provide adhesive label as specified in Division 26 Section "Electrical Identification" on inside door of each switch indicating UL fuse class and size for replacement.

3.5 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip and time delay settings to values as determined by the protective device coordination study.

3.6 CLEANING

- A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.
- B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION 26 2816

SECTION 26 2913 - ENCLOSED CONTROLLERS

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SUMMARY	1
1.3 SUBMITTALS	2
1.4 REFERENCES	2
1.5 QUALITY ASSURANCE	3
1.6 DELIVERY, STORAGE, AND HANDLING	3
1.7 PROJECT RECORD DOCUMENTS	4
1.8 COORDINATION	4
1.9 EXTRA MATERIALS	4
PART 2 - PRODUCTS	4
2.1 MANUFACTURERS	4
2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS	4
2.3 ENCLOSURES	5
2.4 ACCESSORIES	5
2.5 FACTORY FINISHES	5
PART 3 - EXECUTION	6
3.1 EXAMINATION	6
3.2 APPLICATIONS	6
3.3 INSTALLATION	6
3.4 CONCRETE BASES	6
3.5 IDENTIFICATION	6
3.6 CONTROL WIRING INSTALLATION	7
3.7 CONNECTIONS	7
3.8 FIELD QUALITY CONTROL	7
3.9 ADJUSTING	7
3.10 DEMONSTRATION	7

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes ac, enclosed controllers rated 600 V and less, of the following types:

1. Across-the-line, manual and magnetic controllers.
2. Reduced-voltage controllers.
3. Multispeed controllers.

- B. Related Sections include the following:

1. Division 26 Section "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.

1.3 SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each enclosed controller.
 - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Each installed unit's type and details.
 - b. Nameplate legends.
 - c. Short-circuit current rating of integrated unit.
 - d. UL listing for series rating of overcurrent protective devices in combination controllers.
 - e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.
 - 2. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around enclosed controllers where pipe and ducts are prohibited. Show enclosed controller layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- D. Qualification Data: For manufacturer.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Closeout Procedures," include the following:
 - 1. Routine maintenance requirements for enclosed controllers and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
- G. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- H. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

1.4 REFERENCES

- A. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
- B. ANSI/UL 198C - High-Intensity Capacity Fuses; Current-Limiting Types.
- C. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service.
- D. FS W-F-870 - Fuseholders (For Plug and Enclosed Cartridge Fuses).
- E. FS W-S-865 - Switch, Box, (Enclosed), Surface-Mounted.

- F. NECA 402-2000 – Recommended Practice for Installing and Maintaining Motor Control Centers.
- G. NEMA AB 1 - Molded Case Circuit Breakers.
- H. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.
- I. NEMA KS 1 - Enclosed Switches.
- J. ANSI/NFPA 70 - National Electrical Code.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles (160 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
 - 1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
- C. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- E. Comply with NFPA 70.
- F. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prior to beginning work on any system, verify all existing conditions that affect the work and coordinate with all other trade Contractors. Determine that the work can be installed as indicated or immediately report to the Architect/Engineer errors, inconsistencies or ambiguities.
- B. Deliver products to site under provisions of Section 26 0010. Store and protect products under provisions of Section 26 0010.
- C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- D. Handle in accordance with manufacturer's written instructions. Lift large equipment only with lugs provided for the purpose. Handle carefully to avoid damage to motor control center components, enclosure, and finish.
- E. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.7 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations of each contactor and indicate circuits controlled. Submit under provisions of 26 0010.

1.8 COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."
- D. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.
- E. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Spare Fuses: Furnish one spare for every five installed, but no less than one set of three of each type and rating.
 - 2. Indicating Lights: Two of each type installed.
 - 3. Keys: Furnish 2 of each to Owner.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton Corporation; Cutler-Hammer Products.
 - 2. General Electrical Company; GE Industrial Systems.
 - 3. Siemens/Furnas Controls.
 - 4. Square D.

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

- A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."
 - 1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each

phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.

- B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.
 - 1. Control Circuit: 120 V; obtained from integral control power transformer with sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
 - 2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 20 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
- C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.
 - 1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.
 - 2. Nonfusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch.
 - 3. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

2.3 ENCLOSURES

- A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
 - 1. Outdoor Locations: NEMA 250, Type 3R.

2.4 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Push-Button Stations, Pilot Lights: NEMA ICS 2, heavy-duty type.
- C. Indicating Lights: Run (Red), off or ready (Green).
- D. Auxiliary Contacts: Provide two normally open (N.O.) and two normally closed (N.C.) contacts.
- E. Selector Switch: NEMA ISC 2, mounted in front cover to read "hand/off/auto," provide auxiliary contact for auto position monitoring.

2.5 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.
- B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

- A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- B. Install freestanding equipment on concrete bases.
- C. Comply with mounting and anchoring requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- D. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."
- E. Install motor control equipment and contactors in accordance with manufacturer's instructions.
- F. Select and install heater elements in motor starters to match installed motor characteristics.
- G. Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

3.4 CONCRETE BASES

- A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.
- B. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 3.

3.5 IDENTIFICATION

- A. Identify enclosed controller, components, and control wiring according to Division 26 Section "Electrical Identification."

3.6 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers according to Division 26 Section "Conductors and Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
 - 2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.7 CONNECTIONS

- A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding."

3.8 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
 - 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
 - 2. Assist in field testing of equipment.
 - 3. Report results in writing.
- C. 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, except optional tests, stated in NETA ATS, "Motor Control - Motor Starters." Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.9 ADJUSTING

- A. Set field-adjustable switches and circuit-breaker trip ranges.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers. Refer to Division 1 Section "Closeout Procedures."

WAYNE STATE UNIVERSITY
Harwell Field Building

PETER BASSO ASSOCIATES, INC.
PBA Project No. 2014.0202.01
Issued for Bids
April 29, 2016

END OF SECTION 26 2913

SECTION 26 4313 – SURGE PROTECTIVE DEVICES

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SUMMARY	1
1.3 REFERENCES	1
1.4 DEFINITIONS	2
1.5 SUBMITTALS	2
1.6 QUALITY ASSURANCE	2
1.7 PROJECT CONDITIONS	3
1.8 COORDINATION	3
1.9 WARRANTY	3
1.10 EXTRA MATERIALS	3
PART 2 - PRODUCTS	4
2.1 MANUFACTURERS	4
2.2 SURGE PROTECTIVE DEVICE	4
2.3 ENCLOSURES	5
PART 3 - EXECUTION	5
3.1 INSTALLATION OF SURGE PROTECTION DEVICES	5
3.2 PLACING SYSTEM INTO SERVICE	5
3.3 FIELD QUALITY CONTROL	5
3.4 DEMONSTRATION	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 SPDs for low-voltage power, control, and communication equipment.

1.3 REFERENCES

- A. ANSI/IEEE C62.32: IEEE Standard Test Specifications for Low-Voltage Air Gap Surge-Protective Devices (Excluding Valve and Expulsion Type Devices).
- B. ANSI/IEEE C62.41: IEEE Guide on Surge Voltages in Low Voltage AC Power Circuits.
- C. ANSI/IEEE C62.45: IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits.
- D. MLS-STD-E220A:: Military Test Method Standard, Method of Insertion Loss Measurement.
- E. NEMA 250: Enclosures for Electrical Equipment (1000 Volts Maximum).
- F. NEMA LS 1: Low Voltage Surge Protection Devices.
- G. NETA ATS: Acceptance Testing Specifications: "Surge Arresters, Low-Voltage Surge Protection Devices".

- H. NFPA 70: National Electrical Code.
- I. NFPA 75: Standard for the Protection of Electronic Computer/Data Processing Equipment.
- J. UL 1283: Electromagnetic Interference Filters.
- K. UL 1449 Third Edition: Surge Protective Devices.

1.4 DEFINITIONS

- A. ATS: Acceptance Testing Specifications.
- B. SVR: Suppressed voltage rating.
- C. SPD: Surge Protective Devices.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Include rated capacities, operating weights, dimensions, mounting provisions, operating characteristics, furnished specialties, and accessories.
 - 2. Provide connection details and wiring diagrams indicating how SPD device is integrated within panelboards and switchgear.
- B. Product Certificates: For surge protective devices, signed by product manufacturer certifying compliance with the following standards:
 - 1. UL 1283.
 - 2. UL 1449.
- C. Field quality-control test reports, including the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Failed test results and corrective action taken to achieve requirements.
- D. Operation and Maintenance Data: For surge protective devices to include in emergency, operation, and maintenance manuals.
- E. Warranties: Special warranties specified in this Section.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain SPD's and accessories through one source from a single manufacturer. SPD units integral to switchboards, distribution panelboards and branch circuit panelboards shall be warranted and supported by the panelboard manufacturer.
- B. Product Options: Electrical performance of SPD is based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- D. Factory Testing: The specified system shall be factory-tested prior to shipment. Testing of each system shall include but not be limited to quality control checks, "Hi-Pot" tests per UL requirements, IEEE C62.41 Category B and C surge tests, UL ground leakage tests and operational and calibration tests.
- E. Comply with IEEE C62.41, "IEEE Guide for Surge Voltages in Low Voltage AC Power Circuits," and test devices according to IEEE C62.45, "IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits."
- F. Comply with NEMA LS 1, "Low Voltage Surge Protection Devices." Provide independent test reports demonstrating complete system performance showing compliance.
- G. Comply with UL 1283, "Electromagnetic Interference Filters," and UL 1449, "Surge Protective Devices."

1.7 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Construction Manager not less than seven days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Construction Manager's written permission.
- B. Service Conditions: Rate surge protection devices for continuous operation under the following conditions, unless otherwise indicated:
 - 1. Maximum Continuous Operating Voltage: Not less than 115 percent of nominal system operating voltage.
 - 2. Operating Frequency: 47 to 63 Hz.
 - 3. Operating Temperature: -40 to 140 deg F.
 - 4. Humidity: 0 to 95 percent, noncondensing.
 - 5. Altitude: Less than 20,000 feet above sea level.

1.8 COORDINATION

- A. Coordinate location of field-mounted surge suppressors to allow adequate clearances for maintenance.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within five years from date of Substantial Completion.

1.10 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Replaceable Protection Modules: One of each size and type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cutler-Hammer, Inc.; Eaton Corporation.
2. General Electric Company.
3. Siemens Industries, Inc.

2.2 SURGE PROTECTIVE DEVICE

A. Surge Protection Device Description: Sine-wave-tracking type, with the following features and accessories:

1. MOV technology for each suppression mode.
2. Fuses, rated at 200-kA interrupting capacity. Provide fusing for each suppression path.
3. Fabrication using bolted compression lugs for internal wiring. No plug-in component modules, quick disconnect terminals or printed circuit boards shall be used in current-carrying paths.
4. Integral disconnect switch which has been tested to the surge current rating of the SP to match or exceed the fault current rating of the board. Use of circuit breakers for disconnecting means is acceptable.
5. LED indicator lights for power and protection status for each phase mounted in panelboard front cover:
 - a. Green indicates fully operational circuit.
 - b. Red indicates loss of protection.
6. EMI-RFI Noise Rejection: based on MIL-STD-E220A, 50-ohm standard Insertion Loss Test:
 - a. 34dB at 100 kHz.
 - b. 51dB at 1 MHz.
 - c. 54dB at 10 MHz.
 - d. 48dB at 100 MHz.
7. The maximum continuous operating voltage (MCOV) for all voltage configurations shall be 115% if nominal or greater.
8. Audible alarm, with silencing switch, to indicate when protection has failed.
9. One set of dry contacts rated at 5 A and 250-V ac, for remote monitoring of protection status. Coordinate with building power monitoring and control system.

B. Peak Single-Impulse Surge Current Rating for service entrance equipment (C3 Rating): 320 kA per phase; 160 kA per mode based on a single pulse, IEEE C62.41 standard 8 x 20 microsecond waveform. Device shall not suffer more than 10% deviation in clamping voltage at specified surge current.

C. Peak Single-Impulse Surge Current Rating for service entrance equipment (B2 Rating): 240 kA per phase; 120 kA per mode based on a single pulse, IEEE C62.41 standard 8 x 20 microsecond waveform. Device shall not suffer more than 10% deviation in clamping voltage at specified surge current.

D. Minimum Repetitive Surge Current Capability: 10,000 for service entrance and 5,000 for distribution panels and panelboards impulse per mode in accordance with ANSI/IEEE C62.41 and ANSI/IEEE C62.45 utilizing a Category C3 bi-wave at one minute intervals without suffering either performance degradation or more than 10% deviation of specified UL 1449 Suppression Voltage Ratings at specified surge current.

E. Connection Means:

1. Integral: Bus mounted, parallel connection

2. External: Cable connection, parallel wired.

F. Protection modes and UL 1449 Listed and Recognized Component Surge Voltage Rating for grounded wye circuits with voltages of 480Y/277V, 3-phase, 4-wire circuits shall not exceed the following:

1. Line to Neutral: 1200V.
2. Line to Ground: 1200V
3. Neutral to Ground: 1200V
4. Line to Line: 2000V

G. Protection modes and UL 1449 Listed and Recognized Component Surge Voltage Rating for grounded wye circuits with voltages of 208Y/120V, 3-phase, 4-wire circuits shall not exceed the following:

1. Line to Neutral: 700V.
2. Line to Ground: 700V
3. Neutral to Ground: 700V
4. Line to Line: 1500V

2.3 ENCLOSURES

A. NEMA 250, with type matching the enclosure of panel or device being protected.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTION DEVICES

- A. Surge protective devices shall be factory installed in all new distribution equipment.
- B. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.

3.2 PLACING SYSTEM INTO SERVICE

- A. Do not energize or connect distribution equipment to their sources until surge protection devices are installed and connected.

3.3 FIELD QUALITY CONTROL

A. Testing: Perform the following field tests and inspections and prepare test reports. Test all service entrance and electronic grade panelboard suppressors.

1. After installing surge protection devices, but before electrical circuitry has been energized, test for compliance with requirements.
2. Complete startup checks according to manufacturer's written instructions.
3. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.

a. Visual and Mechanical Inspection

- 1) Inspect for physical damage and compare nameplate data with Drawings and Specifications.
- 2) Inspect for proper mounting and adequate clearances.

- 3) Check ground lead on each device for individual attachment to ground bus or ground electrode.

- B. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain surge protection devices. Refer to Division 1.

END OF SECTION 26 4313

SECTION 265119 - LED INTERIOR LIGHTING

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SUMMARY	1
1.3 DEFINITIONS	2
1.4 SUBMITTALS	2
1.5 CLOSEOUT SUBMITTALS	3
1.6 MAINTENANCE MATERIAL SUBMITTALS	3
1.7 QUALITY ASSURANCE	3
1.8 DELIVERY, STORAGE, AND HANDLING	4
1.9 COORDINATION	4
1.10 WARRANTY	4
PART 2 - PRODUCTS	5
2.1 LUMINAIRES (LIGHTING FIXTURES)	5
2.2 LUMINAIRE REQUIREMENTS	5
2.3 EXIT SIGNS	5
2.4 EMERGENCY LIGHTING UNITS	6
2.5 EMERGENCY LOAD TRANSFER DEVICE	6
2.6 MATERIALS	6
2.7 METAL FINISHES	7
2.8 LUMINAIRE FIXTURE SUPPORT COMPONENTS	7
PART 3 - EXECUTION	7
3.1 EXAMINATION	7
3.2 TEMPORARY LIGHTING	7
3.3 INSTALLATION	7
3.4 CONNECTIONS	9
3.5 IDENTIFICATION	9
3.6 FIELD QUALITY CONTROL	9
3.7 STARTUP SERVICE	9
3.8 ADJUSTING	9
3.9 CLEANING	10

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Interior solid-state luminaires that use LED technology.
2. Lighting fixture supports.

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. Lamp: LED and substrate as a replaceable assembly.
- F. LED: Light-emitting diode.
- G. Lumen: Measured output of lamp and luminaire, or both.
- H. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaires.
 - 4. Include emergency lighting units, including batteries and chargers.
 - 5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
 - 6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing and Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps and accessories identical to those indicated for the lighting fixture as applied in this Project per IES LM-79 and IES LM-80.
 - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products or certified by a qualified independent testing agency.
- B. Shop Drawings: For nonstandard or custom luminaires.
 - 1. Include plans, elevations, sections, and mounting and attachment details.
 - 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include diagrams for power, signal, and control wiring.
- C. Samples: For each luminaire and for each color and texture with standard factory-applied finish.
- D. Samples for Initial Selection: For each type of luminaire with custom factory-applied finishes.
 - 1. Include Samples of luminaires and accessories involving color and finish selection.
- E. Samples for Verification: For each type of luminaire.
 - 1. Include Samples of luminaires and accessories to verify finish selection.
- F. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Lighting luminaires.
2. Suspended ceiling components.
3. Partitions and millwork that penetrate the ceiling or extend to within 12 inches of the plane of the luminaires.
4. Structural members to which equipment luminaires will be attached.
5. Initial access modules for acoustical tile, including size and locations.
6. Items penetrating finished ceiling, including the following:

a. Other luminaires.

- G. Qualification Data: For testing laboratory providing photometric data for luminaires.
- H. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- I. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- J. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Lamps: 5% attic stock of each type and rating installed. Furnish at least one of each type.
 2. LED Drivers 5% attic stock of each type and rating installed. Furnish at least one of each type.
 3. Diffusers and Lenses: 1% attic stock of each type and rating installed. Furnish at least one of each type.
 4. Globes and Guards: 5% attic stock of each type and rating installed. Furnish at least one of each type.

1.7 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products, and complying with the applicable IES testing standards.
- C. Provide luminaires from a single manufacturer for each luminaire type.
- D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

- E. Mockups: For interior lighting luminaires in room or module mockups, complete with power and control connections.
 - 1. Obtain Architect's approval of luminaires in mockups before starting installations.
 - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
 - 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- F. 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.
- G. Comply with:
 - 1. NFPA 70 - National Electrical Code.
 - 2. NECA/IESNA 500-1998 – Recommended Practice for Installing Indoor Commercial Lighting Systems.
 - 3. NECA/IESNA 502-1999 – Recommended Practice for Installing Industrial Lighting Systems.
 - 4. Code of Federal Regulations (47 CFR 37342).
 - 5. Michigan Department of State Police, Fire Marshall Division Policy Number 11-06 "Plastic Materials as Interior Finishes" pertaining to the use of plastic lenses in lighting fixtures for health care facilities.
 - 6. Michigan Department of Community Industry Services requirements that all lamps shall be protected from breakage. Exposed lamps are not acceptable.
- H. FMG Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.
- I. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.9 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.10 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Warranty Period: Five year(s) or manufacturer's standard warranty length (whichever is longer) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LUMINAIRES (LIGHTING FIXTURES)

- A. Provide Luminaires as included in specification 26 5700 "Luminaire Product Data." This section contains product data sheets from the basis of design manufacturer with annotations.
- B. Acceptable alternate manufacturers are indicated on the product data sheets. Alternate manufacturer products shall be equal in all respects including materials, finishes, photometric performance and energy performance and shall include all options, features, and accessories identified.
- C. The Luminaire schedule shown on the drawings is supplemental provided for convenience and reference only. The requirements of this section and 26 5700 shall govern.

2.2 LUMINAIRE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
- C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- D. Unless otherwise specified in Luminaire product data, provide products with a minimum CRI of 80.
- E. Unless otherwise specified in Luminaire product data, provide products with a CCT of 4100 K.
- F. Unless otherwise specified in Luminaire product data, provide products with an IES LM-80 rated lamp life of 50,000 hours.
- G. Driver
 - 1. Provided as a integrated component of the luminaire or as a external component of an assembly of luminaries.
 - 2. Nominal Input Voltage: As specified in product data.

2.3 EXIT SIGNS

- A. General: Comply with UL 924; for sign colors and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
 - 1. Lamps: Light-emitting diodes, 70,000 hours minimum of rated lamp life.
- C. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - 1. Battery: Sealed, maintenance-free, nickel-cadmium type with special warranty.
 - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - 3. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

- D. Provide edge lit signs with a mirror plaque background.

2.4 EMERGENCY LIGHTING UNITS

- A. General: Self-contained units complying with UL 924.
 - 1. Battery: Sealed, maintenance-free, lead-acid type with minimum 10-year nominal life and special warranty.
 - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - 3. Operation: Relay automatically turns lamp on when power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - 4. Wire Guard: Where indicated, heavy-chrome-plated wire guard protects lamp heads or fixtures.
 - 5. Integral Time-Delay Relay: Holds unit on for fixed interval when power is restored after an outage; time delay permits high-intensity-discharge lamps to restrike and develop adequate output.

2.5 EMERGENCY LOAD TRANSFER DEVICE

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Nine-24, Inc.: BLTC Series.
 - 2. Bodine GTD Series.
 - 3. Dual Lite.
 - 4. LVS.
 - 5. Side-Lite.
- B. Description: Localized load transfer switch to allow emergency fixture to be controlled on normal lighting circuits and to sense presence of normal power ahead of control circuit and switch luminaire (both line and neutral) over to emergency source upon loss of normal source. Device shall be installed integral to luminaire or mounted remotely for each control circuit as application requires.
- C. U.L. 924 Listed.
- D. Integral test switch and indicating lamps to indicate status.

2.6 MATERIALS

- A. Metal Parts:
 - 1. Free of burrs and sharp corners and edges.
 - 2. Sheet metal components shall be steel unless otherwise indicated.
 - 3. Form and support to prevent warping and sagging.
- B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- C. Diffusers and Globes:
 - 1. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
 - 3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

- D. Factory-Applied Labels: Comply with UL 1598 Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp characteristics:

- a. "USE ONLY" and include specific lamp type.
- b. Lamp diameter, shape, size, wattage, and coating.
- c. CCT and CRI for all luminaires.

2.7 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.8 LUMINAIRE FIXTURE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: Unless otherwise specified in Luminaire product data, provide products with a minimum 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: Unless otherwise specified in Luminaire product data, provide products with a minimum ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.
- D. Rod Hangers: Unless otherwise specified in Luminaire product data, provide products with a minimum 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. Do not use permanent luminaires for temporary lighting.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions and N.E.C.A./I.E.S.N.A. 500-2006 and 502-2006.
- B. Locate ceiling luminaires as indicated on reflected ceiling plan.

- C. Support for Fixtures in or on Grid-Type Suspended Ceilings: Use grid for support.
 - 1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches from fixture corners.
 - 2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
- D. Support luminaires independent of ceiling framing. Support recessed grid luminaires from two opposite corners directly to structure. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- E. Exposed Grid Ceilings: Support surface mounted luminaires on grid ceiling directly from building structure.
- F. Install recessed luminaires to permit removal from below.
- G. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
- H. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- I. Supports:
 - 1. Sized and rated for luminaire weight.
 - 2. Able to maintain luminaire position after cleaning and relamping.
 - 3. Provide support for luminaire without causing deflection of ceiling or wall.
 - 4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.
- J. Flush-Mounted Luminaire Support:
 - 1. Secured to outlet box.
 - 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
 - 3. Trim ring flush with finished surface.
- K. Wall-Mounted Luminaire Support:
 - 1. Attached to structural members in walls.
 - 2. Do not attach luminaires directly to gypsum board.
- L. Ceiling-Mounted Luminaire Support:
 - 1. Ceiling mount with two 5/32-inch- diameter aircraft cable supports 120 inches in length.
- M. Suspended Luminaire Support:
 - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 - 3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
 - 4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

- N. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- C. Bond products and metal accessories to branch circuit equipment grounding conductor.
- D. Connect luminaires to branch circuit outlet boxes provided under Division 26 Section "Raceways and Boxes" using 1/2" flexible conduit.

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.
- D. A visual inspection shall be performed to verify cleanliness and alignment of the fixtures, misalignment and light leaks shall be corrected, and rattles due to ventilation system vibration shall be eliminated.

3.7 STARTUP SERVICE

- A. Comply with requirements for startup specified in Section 260943.16 "Addressable-Fixture Lighting Controls."
- B. Comply with requirements for startup specified in Section 260943.23 "Relay-Based Lighting Controls."

3.8 ADJUSTING

- A. Occupancy Adjustments: When requested within three months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to one visit to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps, drivers, or luminaires that are defective.
 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 3. Adjust the aim of luminaires in the presence of the Architect.
- B. Adjust exit sign directional arrows as indicated on Drawings.
- C. Adjust and calibrate all dimming system controls until the system works as designed. Contact the Architect/Engineer when dimming is complete and demonstrate operation to owner's representative and Architect/Engineer.

3.9 CLEANING

- A. Clean electrical parts to remove conductive and deleterious materials.
- B. Remove dirt and debris from enclosures and lenses.
- C. Clean photometric control surfaces as recommended by manufacturer.
- D. Clean finishes and touch up damage.

END OF SECTION 265119

PORTFOLIO™

DESCRIPTION

6 inch LED recessed medium beam downlight with 50° cut off specially designed for LED technology. Two-stage reflector system produces smooth distribution with excellent light control and low aperture brightness. Lumen packages include 1000 and 1500 delivered lumens with color temperatures of 2700K, 3000K, 3500K, 4000K. Suitable for commercial construction and exceeds high efficacy requirements (with designated trims) for T24. Energy Star qualified.

Other Manufacturers:
Lightolier "C6L" Series

SPECIFICATION FEATURES

Lower Shielding Reflector

Self-flanged, spun .050" thick aluminum lower reflector in combination with a lensed upper optical chamber provides superior lumen output with minimal source brightness. Available in all Portfolio Alzak® finishes.

Trim Retention

Lower reflector is retained with two torsion springs holding the flange tightly to the finished ceiling surface.

Plaster Frame / Collar

New Construction Housing: Die cast aluminum 1-1/2" deep collar accommodates ceiling materials up to 2".

Universal Mounting Bracket

Accepts 1/2" EMT, C channel and bar hangers and adjusts 5" vertically from above and below the ceiling.

Junction Box

(4) 1/2" and (2) 3/4" trade size pry outs positioned to allow straight conduit runs. Listed for (8) #12 AWG (four in, four out) 90°C conductors and feed thru branch wiring.

Thermal

Extruded aluminum heat sink conducts heat away from the LED module for improved performance and longer life.

LED

LED system contains a plurality of high brightness white LED's combined with a high reflectance upper reflector and convex transitional lens producing even distribution with no pixilation. Rated for 50,000 hours at 70% lumen maintenance. Auto resetting, thermally protected, LED's are turned off when safe operating temperatures are exceeded. Color variation within 3-step MacAdam ellipses. Flexible disconnect allows for tool-less replacement of LED engine from below ceiling. Available in 80 or 90 CRI.

Driver

Combination 120-277V 0-10V or 120V trailing edge phase cut driver provides flicker free dimming from 100% to 10%. Optional 1% 0-10V, Fifth Light, DMX or Lutron® Ecosystem. Driver can be serviced from above or through the aperture.

Catalog #	Type
Project	L1
Comments	Date
Prepared by	

Environmental

Fixture should not be operated in ambient temperatures above 40° C.

Code Compliance

Thermally protected and cULus listed for protected wet locations. IP66 rated when used with IP66 gasket kit accessory. Optional City of Chicago environmental air (CCEA) marking for plenum applications. EMI/RFI emissions per FCC 47CFR Part 18 Class B consumer limits. Non-IC rated - Insulation must be kept 3" from top and sides of housing. RoHS Compliant. Photometric testing completed in accordance with IES LM 79 standards. LED life testing completed in accordance with LM 80 standards.

Warranty

5 year warranty on LED housings, LED Modules and LED Trims.



LD6A10 LD6A15 6LM

1000 Lumen LED

1500 Lumen LED

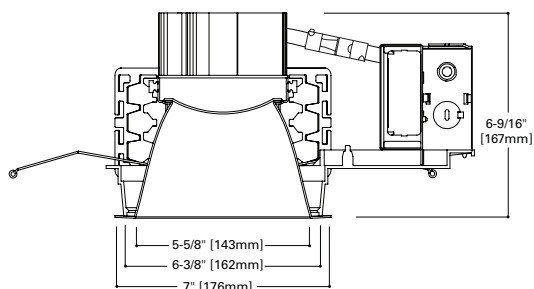
6-Inch

Medium Beam Downlight

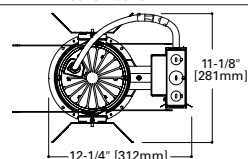
New Construction



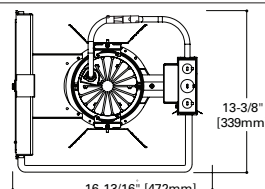
Qualified and Compliant. Refer to the ENERGY STAR® Qualified Product List and CEC (T24) Appliance Database for listings.



TOP VIEW - NEW CONSTRUCTION



TOP VIEW - NEW CONSTRUCTION WITH BATTERY



COOPER Lighting
www.cooperlighting.com

Specifications and dimensions subject to change without notice.
Consult your representative for additional options and finishes.



ENERGY DATA	
Sound Rating: Class A standards	
Operating Temperature: 40°C (104°F)	
1500 Lumen D010TE	
(Values at non-dimming line voltage)	
Minimum Starting Temperature: -30°C (-22°F)	
EMI/RFI: FCC Title 47 CFR, Part 15, Class B (Consumer)	
Input Voltage: UNV (120V - 277V)	
Power Factor: >0.90 (at nominal input 120/277 VAC & 100% of Rated Output Power)	
Input Power: 22.4W	THD: <20%
120V Input Current: 12A	277V Input Current: .09A
Maximum Non-IC Ambient Continuous	
Input Frequency: 50-60Hz	
1000 Lumen D010TE	
(Values at non-dimming line voltage)	
Minimum Starting Temperature: -30°C (-22°F)	
EMI/RFI: FCC Title 47 CFR, Part 15, Class B (Consumer)	
Input Voltage: UNV (120V - 277V)	
Power Factor: >0.90 (at nominal input 120/277 VAC & 100% of Rated Output Power)	
Input Power: 14.1W	THD: <20%
120V Input Current: 12A	277V Input Current: .06A
Maximum Non-IC Ambient Continuous	
Input Frequency: 50-60Hz	

ADP110789
2013-11-20 15:38:35

LD6A10 LD6A15 6LM

L1

ORDERING INFORMATION

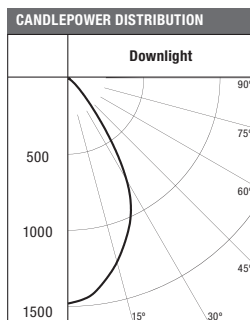
EXAMPLE: LD6A15D010TE ERM6A15835 6LM0L1=6" LED Medium Beam Reflector, 1500 Lumen 3,500 K Color with Universal 120 - 277V, 0 - 10 Dimmer

Housing	Lumens ¹	Driver	Options	Power Module	CRI	Color
LD6A=6" Aperture, LD6ACP=6" Aperture	10=1000 Lumens 15=1500 Lumens	D010TE=120-277V 0-10V 10% Dimming or Trailing Edge 120V Dimming D010TR=120-277V 0-10V 10% Dimming or Leading Edge 120V Dimming D5LT=Fifth Light® (DALI) Dimming 1-100% DE010=1 to 100% Dimming, 120-277V 50/60Hz, 0-10V DL3=1 to 100% Dimming, 120-277V Lutron® Hi-Lume, Ecosystem or 3 Wire DLT=1 to 100% Dimming, 120V Lutron® Hi-Lume Forward Phase Dimming DMX=DMX Dimming 1-100%	EMBOD=Bodine® Emergency Module with Remote Test Switch IEMBOD=Bodine® Emergency Module with Integral test Switch ³	ERM6A10=6", 1000 Lumen Module for Medium Beam Reflector ERM6A15=6", 1500 Lumen Module for Medium Beam Reflector	8=80 CRI 9=90 CRI	27=2700° K 30=3000° K 35=3500° K 40=4000° K 27CP=2700° K, Chicago Plenum 30CP=3000° K, Chicago plenum 35CP=3500° K, Chicago Plenum 40CP=4000° K, Chiago Plenum

Reflector	Finish	Options	Accessories
6LM0=6" Medium Reflector, Polymer Trim Ring 6LM1=6" Medium Reflector, Self-flanged 6LM0E=6" Medium Reflector, Polymer Trim Ring for use with IEM Integral Emergency Option 6LM1E=6" Medium Reflector, Self-flanged for use with IEM Integral Emergency Option	LL=Specular Clear H=Semi-Specular Clear WMH=Warm Haze G=Specular Gold WH=White Haze GP=Graphite GPH=Graphite Haze	B=Specular Black W=Gloss White 6LM0, 6LM0E Only BB=Black Baffle WB=White Baffle Self-flanged Only WF=White Painted Flange	H26=C-channel Bar Hanger, 26" Long, Pair H50=C-channel Bar Hanger, 50" Long, Pair RMB22=Wood Joist Bar Hanger, 22" Long, Pair H277=277 To 120V Step Down Transformer, 300VA H347=347 To 120V Step Down Transformer, 75VA H347200=347 to 120V Step Down Transformer, 200VA Housings, Specify Slope HSA6=Slope Adapter for 6" Aperture Housings, Specify Slope TRM6=Metal Trim Ring, Specify Color ² TRR6=Trimless Trim Ring ² DT6=Deco Trim ² LGSKT6IP66= P66 Gasket Kit

Notes: 1 Nominal Lumens will vary depending on selected color, driver and reflector finish.
2 Order trim with polymer trim ring (Consult specification sheet for color ordering information and options).
3 Not available with Chicago Plenum.

PHOTOMETRICS



Test Number	P98227
LD6A15D010TE ERM6A835 6LM1H	
Lumens	1347
Efficacy	61.8 Lm/W
Watts	21.8
CCT	3500K
SC	0.92

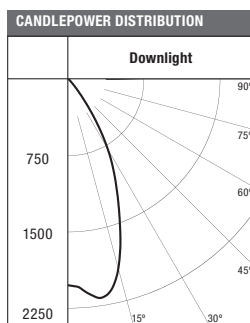
Distance Fixture to Lighted Plane	Initial Footcandles at Nadir	Beam Diameter
5'5"	48	5.0
7'	30	6.5
8'	22	7.0
9'	18	8.0
10'	14	9.0
12'	10	11.0

Degrees Vertical	Candela
0	1468
5	1436
15	1238
25	969
35	468
45	116
55	25
65	8
75	2
85	0
90	0

Zone	Lumens	%Fixture
0-30	919	68.2
0-40	1213	90.1
0-60	1336	99.2
0-90	1347	100
90-180	0	0
0-180	1347	100

Average Candella Degrees	Average 0° Luminance
45	10749
55	2889
65	1158
75	378
85	0

EMBO MULTIPLIER
1000 Lumen= .64
1500 Lumen= .45



Test Number	P97379
LD6A15D010TE ERM6A835 6LM1L	
Lumens	1509
Efficacy	69.2 Lm/W
Watts	21.8
CCT	3500K
SC	0.83

Distance Fixture to Lighted Plane	Initial Footcandles at Nadir	Beam Diameter
5'5"	69	4.0
7'	42	5.6
8'	32	6.0
9'	25	7.0
10'	21	8.0
12'	14	9.5

Degrees Vertical	Candela
0	2018
5	2098
15	1908
25	1097
35	381
45	29
55	4
65	1
75	0
85	0
90	0

Zone	Lumens	%Fixture
0-30	1225	81.2
0-40	1471	97.5
0-60	1507	99.9
0-90	1509	100
90-180	0	0
0-180	1509	100

Average Candella Degrees	Average 0° Luminance
45	2676
55	455
65	154
75	0
85	0

EMBO MULTIPLIER
1000 Lumen= .64
1500 Lumen= .45

Lumen Output Bodine...Emergency .45

COOPER Lighting
www.cooperlighting.com

Specifications and dimensions subject to change without notice.
Customer First Center 1121 Highway 74 South Peachtree City, GA 30269 770.486.4800 FAX 770.468.4801

ADP110789
2013-11-20 15:38:35

L1

LD6A10 LD6A15 6LM

PHOTOMETRICS

CCT Multiplication Factors		CCT [K]	Multiplier from 3500K	80 -> 90 CRI
80 CRI	1000 Lumen	2700	0.93	
		3000	0.99	
		3500	1.00	
		4000	1.01	
	1500 Lumen	2700	0.93	
		3000	0.99	
		3500	1.00	
		4000	1.01	
90 CRI	1000 Lumen	2700	0.88	0.79
		3000	0.95	0.80
		3500	1.00	0.84
		4000	1.03	0.86
	1500 Lumen	2700	0.88	0.79
		3000	0.94	0.79
		3500	1.00	0.84
		4000	1.03	0.86

PORTFOLIO™

DESCRIPTION

6 inch LED recessed wide beam downlight specially designed for LED technology. Two-stage reflector system produces smooth distribution with excellent light control and low aperture brightness. Lumen packages include 1000 and 1500 delivered lumens with color temperatures of 2700K, 3000K, 3500K, 4000K. Suitable for commercial construction and exceeds high efficacy requirements (with designated trims) for T24. Energy Star qualified.

Other Manufacturers:
Lightolier "C6L" Series

SPECIFICATION FEATURES

Lower Shielding Reflector

Self-flanged, spun .050" thick aluminum lower reflector in combination with a lensed upper optical chamber provides superior lumen output with minimal source brightness. Available in all Portfolio Alzak® finishes.

Trim Retention

Lower reflector is retained with two torsion springs holding the flange tightly to the finished ceiling surface.

Plaster Frame / Collar

New Construction Housing: Die cast aluminum 1-1/2" deep collar accommodates ceiling materials up to 2".

Universal Mounting Bracket

Accepts 1/2" EMT, C channel and bar hangers and adjusts 5" vertically from above and below the ceiling.

Junction Box

(4) 1/2" and (2) 3/4" trade size pry outs positioned to allow straight conduit runs. Listed for (8) #12 AWG (four in, four out) 90°C conductors and feed thru branch wiring.

Thermal

Extruded aluminum heat sink conducts heat away from the LED module for improved performance and longer life.

LED

LED system contains a plurality of high brightness white LED's combined with a high reflectance upper reflector and convex transitional lens producing even distribution with no pixilation. Rated for 50,000 hours at 70% lumen maintenance. Auto resetting, thermally protected, LED's are turned off when safe operating temperatures are exceeded. Color variation within 3-step MacAdam ellipses. Flexible disconnect allows for tool-less replacement of LED engine from below ceiling. Available in 80 or 90 CRI.

Driver

Combination 120-277V 0-10V or 120V trailing edge phase cut driver provides flicker free dimming from 100% to 10%. Optional 1% 0-10V, Fifth Light, DMX or Lutron® Ecosystem. Driver can be serviced from above or through the aperture.

Catalog #	Type
Project	L2
Comments	Date
Prepared by	

Environmental

Fixture should not be operated in ambient temperatures above 40° C.

Code Compliance

Thermally protected and cULus listed for protected wet locations. IP66 rated when used with IP66 gasket kit accessory. Optional City of Chicago environmental air (CCEA) marking for plenum applications. EMI/RFI emissions per FCC 47CFR Part 18 Class B consumer limits. Non-IC rated - Insulation must be kept 3" from top and sides of housing. RoHS Compliant. Title 24 Compliant with designated trims. ARRA Compliant. Photometric testing completed in accordance with IES LM 79 standards. LED life testing completed in accordance with LM 80 standards.

Warranty

5 year warranty.



LD6A10
LD6A15

6LW

1000 Lumen LED
1500 Lumen LED

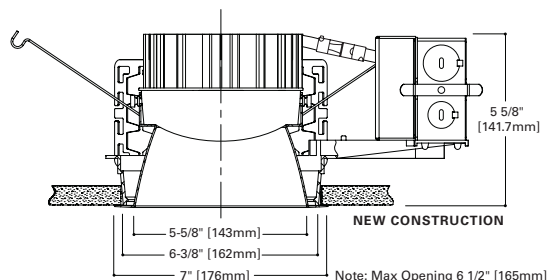
6-Inch

Wide Beam Downlight

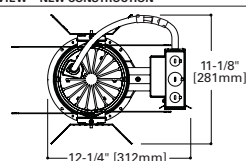
New Construction



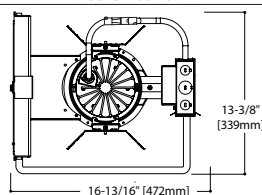
Qualified and Compliant. Refer to the ENERGY STAR® Qualified Product List and CEC (T24) Appliance Database for listings.



TOP VIEW - NEW CONSTRUCTION



TOP VIEW - NEW CONSTRUCTION WITH BATTERY



COOPER Lighting
www.cooperlighting.com

Specifications and dimensions subject to change without notice.
Consult your representative for additional options and finishes.

ENERGY DATA	
Sound Rating: Class A standards	
Operating Temperature: 40°C (104°F)	
1500 Lumen D010TE	
(Values at non-dimming line voltage)	
Minimum Starting Temperature: -30°C (-22°F)	
EMI/RFI: FCC Title 47 CFR, Part 15, Class B (Consumer)	
Input Voltage: UNV (120V - 277V)	
Power Factor: >0.90 (at nominal input 120/277 VAC & 100% of Rated Output Power)	
Input Power: 22.4W	THD: <20%
120V Input Current: 1.2A	277V Input Current: .09A
Maximum Non-IC Ambient Continuous	
Input Frequency: 50-60Hz	
1000 Lumen D010TE	
(Values at non-dimming line voltage)	
Minimum Starting Temperature: -30°C (-22°F)	
EMI/RFI: FCC Title 47 CFR, Part 15, Class B (Consumer)	
Input Voltage: UNV (120V - 277V)	
Power Factor: >0.90 (at nominal input 120/277 VAC & 100% of Rated Output Power)	
Input Power: 14.1W	THD: <20%
120V Input Current: .12A	277V Input Current: .06A
Maximum Non-IC Ambient Continuous	
Input Frequency: 50-60Hz	

ADP100519

2013-12-09 15:38:35

L2

LD6A10 LD6A15 6LW

ORDERING INFORMATION

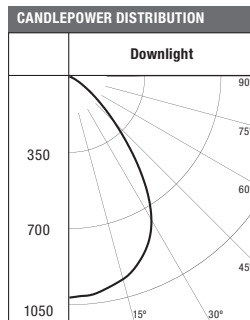
EXAMPLE: LD6A15D010TE ERW6A15835 6LW1LI=6" LED Wide Reflector Lens, 1500 Lumen 3,500 K Color with Universal 120 - 277V, 0 - 10 Driver

Housing	Lumens ¹	Driver	Options	Power Module	CRI	Color
LD6A=6" Aperture LD6ACP=6" Aperture, Chicago Plenum	10=1000 Lumens 15=1500 Lumens	D010TE=120-277V 0-10V 10% Dimming or Trailing Edge 120V Dimming D010TR=120-277V 0-10V 10% Dimming or Leading Edge 120V Dimming D5LT=Fifth Light* (DALI) Dimming 1-100% DE010=1 to 100% Dimming, 120-277V 50/60Hz, 0-10V DL3=1 to 100% Dimming, 120-277V Lutron® Hi-Lume, Ecosystem or 3 Wire DLT=1 to 100% Dimming, 120V Lutron® Hi-Lume Forward Phase Dimming DMX=DMX Dimming 1-100%	EMBOD=Bodine® Emergency Module with Remote Test Switch ⁴	ERW6A10=6" 900 Lumen Module for Wide Beam Reflector ERW6A15=6" 1500 Lumen Module for Wide Beam Reflector	8=80 CRI 9=90 CRI	27=2700° K 30=3000° K 35=3500° K 40=4000° K 27CP=2700° K, Chicago Plenum 30CP=3000° K, Chicago Plenum 35CP=3500° K, Chicago Plenum 40CP=4000° K, Chicago Plenum

Reflector	Finish	Options	Accessories
6LW0=6" Wide Beam Reflector, Polymer Trim Ring 6LW1=6" Wide Beam Reflector, Self-flanged	H=Specular Clear H=Semi-Specular Clear WHH=Warm Haze G=Specular Gold WH=Wheat Haze GPH=Graphite Haze	B=Specular Black W=Gloss White 6LW0 Only BB=Black Baffle WB=White Baffle	Self-flanged Only WF=White Painted Flange HB26=C-channel Bar Hanger, 26" Long, Pair HB50=C-channel Bar Hanger, 50" Long, Pair RMB22=Wood Joist Bar Hanger, 22" Long, Pair H277=277 to 120V Step Down Transformer, 300VA H347=347 to 120V Step Down Transformer, 75VA H347200=347 to 120V Step Down Transformer, 200VA Housings, Specify Slope HSA6=Slope Adapter for 6" Aperture Housings, Specify Slope TRM6=Metal Trim Ring, Specify Color ² TRR6=Trimless Trim Ring ³ DT6=Deco Trim ³ LGSKT6IP66=IP66 Gasket Kit

Notes: 1 Nominal delivered Lumens will vary depending on selected color, driver and reflector finish.
2 Order trim with polymer trim ring (Consult specification sheet for color ordering information and options).
3 Not available with Chicago Plenum.
4 Not CSA approved.

PHOTOMETRICS



Test Number	P98323
ERW6A835	6LW1H
Lumens	1463
Efficacy	67.1 Lm/W
Watts	21.8
CCT	3500K
SC	1.13

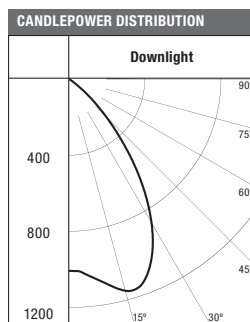
Distance Fixture to Lighted Plane	Initial Footcandles at Nadir	Beam Diameter
5'5"	33	6.0
7'	20	7.8
8'	16	9.0
9'	12	10.0
10'	10	11.2
12'	7	13.4

Degrees Vertical	Candela
0	1008
5	1002
15	956
25	845
35	602
45	281
55	98
65	19
75	5
85	0
90	0

Zone	Lumens	%Fixture
0-30	750	51.3
0-40	1122	76.7
0-60	1434	98
0-90	1463	100
90-180	0	0
0-180	1463	100

Average Candella Degrees	Average 0° Luminance
45	25954
55	11090
65	2964
75	1210
85	0

EMBOD MULTIPLIER
1000 Lumen= .64
1500 Lumen= .45



Test Number	P97443
ERW6A835	6LW1LI
Lumens	1552
Efficacy	71.2 Lm/W
Watts	21.8
CCT	3500K
SC	1.22

Distance Fixture to Lighted Plane	Initial Footcandles at Nadir	Beam Diameter
5'5"	34.0	6.5
7'	21.0	8.5
8'	16.0	9.5
9'	13.0	11.0
10'	10.5	12.0
12'	7.0	14.5

Degrees Vertical	Candela
0	1000
5	1021
15	1142
25	1022
35	663
45	267
55	39
65	2
75	0
85	0
90	0

Zone	Lumens	%Fixture
0-30	885	57
0-40	1294	83.4
0-60	1548	99.7
0-90	1552	100
90-180	0	0
0-180	1552	100

Average Candella Degrees	Average 0° Luminance
45	24598
55	4425
65	340
75	277
85	0

EMBOD MULTIPLIER
1000 Lumen= .64
1500 Lumen= .45

LD6A10 LD6A15 6LW

L2

PHOTOMETRICS

CCT Multiplication Factors		CCT [K]	Multiplier from 3500K	80 -> 90 CRI
80 CRI	1000 Lumen	2700	0.93	
		3000	0.99	
		3500	1.00	
		4000	1.01	
	1500 Lumen	2700	0.93	
		3000	0.99	
		3500	1.00	
		4000	1.01	
90 CRI	1000 Lumen	2700	0.88	0.79
		3000	0.95	0.80
		3500	1.00	0.84
		4000	1.03	0.86
	1500 Lumen	2700	0.88	0.79
		3000	0.94	0.79
		3500	1.00	0.84
		4000	1.03	0.86

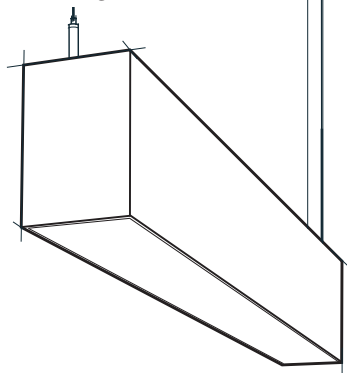
Type
Job Name
Catalog Number



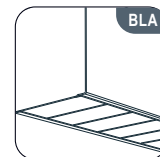
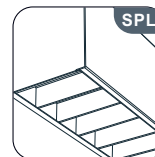
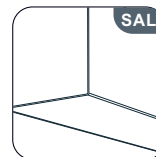
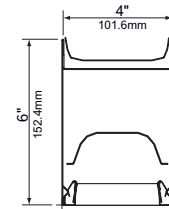
L3

Compliant RightLight™
Made in USA

P46 LED Linear



Other Manufacturers:
Gammlux "G-Beam" Series



ordering - P46 LED

series/ lamp rows	nominal length	shielding*	color/ finish	distribution	circuiting	voltage	mounting	ceiling system*	controls/options
P46-									
LED: (all sizes)	02'	SAL	TMW	D3	SC	UNV*	CA48*	X1	ND non-dimming standard
LED3	03'	satin acrylic extruded lens	textured matte white	direct/indirect	single circuit	*120-277	aircraft cable (ad-justable)	exposed T-bar	DM10 0-10v 10% dimming
LO, SO, HO* 3000K	04'	OPL	YGW	D6	DC*		aircraft cable (ad-justable)	X3 hard ceiling	DM01 0-10v 1% dimming
LED35	06'	opal frost acrylic lens	gloss white	asymmetric direct/indirect	dual circuit		aircraft cable (ad-justable)	X6 slot grid	STEP step dimming 100-50-off
LO, SO, HO* 3500K	08'	R_12'	YPE	D7R	*direct & indirect circuits		aircraft cable (ad-justable)	*specify with cable mount only	DML 1% Lutron dimming
LED4		SPL-OL**	Y	D7W			aircraft cable (ad-justable)		DMD 1% DALI dimming
LO, SO, HO* 4000K		blade louver-anodized	premium color	direct/asymmetric indirect to wall			WB wall bracket (2" standoff)		EML* emergency battery (500-600 lumens)
		BLW-OL**	CC	D8R			WS wall spacer (1/2" stand-off)		EMH* emergency battery (1100-1200 raw lumens)
		blade louver white	custom color	asymmetric indirect to room/asymmetric indirect to wall			WM* direct to wall		IBC insulated braided cord
		*for direct lighting component only	GLV galvanized						C2 90° 2-way corner
		**thin acrylic overlay masks LED's							CX special connector (consult factory)
									ADC acrylic dust cover
									DLH Right-Light™

Features A 4"x 6" direct/indirect linear lighting system with a variety of lens and louver options.

Construction The housing, ballast covers and endplates are made of die-formed 20-gauge steel. Parabolic louver material is semi-specular, low iridescent aluminum with acrylic overlay. Snap-in satin acrylic lens is clear frost extruded acrylic with a matte finish for soft, even light transmission.

Finish The standard housing is textured matte white (TMW) using polyester powder paint. Available in optional galvanized finish or refer to **Controls & Options** Section for paint colors. Canopies match finish when galvanized is specified; all others match body color unless otherwise specified.

Electrical Must specify LED dimming controls. LED fixtures have constant current driver(s) with less than 20% THD when loaded to a mini-

mum of 60%. Drivers sink a maximum of 6mA per driver. DM10 and DM01 LED drivers are 0-10V dimmable and are compatible with most 0-10V wall slide dimmers and direct 0-10V analog signal dimmers. Recommended wall dimmer is Leviton IP710 or equivalent. See data sheet to confirm all specified dimmers meet require specifications. Fixtures are ETL Damp labeled and I.B.E.W. manufactured. Maximum driver size available: 2 3/8" width x 1 1/4" height.



Linear P46 LED

photometric data

P46-LED3HO-SAL-D8R

Report # ITL31620A D=41.87% I=58.13%

Delivered Lumens: 7700

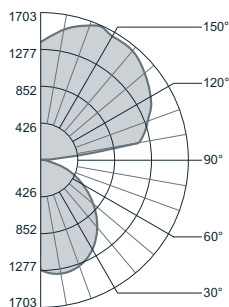
Input Watts: 105

Lumens/Watt: 73.3

Calculated L70 ≥ 100,000 hours

Reported L70 (6k) ≥ 36,000 hours

5 year LED warranty - see prulite.com



Zonal Lumen Summary

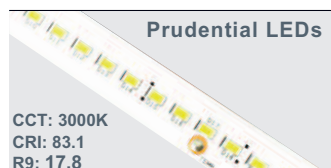
Zone	Lumens	%Luminaire
0-90	3224	41.87
90-180	4476	58.13

Candlepower Summary

Vertical Angle	0°	22.5°	45°	67.5°	90°
0	1261	1261	1261	1261	1261
5	1209	1213	1224	1229	1254
15	1064	1070	1099	1136	1195
25	881	899	943	1001	1081
35	701	717	769	841	925
45	539	555	600	671	745
55	395	407	445	498	557
65	264	272	297	333	371
75	144	149	162	178	194
85	45	46	50	50	48
90	0	0	0	0	0
95	35	34	31	27	50
105	88	89	89	69	245
115	136	732	119	180	487
125	160	157	196	407	721
135	253	291	424	650	922
145	516	558	684	872	1090
155	793	827	925	1059	1215
165	1060	1076	1135	1209	1304
175	1269	1276	1300	1319	1352
180	1361	1361	1361	1361	1361

Coefficients of Utilization (%)

Floor	effective floor cavity reflectance = .20	70	50
Ceiling	80	70	50
Wall	70 50 30 10	70 50 30 10	50 30 10
0	105105105105	96 96 96 96	79 79 79
1	96 92 88 85	88 84 81 78	70 67 65
2	88 81 75 70	80 74 69 65	61 58 55
3	80 71 64 59	73 66 60 55	55 50 46
4	74 64 56 50	67 58 52 47	49 44 40
5	68 56 49 43	62 52 45 40	44 38 35
6	62 51 43 37	57 47 40 35	39 34 30
7	57 45 38 32	52 42 35 30	35 30 26
8	53 41 33 28	48 38 31 26	32 27 23
9	49 37 30 25	45 34 28 23	29 24 20
10	46 34 27 22	42 31 25 21	27 22 18



PruBin™ is Prudential Lighting's exclusive 'job binning' method that ensures color temperature consistency across all luminaires on a project. Meticulously testing and labeling EVERY LED board to +/- 25 lumens, +/- 50k CCT and +/- .004 Duv — while also separating positive from negative — allows us to match color, hue and intensity throughout a project and provides a consistent color temperature within a 2-step MacAdam ellipse.

LED Delivered Lumens and Watts

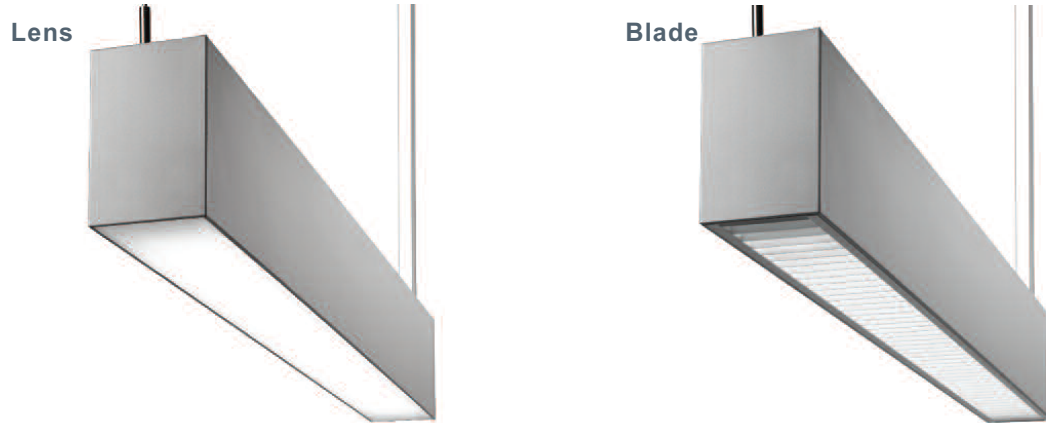
P46	LED LO	LED SO	LED HO
Lumens	770 l/ft	1550 l/ft	1925 l/ft
Watts	10 w/ft	20 w/ft	26 w/ft

Lumen output and wattages are nominal for all 3 color changes and may vary +/- 5%.

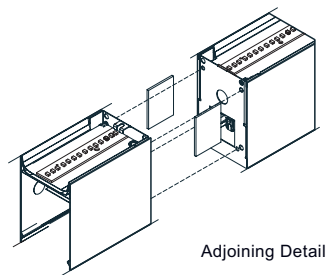


L3

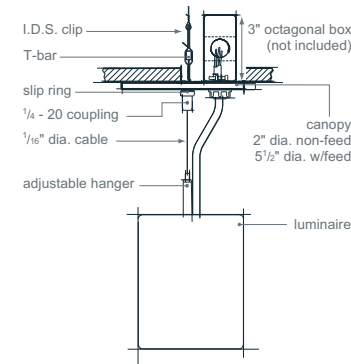
P46 LED Linear



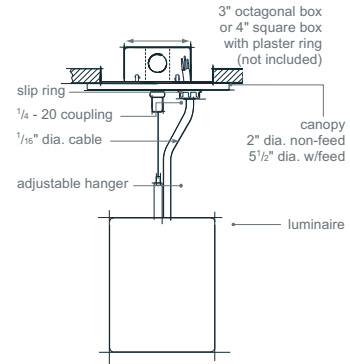
installation



Suspension (x1)

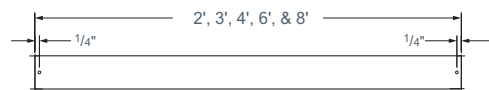


Suspension (x3)

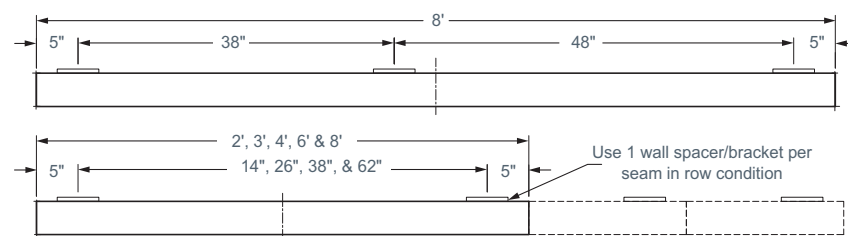


Mounting

Cable Mounting Locations



Wall Mounting Locations



0124 Prudential Ltg. 1737 East 22nd Street, Los Angeles, CA 90058

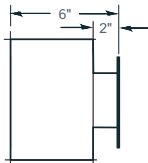


L3

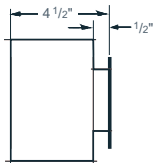
Linear **P46 LED**

Installation

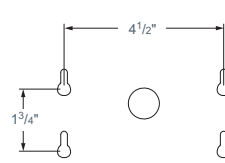
Wall Bracket



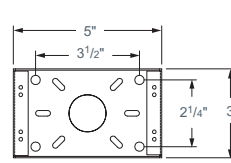
Wall Spacer



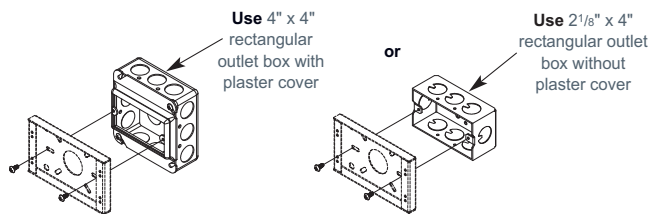
Wall Mount



Wall Spacer/Wall Bracket



Electrical outlet boxes



LED Bionic™ Wall Grazer | Perimeter

L4

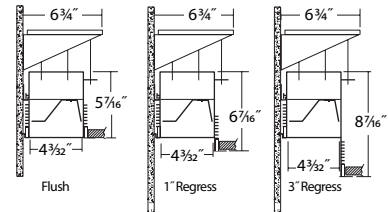


Other Manufacturers:
Gammlux "G-Beam" Series



Type:

Job:



UPTO **81** LM/W

High performance 4" perimeter wall grazer.

Housing: Extruded aluminum accommodates a wide range of ceiling systems and complex installations. Armstrong™ TechZone compatible.

3 Optics: Soft Glow (D1), precise Wall Graze (D1G) or Fill a corridor in light (D1R) from the Perimeter (flush recommended).

Series: See also our Bionic recessed linear and Wall Wash for visual continuity. Our P43 Perimeter System is nearly identical with the same great optics and a budget-friendly steel housing.

BIO-PSTD-FLSH-LED4-LO-AWW-D1G
1408 Delivered Lumens
173 Watts
81 lm/w
84 CRI
4000 CCT



Lumen output may vary +/- 5%
4000K used for lm/ft estimates above
3500K -2% llf, 3000K -4%, 2700K -6%
See LED Details PDF for more info

*BIO-REG3-LED4HO-AWW-D1G is DLC QPL listed. For other DLC listings, please consult factory.

SERIES	LENS POSITION	LED COLOR	OUT-PUT	NOMINAL LENGTH	TRIM COLOR	SHIELD-ING	DISTRI-BUTION	MOUNT-ING	CIRCUIT-ING	VOLT-AGE	CEILING SYSTEMS	CONTROLS	OPTIONS
BIO-PSTD													
Bionic Perimeter Standard	FLSH Flush Lens REG1 1" Regress Lens REG3 3" Regress Lens	LED27 2700K LED3 3000K LED35 3500K LED4 4000K	LO Low MO Medium SO Standard HO High PROG Programmable Light Output (Specify desired lm/ft or w/ft)	2' 3' 4' 6' 8' R (Row length)	TMW Textured Matte White (Standard) YGW Gloss White Y Premium Color CC Custom Color	SAL Satin Acrylic Lens (D1 Only) AWW Acrylic Wall Grazer Lens (D1G Only) AWL Perimeter Fill Lens (D1R Only)	D1 Direct SAL Only D1G Wall Grazer AWW Only D1R Perimeter Fill (AWL Only, NA REG3)	WTW Wall to Wall LP Light Pocket	SC Single Circuit	UNV (120-277)	X1 T-Bar X1M 9/16 T-bar X2 Interlude T-bar X6 Slot Grid X3 Hard Ceiling X7BF Hard ceiling (Trimless mud-over with backer flange)	ND Non-Dimming DM10 0-10v 10% Dimming Standard DM01 0-10v 1% Dimming STEP Step Dimming 100-50-Off DML 1% Lutron Dimming DMD 0.1% DALI Dimming DMG 1% DALI Dimming	EML Emergency Battery, Low (D1, D1W ~ 850 delivered lumens, D1G ~ 600) EMH Emergency Battery, High (D1, D1W ~ 1175 delivered lumens, D1G ~ 900) M1 12" MR16 Module (adj.) 1/50w (max) lamp M2 12" MR16 Module (adj.) 2/50w (max) lamp C2 90° 2-Way Lit Corner w/Acrylic Lens PRUBIN Meticulous Binning and Labeling every LED Board within a 2-Step MacAdams Ellipse Note: All MR16 lamps by others

LED Bionic™ Wall Grazer | Perimeter

L4

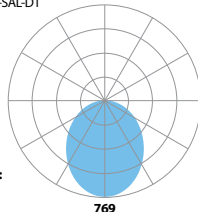


PRUDENTIAL LTG.

PRULITE.COM 213.746.0360

SAL-D1 GLOW

Low Output:
BIO-PSD-FLSH-LED4-LO-SAL-D1
1682 Delivered Lumens
18.1 Watts
88 lm/w
85 CRI
4000 CCT
Light Labs Test
L041412304R01



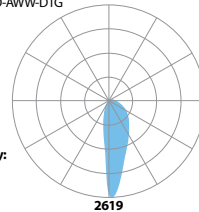
Zonal Lumen Summary:
0-90 = 100%

Vertical Angle	0	25	45	65	90
0	769	769	769	769	769
5	762	763	763	760	760
15	720	717	709	698	693
25	642	632	612	592	582
35	538	522	494	469	457
45	421	403	373	349	337
55	303	303	263	243	234
65	199	188	171	157	151
75	100	93	84	78	75
85	24	23	21	21	20
90	0	0	0	0	0

UPTO	88	LM/W		
	LOW	MEDIUM	STANDARD	HIGH
lm/ft	390	600	875	1000
w/ft	4.5	7	10	12

WALL GRAZER

Low Output:
BIO-PSD-FLSH-LED4-LO-AWW-D1G
1408 Delivered Lumens
17.3 Watts
81 lm/w
85 CRI
4000 CCT
Light Labs Test #



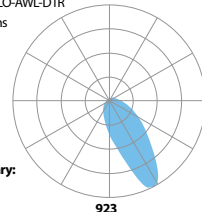
Zonal Lumen Summary:
0-90 = 100%

Vertical Angle	0	22.25	45	67.5	90
0	2619	2619	2619	2619	2619
5	2290	2337	2462	2578	2603
15	1486	1526	1675	2096	2463
25	1101	1134	1233	1588	2149
35	787	814	898	1145	1692
45	559	580	623	792	1141
55	381	394	432	521	673
65	255	260	272	311	346
75	157	153	151	147	146
85	54	50	47	41	32
90	0	0	0	0	0

UPTO	81	LM/W		
	LOW	MEDIUM	STANDARD	HIGH
lm/ft	350	550	775	900
w/ft	4.5	7	10	12

PERIMETER FILL

Low Output:
BIO-PSD-FLSH-LED4-LO-AWL-D1R
1560 Delivered Lumens
17.3 Watts
90 lm/w
85 CRI
4000 CCT
Light Labs Test #
L021507501R01



Zonal Lumen Summary:
0-90 = 100%

Vertical Angle	0	22.5	45	67.5	90
0	785	785	785	785	785
5	979	969	920	850	786
15	1638	1548	1307	1000	763
25	2136	2065	1742	1147	715
35	1909	1946	1894	1253	644
45	1358	1400	1541	1238	548
55	863	890	991	1000	425
65	463	491	552	597	276
75	186	199	236	258	134
85	39	40	45	50	26
90	0	0	0	0	0

UPTO

88

LM/W

	LOW	MEDIUM	STANDARD	HIGH
lm/ft	390	600	875	1000
w/ft	4.5	7	10	12

LUMEN MAINTENANCE

Designed to last with cool running mid-power LEDs projected to maintain 90% (L90) of their initial output for 100,000 hours (at HO), and L70 exceeding 150,000 hours.

LED SYSTEM

LED modules and drivers are field replaceable.

PROG (optional)

Programmable light output. Specify desired lumens or watts per linear foot. Min: 2.5 w/ft, consult factory for requests above 12 w/ft.

BINNING

Standard binning (all Prudential LED boards) includes testing at the chip level and board integration to provide consistent color temperature within a 3-step MacAdam ellipse, with +/- 5% lumen output range and +/- .004 Duv.

PRUBIN™ (OPTIONAL)

Prudential Ltg's exclusive 'job binning' method that ensures color temperature consistency across all luminaires on a project. Meticulously testing and labeling EVERY LED BOARD to +/- 25 lumens, +/- 50K CCT and +/- .004 Duv — while also separating positive from negative — allows us to match color, hue and intensity throughout a project and provides a consistent color temperature within a 2-step MacAdam ellipse.

LABELS

ETL damp labeled and I.B.E.W. manufactured

ELECTRICAL

Must specify LED dimming controls. LED fixtures have constant current driver(s) with less than 20% THD when loaded to a minimum of 60%. Drivers sink a maximum of 6mA per driver. DM10 LED drivers are 0-10V dimmable and are compatible with most 0-10V wall slide dimmers and direct 0-10V analog signal dimmers. Max driver size 1.25" w x 1" h.

CONSTRUCTION

Housing

Extruded aluminum >25% PC recycled, 100% recyclable

Lens

Acrylic, 100% recyclable

MOUNTING

Recessed into drywall or T-bar ceilings

WARRANTY

Single-source, 5 year limited warranty covers standard components and construction



Prudential Ltg. reserves the right to change design specifications or materials without notice. Please visit www.prulite.com for most current data.
© 2014 All rights reserved — All products manufactured at: Prudential Ltg. 1774 E. 21st Street, Los Angeles, CA 90058

Perimeter

2

01-07-16

Lighting Services Inc

L5

LUMeLEX® MAR2 SERIES • 120/277V • LED



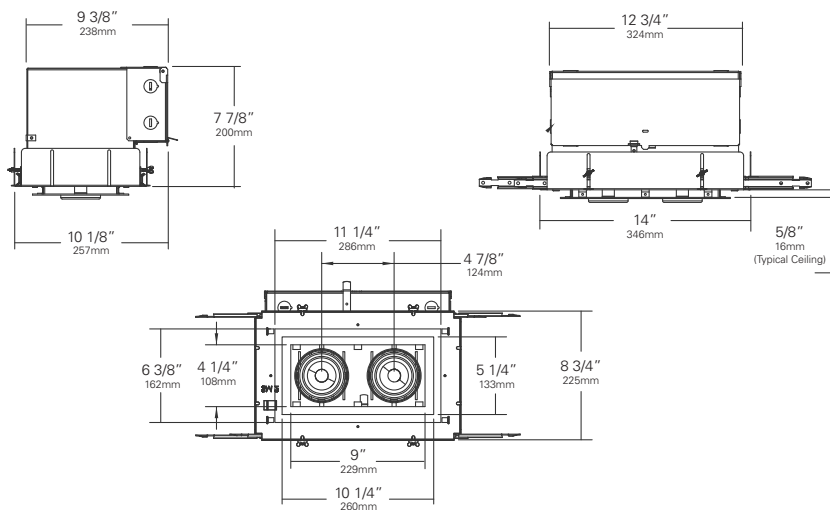
Other Manufacturers:
Lightolier "LLAVRM" Series

The LumeLEX MAR2 Series features the highly efficient Xicato XTM Modules and a variety of optics and accessory options for unprecedented flexibility.

- Designed for the Xicato™ XTM LED module up to 20 Watts
- Extremely tight color consistency (less than 2 MacAdam Ellipses)
- System efficiency up to 100 lumens/watt
- Backed by Xicato's Five Year Color Consistency and Lumen Maintenance Warranty
- Tested to LM79 and LM80 Protocols
- 50,000 hour life to 70% lumen output, L₇₀ at 95°F max ambient
- Integral electronic driver compatible with reverse phase (ELV compatible) dimmers down to 5%
- 40° and 60° field changable optics included
- Choice of LED modules with various lumen outputs
- Choice of color temperatures
- Color Rendering Index (CRI) of either 98 (high) or 83+ (standard)
- No UV or IR emissions; no mercury or lead
- Sturdy cast aluminum housing
- All LumeLEX modules are field replaceable
- Can be ordered for 120V or 277V
- Sturdy steel and die cast aluminum construction
- Accepts up to three size-AAA LSI filters and accessories
- Thermally protected and approved for all Non-IC ceiling types, including air handling plenums
- Unique spring-loaded clamping system facilitates installation in plaster, sheetrock or acoustic tiles
- Supplied with LED driver
- Flange finishes: LSI Black, White and Silver
- Fixture weight: 10 LB



SPECIFICATIONS



03/16 www.LightingServicesInc.com

Lighting Services Inc

L5

ORDERING INFORMATION

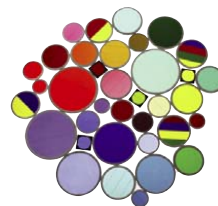
1. Choose the desired LED Module **(T19)** for XTM (19mm)
2. Choose the numeric code to designate the desired LED Rating
LED Module/CRI/Wattage
(7-98) for 700/98/12
(10-83) for 1000/83/12
(10-98) for 1000/98/17
(15-83) for 1500/83/15
3. Choose the numeric code to designate the desired
Color Temperature
(27) for 2700K **(30)** for 3000K **4000K**
For other CCT, consult factory
4. Choose the letter code for **Driver Type:**
(TE) Trailing Edge (Reverse Phase) (5%)
(10) 0-10V (10%) (Canopy mount only)
5. Choose the desired **Voltage:**
(120) for 120V **(277)** for 277V
6. Choose a **Finish** for your fixture:
Black **(B)** White **(W)** Silver **(S)** Trimless **(T)**

Confirm with architect

Example: **LXMAR2** - **T19** **15-83** **27** - **TE** **120** **W**
FIXTURE LED MODULE LED RATING COLOR TEMP DRIVER VOLTAGE FINISH

7. Don't forget your Accessories!

ACCESSORIES



Glass Color Filters AAA
Selection of 95 permanent rimmed dichroic and rimmed and slotted standard colors.

Other accessories:

- Spread Lenses AAA990, AAA992, AAA995, AAA996
- Beam Softener AAA998
- Louver Hex AAA
- Light Blocking Screens AAA801S, AAA802S, AAA803S
- Hood AAA
- Cross Baffle AAA

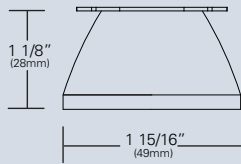
- Color and Spread Gels AAA
- Backer Ring AAA

www.LightingServicesInc.com • Solid State 03/16

Lighting Services Inc

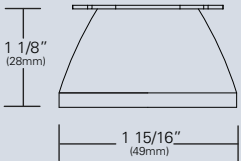
L5

LUMeLEX® MAR2 SERIES • OPTICS



LX-S40-REF-CLR (49mm/40°)

Computer designed polycarbonate specular optic. Tool-less, twist and lock installation.



LX-S60-REF-CLR (49mm/60°)

Computer designed polycarbonate specular optic. Tool-less, twist and lock installation.

Lighting Services Inc

L5

LUMeLEX® MAR2 SERIES • PERFORMANCE

The performance characteristics of the Lumex MAR Series can be customized based on the LED module and the optic (reflector) selected.

Each available LED module is defined by four characteristics – the color rendering index (CRI), the correlated color temperature (CCT), the power that it uses (watts), and its “available lumens.” Note that available lumens is a theoretical value that represents the light output of the module on its own – no fixture or optic attached.

In the LSI part number, the LED module is specified with a number that immediately follows the product series number.

For example, in the part number LXMAR2-T1910-8327-TE120W, the “T1910-8327” represents an LED module with an output of 1000 lumens, a CRI of 83, a power usage of 12 watts and a color temperature of 2700K.

Additional parameters, such as Center Beam Candle Power (CBCP), Delivered Lumens, and Efficiency (Lumens per Watt) are all shown in a table that is organized by LED module and optic combination.

CBCP = Center Beam Candle Power		
LED Module	Optic (Reflector)	
Lumens/CRI/Wattage	S4	S6
700/98/12	1050	700
1000/83/12	1500	1000
1000/98/17	1500	1000
1500/83/15	2000	1400

Delivered Lumens		
LED Module	Optic (Reflector)	
Lumens/CRI/Wattage	S4	S6
700/98/12	402	668
1000/83/12	602	864
1000/98/17	602	864
1500/83/15	783	1123

Efficiency = Lumens Per Watt		
LED Module	Optic (Reflector)	
Lumens/CRI/Wattage	S4	S6
700/98/12	33	56
1000/83/12	50	72
1000/98/17	35	51
1500/83/15	52	75

Absolute range of values are +/- 10% of typical value, and are for all color temperatures

LED Module				
Lumens/CRI/Wattage SKU Code	700/98/12 07-98	1000/83/12 10-83	1000/98/17 10-98	1500/83/15 15-83
Nominal Fixture Power (+/- 20%), Watts	12	12	17	15
Maximum Inrush Current Amps	10	10	10	10
Minimum Power Factor	0.92	0.92	0.92	0.92

Inrush current is instantaneous current drawn by the LED only when fixture is initially powered on or instantaneously changed from full dim to full bright. For more details see Dimming Application Sheet, IS-0119.

Lighting Services Inc

L5

LUMELUX® MAR2 SERIES • PHOTOMETRIC DATA

LED RATING: 15-83

S4- 49mm DIA Optic
Beam Spread (minimum) **40°**
Center Beam Candlepower **2000**
CRI **83**

S6- 49mm DIA Optic
Beam Spread (minimum) **60°**
Center Beam Candlepower **1400**
CRI **83**

LED RATING: 10-98

S4- 49mm DIA Optic
Beam Spread (minimum) **40°**
Center Beam Candlepower **1482**
CRI **83**

S6- 49mm DIA Optic
Beam Spread (minimum) **60°**
Center Beam Candlepower **1009**
CRI **83**

LED RATING: 15-83

S6
(60°)

S4
(40°)

All Distances in Feet

All Max. Footcandles at 0° Beam Axis

	6	4	2	0	2	4	6	
1								1
2								2
3								3
4								4
5								5
6								6
7								7
8								8
9								9
10								10
11								11
12								12
13								13
14								14
15								15
16								16
17								17
18								18
19								19
20								20
21								21
22								22
23								23
24								24
25								25

Photometric Data based on LED Rating: 15-83 (1500 Lumens/83CRI/15watts)

LED RATING: 10-98

S6
(60°)

S4
(40°)

All Distances in Feet

All Max. Footcandles at 0° Beam Axis

	6	4	2	0	2	4	6	
1								1
2								2
3								3
4								4
5								5
6								6
7								7
8								8
9								9
10								10
11								11
12								12
13								13
14								14
15								15
16								16
17								17
18								18
19								19
20								20
21								21
22								22
23								23
24								24
25								25

Photometric Data based on LED Rating: 10-98 (1000 Lumens/98CRI/17watts)

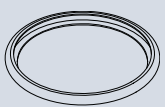
L5

LUMeLEX® MAR2 • ACCESSORIES



SPREAD LENSES AND BEAM SOFTENER

No.	Description	% of Light Transmission
990	Spread Lens/Clear	83 (5°X 50°)
992	Spread Lens/Clear	85 (5°X 30°)
995	Spread Lens/Clear	83 (50°X 50°)
996	Spread Lens/Clear	86 (45°X 50°)
998	Beam Softener/Clear	80 (45°X 45°)



BACKER RING AAA
Stainless steel ring to hold gel when no other size AAA accessories are being used.



LOUVER HEX AAA
1/8" thick Hexcell black metal louver used for thin profile.



¹ LIGHT BLOCKING SCREENS AAA
Stainless steel mesh screens used alone or in combinations will block from approximately 20% to 90% of the transmitted light without changing color temperature of the light.

No.	% of Light Blocked
AAA801S	20
AAA802S	30
AAA803S	40

1. Figures vary based upon LED Module/Optic being used and relationship of screen(s) to LED Module/Optic and to each other.

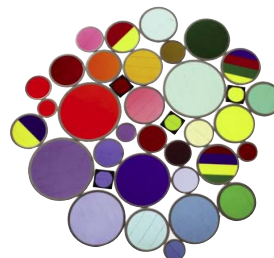
Lighting Services Inc

L5

SOLID STATE • COLOR MEDIA

COLOR MEDIA

As the foremost innovator in accent lighting, LSI offers a complete range of permanent fade-free glass color filters, which are available in nine stock diameters. All glass color filters are rimmed in a seamless aluminum ring and are slotted for heat expansion.



Size	Diameter	LSI Fixture Series	Duocolor® Filters		No.	Color	% of Light Transmission
AAA	2 3/8"	LumeLEX® 2030/2031, SSLGR16, LumeLEX MAR	LSI two color glass filters blend to form one unique color that previously could only be achieved by using two separate color filters in the same fixture. Two color fringed shadows produced on background.		902	Medium Pink	36
AA	3"	LumeLEX® 2024 (with LX2024-Holder or LX2024-Barndoor), LumeLEX® 2026, LumeLEX® 2044, LumeLEX 2048	No. Glass Colors Used		903	Deep Pink	37
A	3 1/2"	LumeLEX® 2060, SSL230, SSLGR30, SSLGR36	770 910/944		904	Flesh Pink	73
C	4 3/4"	SSL238, SSLGR38CL, LumeLEX® 2084	771 910/921		906	Pale Lavender	14
			772 910/930		907	Surprise Pink	19
			773 944/933		908	Lilac	21
			774 921/930		910	Warm Red	10
			775 930/933		911	Strawberry	6
			776 910/948		912	Ruby	4
					913	Magenta	1
					914	Light Amethyst	25
					915	Medium Amethyst	16
					916	Deep Amethyst	4
					917	Olive	18
					918	Light Green	68
					920	Medium Green	25
					921	Deep Green	7
					922	Silver green	65
					923	Yellow Green	49
					924	Emerald Green	12
					925	Light Turquoise	68
					926	Medium Turquoise	40
					927	Deep Turquoise	17
					928	Light Blue	34
					930	Medium Blue	3
					932	Daylight	59
					933	Gene Moore Blue	18
					936	Grey	56
					937	Light Blue Green	17
					939	Light Amber	68
					940	Medium Amber	48
					941	Deep Amber	43
					942	Straw	78
					943	Gold	87
					944	Canary Yellow	84
					945	Lemon	81
					946	Pumpkin	32
					947	Tangerine	20
					948	Orange	23
					949	Pink Gold	54
					950	Bronze	48
					951	Brass	11
					952	Autumn Tan	11
					953	Leaf Brown	19
					954	Butter Pecan	3
					955	Toasted Almond	1

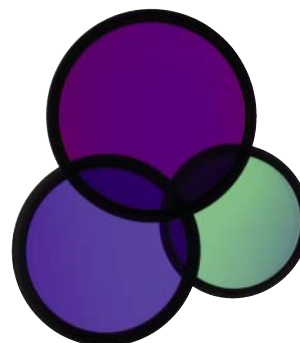
SOLID STATE • COLOR MEDIA

DICHROIC COLOR FILTERS

In addition to our complete line of glass color filters, LSI now offers dichroic glass color filters that achieve purer, more saturated, richer color by selective wavelength transmission. Since these filters reflect rather than absorb the unwanted color wavelengths, a higher intensity of colored light can be obtained with fewer or lower wattage fixtures. In addition, this selective transmission allows for very accurate color matching from filter to filter.

All standard LSI filter sizes are available in a wide palette of well chosen dichroic colors that can be used with all LSI fixtures that accept accessories.

LSI dichroic glass color filters have the added benefit of being rimmed for extra durability to allow for frequent usage without fear of breakage or edge chipping.



Size	Diameter	LSI Fixture Series	Technical Data	No.	Color	% of Light Transmission
AAA	2 3/8"	LumeLEX® 2030/2031, SSLGR16, LumeLEX MAR	Dichroic color filters are created in a vacuum chamber by multi-layer vapor deposits of different minerals onto low expansion, chemically resistant Borosilicate glass.	2001	Light Pink	69
AA	3"	LumeLEX® 2024 (with LX2024-Holder or LX2024-Barndoor), LumeLEX® 2026, LumeLEX® 2044, LumeLEX 2048	Deposits are made in alternating layers of varying microscopic thickness which allow very narrow color wavelengths to be selectively transmitted and all other wavelengths to be reflected.	2002	Medium Pink	43
A	3 1/2"	LumeLEX® 2060, SSL230, SSLGR30, SSLGR36	LSI does not recommend using dichroic color filters with lamps or fixtures that have beam spreads greater than 40° because a secondary color aura is created by the wide angular transmitted wavelengths that are different than the desired color wavelength.	2003	Hot Pink	11
C	4 3/4"	SSL238, SSLGR38CL, LumeLEX® 2084	Since there is mainly transmission and reflection of the color wavelengths by the dichroic filter and very little absorption, the dichroic filter can be used with many high temperature lights that normally would not accept color filters.	2004	Pale Pink	55
Special Glass Color Filters				2010	Deep Magenta	29
LSI will fabricate, on special order, dichroic glass color filters in most sizes and shapes not exceeding a 13" diameter circle overall.				2011	Lavender	24
FS4 — Color Filter Samples				2012	Vivid Magenta	31
To facilitate selection of glass color filters, LSI supplies a complete set of 1 3/4" X 1 3/4" labeled glass and dichroic samples in a handy carrying case.				2013	Lavender Accent	48
				2014	Lilac	37
				2015	Purple Fusion	12
				2020	Sky Blue	39
				2021	Sea Blue	39
				2022	Cyan	33
				2023	Light Blue Green	30
				2024	Primary Blue	24
				2025	Medium Red Blue	15
				2026	Deep Purple	16
				2027	Peacock Blue	53
				2028	Mediterranean Blue	20
				2029	Boost Blue	51
				2040	Light Yellow Green	64
				2041	Fern Green	47
				2042	Turquoise	35
				2043	Primary Green	31
				2044	Industrial Green	64
				2050	Yellow	80
				2051	Amber	71
				2052	Amber Blush	38
				2053	Bastard Amber	71
				2054	Goldenrod	63
				2055	Bright Straw	56
				2060	Medium Orange	51
				2061	Orange	44
				2070	Flame Red	27
				2071	Primary Red	25

Lighting Services Inc

L5

LUMeLEX® MAR2 SERIES • GELS

As the foremost innovator in accent lighting, LSI offers a complete range of pre-cut Gels to modify the color and distribution of light for the LumeLEX 2000 LED Series.



LumeLEX® SPREAD GELS

Size: AAA (60 mm diameter)	Spread Gel
GELL1-AAA	1° Spread Gel
GELL5-AAA	5° Spread Gel
GELL10-AAA	10° Spread Gel
GELL20-AAA	20° Spread Gel
GELL30-AAA	30° Spread Gel
GELL40-AAA	40° Spread Gel
GELL60-AAA	60° Spread Gel
GELL80-AAA	80° Spread Gel
GELL30B5-AAA	30° by 5° Spread Gel
GELL40B2-AAA	40° by 0.2° Spread Gel
GELL60B1-AAA	60° by 1° Spread Gel
GELL60B10-AAA	60° by 10° Spread Gel
GELL75B45-AAA	5° by 45° Spread Gel
GELL90B60-AAA	90° by 60° Spread Gel
GELR101-AAA	Beam Softener

LumeLEX® COLOR GELS

Size: AAA (60 mm diameter)	Gel Color	Size: AAA (60 mm diameter)	Gel Color
GELR7-AAA	Pale Yellow	GELR3204-AAA	Half Blue
GELR12-AAA	Straw	GELR331-AAA	Shell Pink
GELR13-AAA	Straw Tint	GELR383-AAA	Sapphire Blue
GELR14-AAA	Medium Straw	GELR397-AAA	Pale Grey
GELR21-AAA	Golden Amber	GELR2001-AAA	Storaro Red
GELR25-AAA	Orange Red	GELR2004-AAA	Storaro Green
GELR26-AAA	Light Red	GELR2009-AAA	Storaro Violet
GELR27-AAA	Medium Red	GELR3202-AAA	Full Blue
GELR57-AAA	Lavender	GELR3206-AAA	Third Blue
GELR71-AAA	Sea Blue	GELR3216-AAA	Eighth Blue (Boosts 3200K to 3300K)
GELR72-AAA	Azure Blue	GELR3318-AAA	Tough 1/8 Minusgreen
GELR91-AAA	Primary Green	GELR3410-AAA	Roscosun (1/8 CTO) (Reduces 5500K to 4900K)
GELR97-AAA	Light Grey	GELR3441-AAA	Full Straw (CTS)
GELR98-AAA	Medium Grey	GELR3443-AAA	Quarter Straw (CTS)
GELR101-AAA	Light Frost	GELR4330-AAA	CalColor 30 Cyan
GELR104-AAA	Tough Silk	GELR4415-AAA	CalColor 15 Green
GELR119-AAA	Lt. Hamburg Frost	GELR4490-AAA	CalColor 90 Green
GELR121-AAA	Blue Diffusion	GELR4860-AAA	CalColor 60 Pink
GELR305-AAA	Rose Gold	GELR4890-AAA	CalColor 90 Pink
GELR312-AAA	Canary	GELR4930-AAA	CalColor 30 Lavender

CORELITE™

DESCRIPTION

The Corelite R3 LED combines the internally developed Linear LED platform from Cooper Lighting with the high sense of style and superior brightness management that characterizes the CoreLite Class R family. The proprietary LED platform delivers a soft, diffuse volume of pure white light that carries the general character of a fluorescent source while simultaneously eliminating unsightly socket shadows and the hassle of luminaire maintenance. A guaranteed system life of 50,000 hrs combined with exceptional efficacy make the R3 LED the ultimate solution to satisfy the most stringent energy requirements with an ultra-light carbon footprint.

Catalog #	Type
Project	L6
Comments	Date
Prepared by	

SPECIFICATION FEATURES

A ... Construction

Low profile housing constructed of die formed 20 gauge cold rolled steel with integral 20 gauge gear tray.

B ... Reflectors

Precision tooled, high reflectance sheet metal which allows for easy access to driver compartment from below ceiling plenum.

C ... Shielding

High light transmission clear acrylic outer lens contains acrylic frosted sheet inlay with perf pattern. Each component contains UV inhibitors. The lens assembly minimizes lamp image and ensures efficient light distribution. Lenses secured to housing via injection molded inserts for easy lamp access.

D ... Electrical

Fixture equipped with proprietary Cooper LED modules available in 3000, 3500 or 4000k with a CRI plus or minus 85. Removable module features aluminum extrusion providing exceptional thermal management. Modules are driven using universal voltage switch mode LED drivers. Fixture and modules certified to UL and CUL standards. A 0 to 10V dimming control is available (standard).

E ... Finish

Fixture housings are high reflectance white using electrostatically applied polyester powder coat paint.

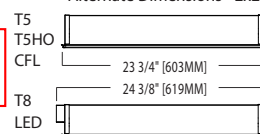
Mounting

Standard flange design works with most lay in ceiling types. Integral pryout tabs secure luminaire to ceiling grid from above. Fixture offers tie in locations for tie wire on all corners, consult local code for appropriate tie wire recommendations.

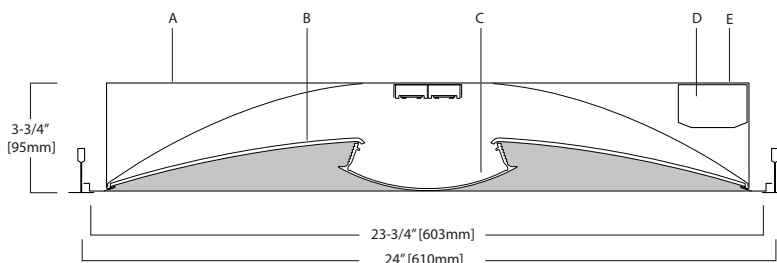
NOTE: Concealed Ceiling

Class R may be installed into inaccessible ceilings (sheet rock, wood panel, etc.). This is achieved with the Metalux DFW series drywall frame-in kit, ordered separately from Metalux. Specify CC for the Corelite Ceiling Type. Specify the following part numbers separately, from Metalux: For 2x2, order Metalux part DF-22W-U.

Alternate Dimensions - 2x2



Other Manufacturers:
Day-Brite "CA" Series



CLASS R3
Rectangular Perf
Inlay
Round Perf Inlay

LED

2'x2' Recessed
3-3/4" Depth

ORDERING INFORMATION

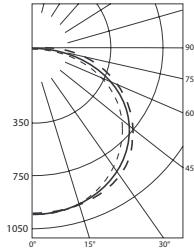
Sample Number: R3-WG-1L30-1C-UNV-22-T1

Series	Shielding	Color Temperature	Wiring ¹	Voltage ¹	Ceiling Type	Options ¹
R3: Class R3	D: Round Perf Inlay G: Rectangular Perf Inlay	L30: LED, 3000K L35: LED, 3500K L40: LED, 4000K	B: Battery Pack C: Standard Circuit D: Dimming E: Emergency T: Nightlight V: Daylight	120: 120V 277: 277V 347: 347V UNV: Universal (120V-277V)	T1: 1" Grid, Slot-Grid, 9/16" Tegular T9: 9/16" Grid CC: Concealed Ceiling SU: Surface Mount	AR: Air Return CP: Chicago Plenum NY: New York City Construction W6: 6" Whip Flex W12: 12" Whip Flex
Reflector W: White	Light Level 1: Light Level 1 2: Light Level 2	Number of Circuits 1: 1 Circuit		Size 22: 2' x 2'		

Notes: ¹ Not all options available. Please consult your Cooper Lighting Representative for availability.

PHOTOMETRICS

L6 Corelite



R3-WD-2L35-2x2
2901 Lumens
34.5 Watts
84.2 LPW
LED ALM 2.0

Test Report: #P22367

Coefficients of Utilization

Effective floor cavity reflectance													20%												
rc	80%				70%				50%				30%				10%				0%				
rw	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	50	30	10	0				
RCR																									
0	119	119	119	119	116	116	116	116	111	111	111	106	106	106	102	102	102	100	100	100	100				
1	108	103	99	95	105	101	97	93	97	93	90	93	90	87	89	87	85	83	83	83	83				
2	98	90	82	76	95	88	81	76	84	79	74	81	76	72	78	74	70	68	68	68	68				
3	89	78	70	63	87	77	69	63	74	67	61	71	65	60	68	63	59	57	57	57	57				
4	82	69	60	53	79	68	59	53	65	58	52	63	57	51	61	55	51	48	48	48	48				
5	75	62	52	46	73	61	52	45	58	51	45	56	50	44	55	49	44	42	42	42	42				
6	69	55	46	40	67	54	46	40	53	45	39	51	44	39	49	43	38	36	36	36	36				
7	64	50	41	35	62	49	41	35	48	40	35	46	39	34	45	39	34	32	32	32	32				
8	60	46	37	31	58	45	37	31	44	36	31	42	36	31	41	35	30	29	29	29	29				
9	56	42	34	28	54	41	33	28	40	33	28	39	32	28	38	32	27	26	26	26	26				
10	52	39	31	25	51	38	30	25	37	30	25	36	30	25	35	29	25	23	23	23	23				

Zonal Lumen Summary

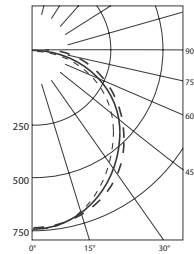
Zone	Lumens	% Lamp	% Fixture
0-30	757	N.A.	26.1
0-40	1242	N.A.	42.8
0-60	2223	N.A.	76.6
0-90	2901	N.A.	100
40-90	1659	N.A.	57.2
60-90	678	N.A.	23.4
90-180	0	N.A.	0
0-180	2901	N.A.	100

Luminance Data

Angle in Deg	0-Deg cd/sm	45-Deg cd/sm	90-Deg cd/sm
45	2468	2678	2901
55	2258	2627	2987
65	1959	2535	3146
75	1494	2469	3609
85	953	1874	2433

Candela

Angle	0-Deg	23-Deg	45-Deg	68-Deg	90-Deg
0	971	971	971	971	971
5	969	967	966	965	966
10	954	955	956	956	957
15	931	934	937	940	942
20	899	901	908	913	917
25	855	859	869	878	883
30	803	810	824	840	846
35	746	752	774	796	806
40	680	690	719	754	766
45	609	622	661	702	716
50	536	549	598	644	661
55	452	473	526	580	598
60	371	395	453	509	530
65	289	316	374	436	464
70	211	238	299	366	400
75	135	165	223	292	326
80	73	99	147	195	214
85	29	41	57	63	74
90	0	0	0	0	0



R3-WD-1L35-2x2
2260 Lumens
28.1 Watts
80.4 LPW
LED ALM 2.0

Test Report: #P22359

Coefficients of Utilization

Effective floor cavity reflectance													20%												
rc	80%				70%				50%				30%				10%				0%				
rw	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0							
RCR																									
0	119	119	119	119	116	116	116	116	111	111	111	106	106	106	102	102	102	100							
1	108	103	99	95	105	101	97	93	97	93	90	93	90	87	89	87	85	83							
2	98	89	82	76	95	87	81	75	84	78	74	81	76	72	77	74	70	68							
3	89	78	70	63	87	77	69	62	74	67	61	71	65	60	68	63	59	57							
4	81	69	60	53	79	68	59	53	65	58	52	63	56	51	61	55	50	48							
5	75	61	52	45	73	60	52	45	58	51	45	56	49	44	54	48	44	41							
6	69	55	46	40	67	54	46	39	52	45	39	51	44	39	49	43	38	36							
7	64	50	41	35	62	49	41	35	48	40	34	46	39	34	45	39	34	32							
8	59	46	37	31	58	45	37	31	44	36	31	42	35	30	41	35	30	28							
9	55	42	33	28	54	41	33	28	40	33	28	39	32	27	38	32	27	25							
10	52	39	31	25	51	38	30	25	37	30	25	36	30	25	35	29	25	23							

Zonal Lumen Summary

Zone	Lumens	% Lamp	% Fixture
0-30	584	N.A.	25.8
0-40	960	N.A.	42.5
0-60	1725	N.A.	76.3
0-90	2260	N.A.	100
40-90	1300	N.A.	57.5
60-90	535	N.A.	23.7
90-180	0	N.A.	0
0-180	2260	N.A.	100

Luminance Data

Angle in Deg	0-Deg cd/sm	45-Deg cd/sm	90-Deg cd/sm
45	1912	2079	2265
55	1753	2058	2353
65	1546	2000	2495
75	1184	1959	2878
85	723	1446	1841

Candela

Angle	0-Deg	23-Deg	45-Deg	68-Deg	90-Deg
0	748	748	748	748	748
5	745	744	744	744	744
10	735	735	736	737	737
15	717	719	722	725	727
20	693	696	700	705	708
25	659	663	673	679	683
30	619	625	637	650	656
35	575	584	601	618	627
40	525	533	558	587	596
45	472	483	513	547	559
50	413	427	466	503	518
55	351	370	412	455	471
60	288	308	354	401	420
65	228	248	295	346	368
70	163	187	236	291	318
75	107	129	177	232	260
80	58	78	117	154	169
85	22	32	44	49	56
90	0	0	0	0	0

COOPER LIGHTING - METALUX®

DESCRIPTION

SNLED Lensed is a narrow LED lensed striplight series. This high quality luminaire is dedicated to the latest solid state lighting and electronic driver technology for optimal performance and energy efficiency. This Lensed product is available with three different lens types.

The small size of the SNLED makes it an ideal choice for size restricted architectural applications. The SNLED Series can be the illumination solution in commercial, industrial, retail and residential applications. Fixtures can be used in storage/utility areas, corridors, display cases, task and general area lighting.

Other Manufacturers:
Day-Brite "LF" Series

Catalog #		Type
Project		L7
Comments		Date
Prepared by		

SPECIFICATION FEATURES

Construction

Channel is die formed cold rolled steel with numerous KOs for ease of installation. Groove for Tong Hanger. End plate quickly converts to snap-in channel connector for continuous row alignment. Channel/wireway cover secured with sheet metal screws.

Controls

Equipped standard with a 0-10V continuous dimming driver that works with any standard 0-10V control/dimmer. Dimming range is 10% to 100%; varies by control device. Combine with energy-saving products like occupancy sensors, day lighting controls, and lighting relay panels from Cooper Controls (www.coopercontrol.com) to maximize energy savings. For motion control, reference options for both end and middle of the row applications.

Electrical

Long-Life LED system coupled with electronic (120-277V) driver to deliver optimal lighting performance. LED's available in 3500k, 4000k, or 5000k with a CRI ≥ 85 . Other color temperatures are available. Projected life is 72,000 hours at 70% lumen output. This driver is 0-10V dimming standard.

Finish

Multistage iron phosphate pretreatment ensures maximum bonding and rust inhibitor. High reflective paint after fabrication, baked white enamel finish is standard.

Channel/Wireway Cover

Die formed heavy gauge steel. Tight fit for ease of maintenance.

Shielding

Offers three different lensed optical distributions.

Installation

Fixture may be surface, pendant, or stem mounted. See accessories below in ordering information.

Compliance

Components are CSA recognized. Product is damp location listed. Indoor luminaires are CSA listed for 35°C ambient environments, RoHS compliant, and comply with IESNA LM-79. LEDs comply with LM-80 standards. DesignLights™ Consortium Qualified (both lumen versions). Refer to www.designlights.org Qualified Products under Family Models for details.

Warranty

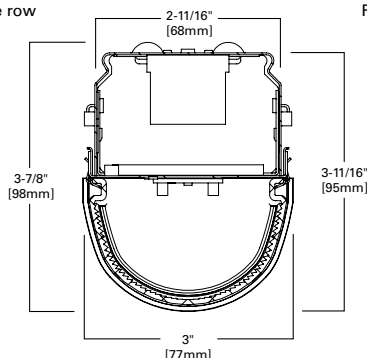
Five-year warranty.



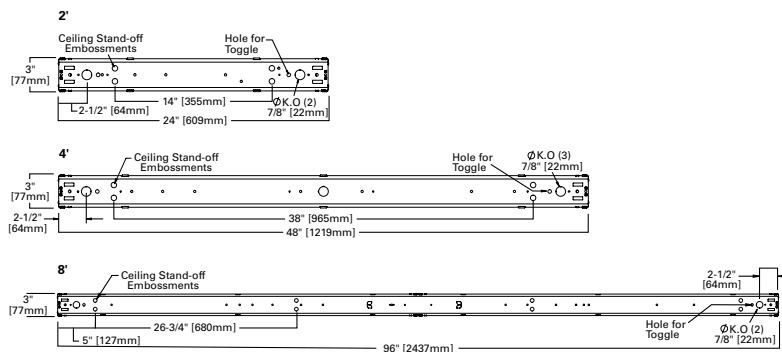
SNLED LENSED LED

Lensed LED Striplight

powered by
fifthlight
technology



MOUNTING DATA



Cooper Lighting
by **EATON**

LINEAR DISCONNECT
Safe and convenient means of
disconnecting power

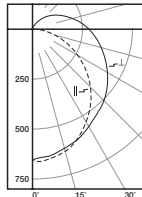


ADF121822
2014-04-30 09:21:29

SNLED LENSED

L7

PHOTOMETRICS



SNLED-LD1-52-LW-UNV-L835-CD1-U
Electronic Driver
3500K LEDs
Spacing criterion:
(H) 1.2 x mounting
height, (L) 1.3 x
mounting height
Test Report:
P32263-R2

Candlepower

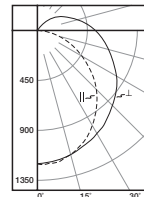
Angle	Along H	45°	Across L
0	1199	1199	1199
5	1200	1190	1190
10	1190	1179	1181
15	1159	1152	1162
20	1115	1119	1133
25	1052	1072	1101
30	990	1029	1067
35	915	978	1031
40	832	922	996
45	743	866	958
50	654	805	911
55	559	743	867
60	471	684	818
65	375	625	765
70	284	565	716
75	198	508	663
80	120	454	611
85	57	402	562
90	10	355	514

Coefficients of Utilization

rc rw RCR	Effective floor cavity reflectance											
	80%				70%				50%			
	70	50	30	10	70	50	30	10	50	30	10	0
0	115	115	115	115	110	110	110	110	102	102	102	94
1	102	96	91	86	97	92	87	83	84	81	77	78
2	92	82	74	68	87	79	72	65	72	66	61	66
3	83	71	62	55	79	68	60	53	63	56	50	58
4	75	63	53	46	72	60	51	45	55	48	42	51
5	69	56	46	39	66	53	45	38	49	42	36	46
6	64	50	40	34	61	48	39	33	44	37	31	41
7	59	45	36	29	56	43	35	29	40	33	27	37
8	55	41	32	26	52	39	31	26	37	29	24	34
9	51	37	29	23	49	36	28	23	34	27	22	31
10	48	34	26	21	46	33	26	21	31	24	20	29

Zonal Lumen Summary

Zone	Lumens	%Fixture
0-30	939	17.9
0-40	1551	29.6
0-60	2869	54.7
0-90	4362	83.2
0-180	5245	100.0



SNLED-LD1-28-LW-UNV-L840-CD1-U
Electronic Driver
4000K LEDs
Spacing criterion:
(H) 1.2 x mounting
height, (L) 1.3 x
mounting height
Test Report:
P23279-R2

Candlepower

Angle	Along H	45°	Across L
0	654	654	654
5	661	652	646
10	651	641	635
15	633	626	622
20	609	605	605
25	578	579	586
30	541	551	567
35	500	522	547
40	455	491	527
45	408	459	505
50	358	426	483
55	308	393	460
60	257	361	435
65	206	330	410
70	156	299	384
75	108	269	357
80	65	241	330
85	30	214	303
90	1	188	276

Coefficients of Utilization

rc rw RCR	Effective floor cavity reflectance											
	80%				70%				50%			
	70	50	30	10	70	50	30	10	50	30	10	0
0	115	115	115	115	110	110	110	110	102	102	102	94
1	102	96	90	86	97	92	87	83	84	80	77	77
2	92	82	74	68	87	79	71	65	72	66	61	66
3	83	71	62	55	79	68	60	53	63	56	50	58
4	75	63	53	46	72	60	51	45	55	48	42	51
5	69	56	46	39	66	53	45	38	49	42	36	46
6	64	50	40	34	61	48	39	33	44	37	31	41
7	59	45	36	30	56	43	35	29	40	33	27	37
8	55	41	32	26	52	39	31	26	37	30	24	34
9	51	37	29	23	49	36	28	23	34	27	22	31
10	48	34	26	21	46	33	26	21	31	24	20	29

Zonal Lumen Summary

Zone	Lumens	%Fixture
0-30	505	18.0
0-40	831	29.6
0-60	1530	54.5
0-90	2326	82.8
0-180	2326	100.0

LUMEN MAINTENANCE

Ambient Temperature	TM-21 Lumen Maintenance (12,000 hours)	Theoretical L70 (Hours)
25°C	83.05%	99,000

Max Ambient temp in compliance with CSA: 40°C

Cooper Lighting
by E.T.N

Eaton
1000 Eaton Boulevard
Cleveland, OH 44122
United States
Eaton.com

Eaton's Cooper Lighting Business
1121 Highway 74 South
Peachtree City, GA 30269
P: 770-486-4800
www.cooperlighting.com

Specifications and
dimensions subject to
change without notice.

ADF121822
2014-04-30 09:21:29

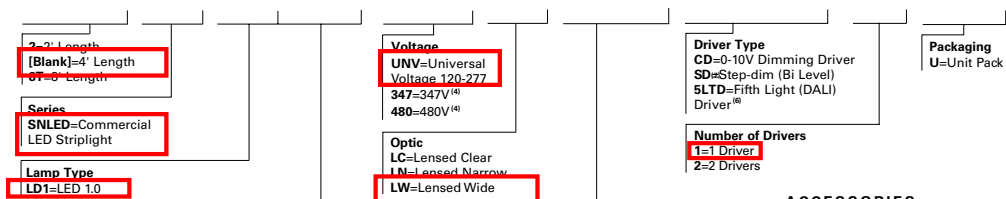
L7 SNLED LENSED

WATTAGE

Product Type	LED Type	Product Configurations	Length	Lumen Package	Wattage	LPW
Lensed - Clear	Standard Lumen	2SNLED-LD1-23-LC-UNV-L8XX-CD1-U	2 ft.	2300	23.11	100
Lensed - Clear	Standard Lumen	SNLED-LD1-31-LC-UNV-L8XX-CD1-U	4 ft.	3100	28.32	109.5
Lensed - Clear	Standard Lumen	SNLED-LD1-49-LC-UNV-L8XX-CD1-U	4 ft.	4900	49.6	98.8
Lensed - Clear	High Lumen	SNLED-LD1-58-LC-UNV-L8XX-CD1-U	4 ft.	5800	53.15	109
Lensed - Clear	Standard Lumen	8TSNLED-LD1-67-LC-UNV-L8XX-CD1-U	8 ft.	6700	64.49	106
Lensed - Clear	Standard Lumen	8TSNLED-LD1-94-LC-UNV-L8XX-CD2-U	8 ft.	9400	96.45	97
Lensed - Clear	High Lumen	8TSNLED-LD1-115-LC-UNV-L8XX-CD2-U	8 ft.	11500	107.84	106.7
Lensed - Narrow	Standard Lumen	2SNLED-LD1-23-LN-UNV-L8XX-CD1-U	2 ft.	2300	23.06	100
Lensed - Narrow	Standard Lumen	SNLED-LD1-30-LN-UNV-L8XX-CD1-U	4 ft.	3000	28.32	106
Lensed - Narrow	Standard Lumen	SNLED-LD1-48-LN-UNV-L8XX-CD1-U	4 ft.	4800	49.6	97
Lensed - Narrow	High Lumen	SNLED-LD1-57-LN-UNV-L8XX-CD1-U	4 ft.	5700	53.15	107
Lensed - Narrow	Standard Lumen	8TSNLED-LD1-64-LN-UNV-L8XX-CD1-U	8 ft.	6400	64.49	99
Lensed - Narrow	Standard Lumen	8TSNLED-LD1-90-LN-UNV-L8XX-CD2-U	8 ft.	9000	96.45	93
Lensed - Narrow	High Lumen	8TSNLED-LD1-109-LN-UNV-L8XX-CD2-U	8 ft.	10900	107.84	101
Lensed - Wide	Standard Lumen	2SNLED-LD1-21-LW-UNV-L8XX-CD1-U	2 ft.	2100	23.04	91
Lensed - Wide	Standard Lumen	SNLED-LD1-28-LW-UNV-L8XX-CD1-U	4 ft.	2800	28.31	99
Lensed - Wide	Standard Lumen	SNLED-LD1-44-LW-UNV-L8XX-CD1-U	4 ft.	4400	49.78	88.4
Lensed - Wide	High Lumen	SNLED-LD1-52-LW-UNV-L8XX-CD1-U	4 ft.	5200	53.13	98
Lensed - Wide	Standard Lumen	8TSNLED-LD1-60-LW-UNV-L8XX-CD1-U	8 ft.	6000	64.49	93
Lensed - Wide	Standard Lumen	8TSNLED-LD1-85-LW-UNV-L8XX-CD2-U	8 ft.	8500	96.45	88
Lensed - Wide	High Lumen	8TSNLED-LD1-99-LW-UNV-L8XX-CD2-U	8 ft.	9900	107.84	92

ORDERING INFORMATION

SAMPLE NUMBER: SNLED-LD1-47-LN-UNV-L840-CD1-U



LED Lumens Output ⁽²⁾	Lensed - Clear	Lensed - Narrow	Lensed - Wide
23=2300 ⁽¹⁾	23=2300 ⁽¹⁾	21=2100 ⁽¹⁾	
31=3100	30=3000	28=2800	
49=4900	48=4800	44=4400	
58=5800	57=5700	52=5200	
67=6700	64=6400	60=6000	
94=9400 ⁽³⁾	90=9000 ⁽³⁾	85=8500 ⁽³⁾	
115=11500 ⁽³⁾	109=10900 ⁽³⁾	99=9900 ⁽³⁾	

NOTES: ⁽¹⁾ 2 ft. only. ⁽²⁾ Nominal lumen values. ⁽³⁾ Two driver required.
⁽⁴⁾ 4 ft. and 8 ft. only. ⁽⁵⁾ Motion Sensor offers dimmability. ⁽⁶⁾ For a complete listing of Fifth Light Technology products and other solutions from Cooper Controls, visit www.coopercontrols.com. ⁽⁷⁾ EL options are integral. ⁽⁸⁾ Must specify voltage (120V or 277V) when selecting EL option. ⁽⁹⁾ For delivered lumens, take lumens per watt of desired fixture and multiply by 10 watts (100 lp/W x 10 = 1000 lumens delivered).

Specifications & dimensions subject to change without notice. Consult your Cooper Lighting Representative for availability and ordering information.

Options
Emergency
EL=Emergency Installed, 700 Lumens ^{(7), (8)}
EL10W=Emergency Installed, 10 Watts ⁽⁸⁾
Wiring
PI/CP=Plug-in Option
Motion Sensors
LB-ERMS360=360° Low Bay Motion Sensor - End of Row
LB-MRMS360=360° Low Bay Motion Sensor - Middle of Row
HB-ERMS360=360° High Bay Motion Sensor - End of Row ⁽⁸⁾
HB-MRMS360=360° High Bay Motion Sensor - Middle of Row ⁽⁸⁾
CCT
L835=3500K
L840=4000K
L850=5000K

ACCESSORIES

(Order Separately)
AYC-Chain/Set=36" Chain Hanger (Use 1 set per fixture)
SCF=Fixed Stem Set (Specify Length)
SCS=Swivel Stem Set (Specify Length)
SCA=Adjustable 48" Stem Set
EYE CHAIN SET/3FT=Eye Bolt Chain (Use 1 set per fixture)
A1B/Spacer-U=Spacer 1-1/2" to 2-1/2" from ceiling (Use 2 per fixture)
TOGGLE=Single Toggle No. 2 (Specify Length)
Y-TOGGLE=Y Toggle No. 2 (Specify Length)

SHIPPING DATA

Length.	Wt.
2 ft.	4.3 lbs.
4 ft.	8.2 lbs.
8 ft.	15.1 lbs.

Cooper Lighting
by **EATON**

Eaton
1000 Eaton Boulevard
Cleveland, OH 44122
United States
Eaton.com

Eaton's Cooper Lighting Business
1121 Highway 74 South
Peachtree City, GA 30269
P: 770-486-4800
www.cooperlighting.com

Specifications and dimensions subject to change without notice.

ADF121822
2014-04-30 09:21:29

L8

SENTI EQ LED



32 0251 • MS

32 0251 • MB



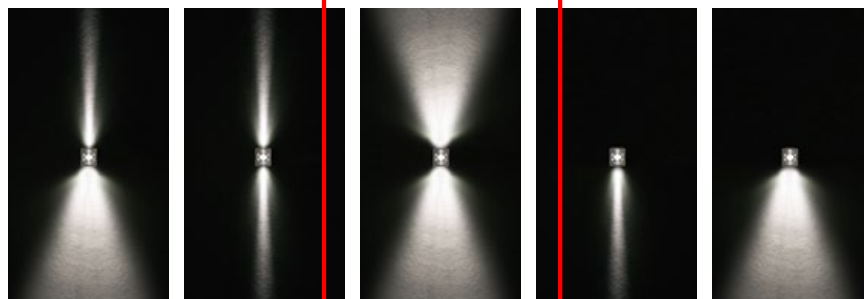
End cap without LED module.



End cap with narrow beam LED module.



End cap with wide beam LED module.



GENERAL SPECIFICATION

Housing: Die-cast and extruded (low copper) aluminum. Front housing hinges open for access and secures via a bolt hidden behind a spring loaded flap. Central perforated mesh band, optional (PM).

Finish: Exterior grade, metallic powder coated paint.

Gaskets: One piece silicone.

Diffuser: UV stabilized polycarbonate.

LEDs: Luxeon Rebel.

LED arrangement: Single LED to illuminate front diffuser. Single LED for narrow beam. Three LEDs for wide beam.

Drivers: HPF, electronic, 120-277V.

Minimum Starting Temperature: -25°C (-13°F).

Mechanical: Mounts directly over a standard electrical junction box (by others). Mounting hardware (by others).

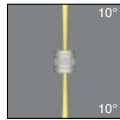
Approval: ETL. Wet location, IP65.

L8

SENTI EQ LED

A SPECIFY LAMP/LUMINAIRE TYPE

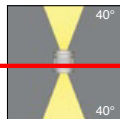
Code: **Narrow/narrow beam:**
32 0251 8W LED 3000K
32 0252 8W LED 4000K



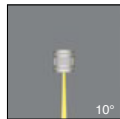
Code: **Narrow/wide beam:**
32 0261 12W LED 3000K
32 0262 12W LED 4000K



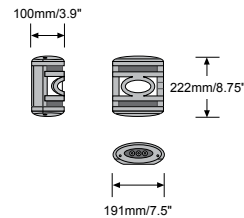
Code: **Wide/wide beam:**
32 0271 17W LED 3000K
32 0272 17W LED 4000K



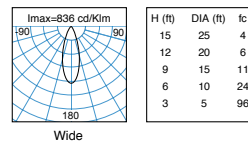
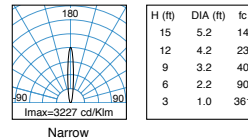
Code: **Single narrow beam:**
32 0281 5W LED 3000K
32 0282 5W LED 4000K



Code: **Single wide beam:**
32 0291 10W LED 3000K
32 0292 10W LED 4000K



All data for 4000K, x 0.73 for 3000K.



EXTERIOR
WALL SURFACE

B SPECIFY FINISH

MS Metallic silver
MB Metallic bronze
OT Other (please specify an RAL number)

Finish as selected by
Architect

C SPECIFY OPTIONS

PM Perforated band (applies to middle section only)

Example Specification Code: 32 0251 • MS

Note: Due to constant changes in LEDs, please check our website for current product specifications.

WWW.BETACALCO.COM | © 2013 BETA-CALCO INC.

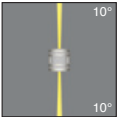
425

SENTI PM
LED

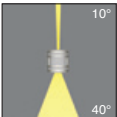
L8

A SPECIFY LAMP/LUMINAIRE TYPE

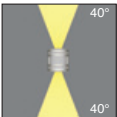
Code: Narrow/narrow beam:
32 0201 8W LED 3000K
32 0202 8W LED 4000K



Code: Narrow/wide beam:
32 0211 12W LED 3000K
32 0212 12W LED 4000K



Code: Wide/wide beam:
32 0221 17W LED 3000K
32 0222 17W LED 4000K



Code: Single narrow beam:
32 0231 5W LED 3000K
32 0232 5W LED 4000K



Code: Single wide beam:
32 0241 10W LED 3000K
32 0242 10W LED 4000K



B SPECIFY FINISH

- MS Metallic silver
MB Metallic bronze
OT Other (please specify an RAL number)

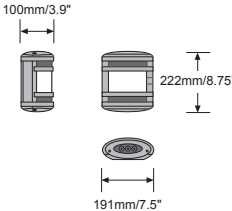
C SPECIFY OPTIONS

PM Perforated band (applies to middle section only)

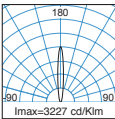
Example Specification Code: 32 0201 • MS

Note: Due to constant changes in LEDs, please check our website for current product specifications.

WWW.BETACALCO.COM | © 2011 BETA-CALCO INC.

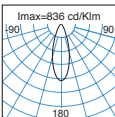


All data for 4000K, x 0.73 for 3000K.



Narrow

H (ft)	DIA (ft)	Ic
15	5.2	14
12	4.2	23
9	3.2	40
6	2.2	90
3	1.0	361



Wide

H (ft)	DIA (ft)	Ic
15	25	4
12	20	6
9	15	11
6	10	24
3	5	96

EXTERIOR

WALL SURFACE

SENTI PM

LED



32 0202 - MS



32 0202 - MB



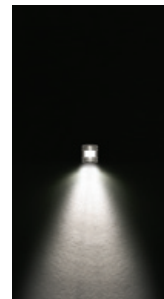
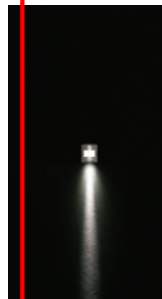
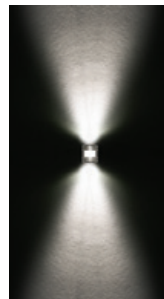
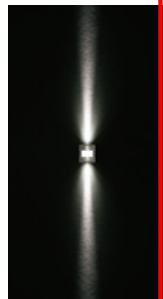
End cap without LED module.



End cap with narrow beam
LED module.



End cap with wide beam
LED module.



GENERAL SPECIFICATION

Housing: Die-cast and extruded (low copper) aluminum. Front housing hinges open for access and secures via a bolt hidden behind a spring loaded flap. Central perforated mesh band, optional (PM).

Finish: Exterior grade, metallic powder coated paint.

Gaskets: One piece silicone.

Diffuser: UV stabilized polycarbonate.

LEDs: Luxeon Rebel.

LED arrangement: Single LED to illuminate front diffuser. Single LED for narrow beam. Three LEDs for wide beam.

Drivers: HPF, electronic, 120-277V.

Minimum Starting Temperature: -25°C (-13°F).

Mechanical: Mounts directly over a standard electrical junction box (by others). Mounting hardware (by others).

Approval: ETL. Wet location, IP65.

L9

SENTI EQ LED



32 0251 - MS



32 0251 - MB



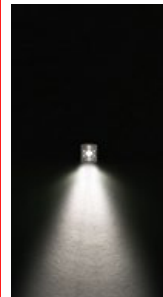
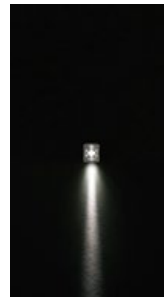
End cap without LED module.



End cap with narrow beam LED module.



End cap with wide beam LED module.



GENERAL SPECIFICATION

Housing: Die-cast and extruded (low copper) aluminum. Front housing hinges open for access and secures via a bolt hidden behind a spring loaded flap. Central perforated mesh band, optional (PM).

Finish: Exterior grade, metallic powder coated paint.

Gaskets: One piece silicone.

Diffuser: UV stabilized polycarbonate.

LEDs: Luxeon Rebel.

LED arrangement: Single LED to illuminate front diffuser. Single LED for narrow beam. Three LEDs for wide beam.

Drivers: HPF, electronic, 120-277V.

Minimum Starting Temperature: -25°C (-13°F).

Mechanical: Mounts directly over a standard electrical junction box (by others). Mounting hardware (by others).

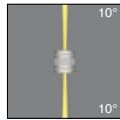
Approval: ETL. Wet location, IP65.

L9

SENTI EQ LED

A SPECIFY LAMP/LUMINAIRE TYPE

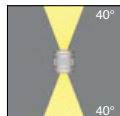
Code: **Narrow/narrow beam:**
32 0251 8W LED 3000K
32 0252 8W LED 4000K



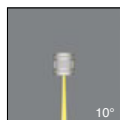
Code: **Narrow/wide beam:**
32 0261 12W LED 3000K
32 0262 12W LED 4000K



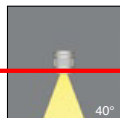
Code: **Wide/wide beam:**
32 0271 17W LED 3000K
32 0272 17W LED 4000K



Code: **Single narrow beam:**
32 0281 5W LED 3000K
32 0282 5W LED 4000K



Code: **Single wide beam:**
32 0291 10W LED 3000K
32 0292 10W LED 4000K



B SPECIFY FINISH

MS Metallic silver
MB Metallic bronze
OT Other (please specify an RAL number)

Finish as selected by
Architect

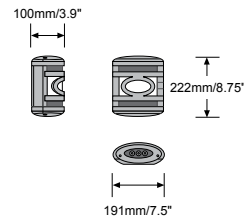
C SPECIFY OPTIONS

PM Perforated band (applies to middle section only)

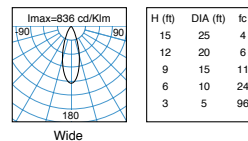
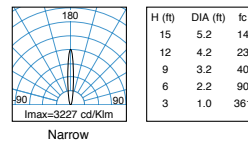
Example Specification Code: 32 0251 • MS

Note: Due to constant changes in LEDs, please check our website for current product specifications.

WWW.BETACALCO.COM | © 2013 BETA-CALCO INC.



All data for 4000K, x 0.73 for 3000K.



EXTERIOR
WALL SURFACE

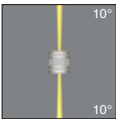
425

SENTI PM
LED

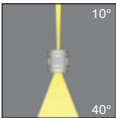
L9

A SPECIFY LAMP/LUMINAIRE TYPE

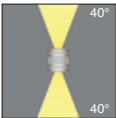
Code: Narrow/narrow beam:
32 0201 8W LED 3000K
32 0202 8W LED 4000K



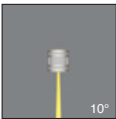
Code: Narrow/wide beam:
32 0211 12W LED 3000K
32 0212 12W LED 4000K



Code: Wide/wide beam:
32 0221 17W LED 3000K
32 0222 17W LED 4000K



Code: Single narrow beam:
32 0231 5W LED 3000K
32 0232 5W LED 4000K



Code: Single wide beam:
32 0241 10W LED 3000K
32 0242 10W LED 4000K



B SPECIFY FINISH

- MS Metallic silver
MB Metallic bronze
OT Other (please specify an RAL number)

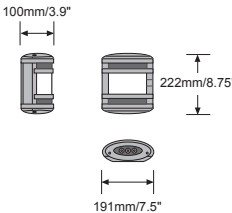
C SPECIFY OPTIONS

PM Perforated band (applies to middle section only)

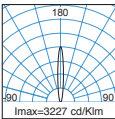
Example Specification Code: 32 0201 • MS

Note: Due to constant changes in LEDs, please check our website for current product specifications.

WWW.BETACALCO.COM | © 2011 BETA-CALCO INC.

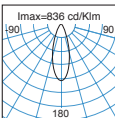


All data for 4000K, x 0.73 for 3000K.



Narrow

H (ft)	DIA (ft)	Ic
15	5.2	14
12	4.2	23
9	3.2	40
6	2.2	90
3	1.0	361



Wide

H (ft)	DIA (ft)	Ic
15	25	4
12	20	6
9	15	11
6	10	24
3	5	96

EXTERIOR

WALL SURFACE

L9

SENTI PM

LED



32 0202 • MS



32 0202 • MB



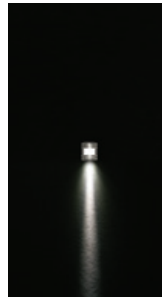
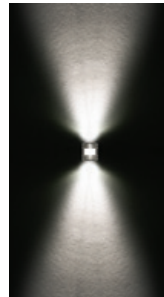
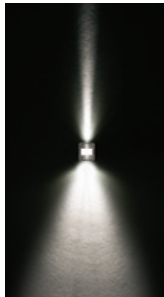
End cap without LED module.



End cap with narrow beam
LED module.



End cap with wide beam
LED module.



GENERAL SPECIFICATION

Housing: Die-cast and extruded (low copper) aluminum. Front housing hinges open for access and secures via a bolt hidden behind a spring loaded flap. Central perforated mesh band, optional (PM).

Finish: Exterior grade, metallic powder coated paint.

Gaskets: One piece silicone.

Diffuser: UV stabilized polycarbonate.

LEDs: Luxeon Rebel.

LED arrangement: Single LED to illuminate front diffuser. Single LED for narrow beam. Three LEDs for wide beam.

Drivers: HPF, electronic, 120-277V.

Minimum Starting Temperature: -25°C (-13°F).

Mechanical: Mounts directly over a standard electrical junction box (by others). Mounting hardware (by others).

Approval: ETL. Wet location, IP65.



Other Manufacturers:
Chloride "45VL" Series
Isolite "EUN" Series

FEATURES & SPECIFICATIONS

INTENDED USE — Suitable for applications requiring attractive edge-lit exit signage, universal installation and low energy consumption.

CONSTRUCTION — Extruded brushed aluminum finish.

Clear acrylic panels- letters measure 6" high with 3/4" stroke, with 100 ft viewing distance rating, based upon UL 924 standard.

For single-face clear panels, EXIT is seen as a reversed image from the back.

OPTICS — LEDs mounted on printed circuit board. The typical life of the exit LED lamp is 10 years.

Low energy consumption — less than 3 watts for AC only and less than 5 watts for battery back-up.

ELECTRICAL — Dual voltage input capacity (120/277V).

Battery: (EL Option) — Sealed, maintenance free nickel-cadmium battery delivers 90 minutes capacity to emergency lamps. Test switch provides manual activation of 30-second diagnostic testing for on-demand visual inspection.

Self-diagnostic testing (EL Option Only) for 30 seconds every 30 days and 90 minutes annually. Diagnostic evaluation of LED light source, AC to DC transfer, charging and battery condition.

INSTALLATION — EDG — Universal surface (top, end or back) mounting. Canopy provided.

EDGR — Recessed mounting. Bar hanger and brackets provided for both new or restricted ceiling access installation applications. Back wall mount (WM) option.

Universal directional indicators. Field selected and attached.

LISTINGS — UL damp location listed 32°-122°F (0°-50°C) standard. Meets UL924, NFPA 101 (current Life Safety Code), NEC and OSHA illumination standards.

WARRANTY — 3-year limited warranty. Complete warranty terms located at www.acuitybrands.com/CustomerResources/Terms_and_conditions.aspx

NOTE: Actual performance may differ as a result of end-user environment and application.

All values are design or typical values, measured under laboratory conditions at 25°C.

Specifications subject to change without notice.

Catalog Number
Notes
Type



EDG (surface mount)



EDGR (recessed mount)

LED Edge-Lit Exits

EDG
EDGR

LED Lamps



Specifications

EDG (End Mount)	EDG (Top Mount)
Length: 13-5/8 (34.6)	Length: 13 (33.0)
Depth: 5-1/2 (14.0)	Depth: 4-5/16 (11.0)
Height: 11-1/8 (28.3)	Height: 11-3/4 (29.8)
Shipping Weight : 4 lbs (1.8 kgs)	Shipping Weight : 4 lbs (1.8 kgs)
EDG (Back Mount)	EDGR
Length: 13 (33.0)	Length: 13 (33.0)
Depth: 3 (7.6)	Depth: 1-3/4 (4.4)
Height: 11-1/8 (28.3)	Height: 8 (20.3)
Shipping Weight : 4 lbs (1.8 kgs)	Shipping Weight : 6.8 lbs (3.1 kgs)
	Shipping Weight (WM option) : 8.1 lbs (3.7 kgs)

All dimensions are inches (centimeters) unless otherwise noted.

ORDERING INFORMATION

For shortest lead times, configure products using **bolded options**.

Example: EDG 1 R EL

Family	Housing color	Number of faces	Letter color	Operations	Options
EDG Surface mount LED edge-lit exit	(blank) Brushed aluminum	1 Single face	R Red on clear (single face only) ¹	(blank) AC only	(blank) None
EDGR Recessed LED edge-lit exit	W White	2 Double face	G Green on clear (single face only) ¹	EL Nickel-cadmium battery	WM Recessed wall mount ⁶
			RMR Red on mirror ²	X2 Provides primary and secondary AC input ⁴	
			GMR Green on mirror ²	SD Self-diagnostics ⁵	
			RW Red on white ³		
			GW Green on white ³		

Accessories: Order as separate item.

ELA US12	12" stem kit with brushed aluminum canopy ⁷
ELA W US12	12" stem kit with white canopy ⁷

Notes

- For single-face clear panels, EXIT is seen as a reversed image from the back.
- Available with single and double face.
- White panel standard for double and single face.
- Not available with EL and SD options.
- Available with EL option only.
- Available on EDGR single face only
- See spec sheet [ELA-StemKits](#). Only available for EDG.

EMERGENCY

EDG-EDGR

EDG-EDGR LED, Surface and Recessed Mount Edge-Lit Exits

SPECIFICATIONS

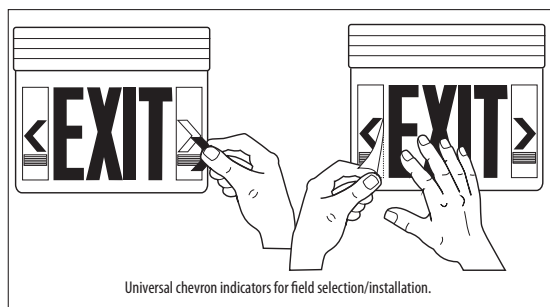
ELECTRICAL						
Primary Circuit						
Type	Typical LED life ¹	Supply voltage	EDG		EDGR	
			Input Watts	Max amps.	Input Watts	Max amps.
Red LED AC only	10 years	120	2.5	0.020	3.8	0.030
		277	2.8	0.010	4.5	0.014
Green LED AC only	10 years	120	2.2	0.020	3.8	0.030
		277	2.2	0.010	4.5	0.020
Red LED emergency	10 years	120	3.0	0.030	3.8	0.031
		277	3.1	0.010	4.5	0.015
Green LED emergency	10 years	120	2.6	0.020	3.8	0.031
		277	2.8	0.010	4.5	0.020

BATTERY (EL option)			
Sealed Nickel-Cadmium			
Shelf life ²	Typical life ²	Maintenance ³	Optimum temperature ⁴
3 years	7-9 years	none	32-122°F (0-50°C)

Notes

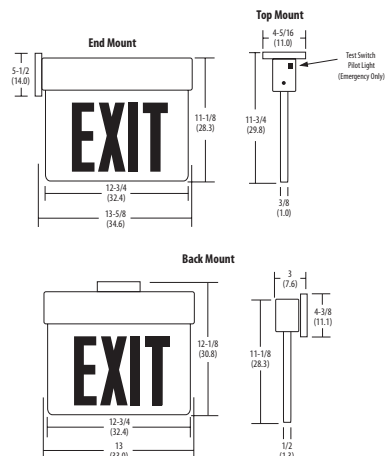
- Based on continuous operation. The typical life of the exit LED lamp is 10 years.
- At 77°F (25°C).
- All life safety equipment, including emergency lighting for path of egress must be maintained, serviced, and tested in accordance with all National Fire Protection Association (NFPA) and local codes. Failure to perform the required maintenance, service, or testing could jeopardize the safety of occupants and will void all warranties.
- Optimum ambient temperature range where unit will provide capacity for 90 minutes. Higher and lower temperatures affect life and capacity. Consult factory for detailed information.

KEY FEATURES

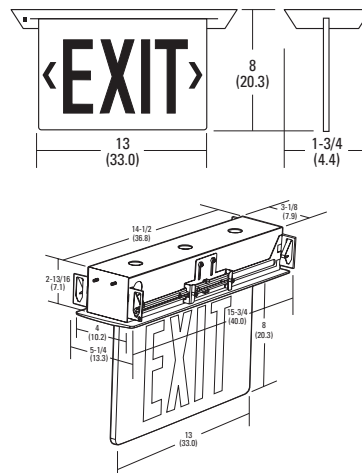


MOUNTING

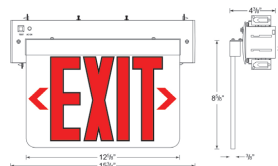
EDG



EDGR



EDGR WM option



EDG-EDGR

EMERGENCY: One Lithonia Way Conyers, GA 30012 Phone: 800-334-8694 Fax: 770-981-8141 www.lithonia.com © 2003-2013 Acuity Brands Lighting, Inc. All rights reserved. Rev. 02/25/16

SECTION 27 0010 - TELECOMMUNICATIONS GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including general and supplementary conditions including division 1 specifications apply to work in this section.

1.2 SUMMARY

- A. This Section includes telecommunications 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 DRAWINGS

- A. The Drawings must show the location of equipment racks & elevations, Ladder rack on 3 walls, power outlet locations, general arrangement of equipment, electrical systems and related items. The installation will follow as closely as elements of the construction will permit.
- B. The Drawings must show a conduit & cabling riser diagram from MDF & related IDFs. Copper pair & fiber strand counts will be detailed showing the distribution of riser cabling between the MDF & related IDFs.
- 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 and WSU C&IT.
- 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 and WSU C&IT for resolution.

1.4 INSPECTION OF SITE

- A. Visit the site, examine and verify the conditions under which the work must be conducted before submitting proposal.
- B. The submitting of a proposal implies that the Contractor has visited the site and understands the conditions under which the work must be conducted.

1.5 CONTRACT BREAKDOWN

- A. WSU Facilities Department retains the installation and coordination for all projects initiated by that department.. WSU C&IT retains the design review, installation and coordination for all other voice, data & video projects not initiated by WSU Facilities.
- B. Within two (2) weeks following award of contract, submit to the Architect/Engineer for approval a contract amount breakdown. Breakdown shall be submitted on a form similar to the form available at the Architect's/Engineer's office. All requests for payment shall be based on the approved breakdown.

1.6 GUARANTEE

- A. Contractor guarantees that the installation is free from defects and agrees to replace or repair, any part of this installation which becomes defective within a period of one year following final acceptance, provided that such failure is due to defects in the equipment, material or installation or to follow the Specifications and Drawings. File with the Owner any and all guarantees from the equipment manufacturers and warranty certificates.

1.7 CODES, PERMITS AND FEES

- A. Unless otherwise indicated, all required permits, licenses, inspections, approvals and fees for telecommunications 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.

1.8 STANDARDS OF MATERIAL AND WORKMANSHIP

- A. All materials shall be new, never used, reused, reconditioned, or refurbished components. 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:

A.N.S.I.	American National Standards Institute
A.S.T.M.	American Society for Testing Materials
BICSI	Building Industry Consulting Services International
I.C.E.A.	Insulated Cable Engineer's Association
I.E.E.E.	Institute of Electrical and Electronics Engineers
N.E.C.	National Electrical Code
N.E.M.A.	National Electrical Manufacturer's Association
TIA/EIA	Telecommunications Industry Association/Electronic Industries Association
U.L.	Underwriters Laboratories, Inc. NFPA National Fire Protection Agency

- B. Perform all work in a first class and workmanlike manner, in accordance with the latest accepted standards and practices for the Trades involved.
- C. All equipment of the same or similar systems shall be by the same manufacturer.

1.9 RECORD DRAWINGS

- A. Provide complete operating and maintenance instruction manuals covering all telecommunications equipment herein specified, together with parts lists. All literature shall be furnished in triplicate for Owner and shall be bound in book or ring binder form as directed by Architect/Engineer.
- B. 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.
 - 4. Shop Drawings.
 - 5. Recommended spare parts lists.
 - 6. Names and telephone numbers of major material suppliers.
- C. Provide revised telecommunications working Drawings indicating "as-built" conditions. Drawings shall indicate all changes that have occurred during construction. Properly and identify backbone and horizontal wiring pathways. Locate all network and workstation devices. Identify all devices on plan with proper labeling. Identify outside plant backbone conduits, man holes & fiber cables installed on a site plan. "as-Built" Drawings shall be submitted on AutoCAD 2000 or newer electronic DWG file format. Provide (1) copy paper and (1) copy electronic DWG file.
- D. Provide a site plan with elevations showing any man holes, hand holes or conduit installed outside.

1.10 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 telecommunications equipment and shall be of the manufacturer's latest design.
- B. No substitutions will be allowed without WSU C&IT approval.

1.11 SHOPDRAWINGS/SUBMITTALS

- A. All shop drawings shall be submitted in groupings of similar and/or related items (cable and connectors, equipment cabinets and racks, etc.). Incomplete submittal groupings will be returned unchecked.
- B. Provide detailed layout shop drawings (on transparent media) of backbone and horizontal cabling distribution, pathways, equipment room layouts, details and related information necessary of installation and maintenance. After review by the Engineer and WSU C&IT, a copy of Drawings will be stamped and returned to the Contractor.
- C. Submit for approval eight (2) copies of shop drawings for all telecommunications 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. Refer to other sections of the Specifications for additional requirements.
 - 1. Structured cabling system components
 - 2. Structured cable system raceways and supports
 - 3. Outside plant cabling and components
 - 4. Outside plant ducts manholes, hand holes & conduit systems on a site plan with elevations.
 - 5. Equipment racks and cabinets including management components
 - 6. Labeling equipment
 - 7. Telecommunications grounding components
 - 8. Conduit, inner duct, junction and pullboxes
 - 9. Surface raceway components
 - 10. Manholes, hand holes and all accessories
 - 11. Telephone system components
 - 12. Data network system components
 - 13. Audio/video system components
 - 14. Access control system components
 - 15. Security Camera system components

1.12 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.

1.13 WORK SPECIFIED UNDER OTHER DIVISIONS

- A. The following items are an integral part of the telecommunications system and will be provided by the Electrical Contractor & or Telecommunications Contractor.
 - 1. Raceways
 - 2. Boxes, cabinets and enclosures.
 - 3. Grounding and Bonding

4. Underground Utilities

1.14 CONTRACTOR QUALIFICATIONS

- A. The Installing Contractor for each communications system shall have a minimum of 5 years of experience with the types of systems specified. They must be certified to install, test & warranty the product specified prior to a bid submittal. No exception to this will be allowed.
- B. The Installing Contractor shall submit a reference list consisting of a minimum of 3 installations of equivalent size and complexity of this contract. The reference list shall contain the following information for each installation:
 - 1. Name of project, square footage, location and brief description of systems.
 - 2. Date of completed installation.
 - 3. Contact name and phone number of facility representative.
 - 4. Total bid amount of each system installed.
 - 5. Final contract amount of each system installed, including all change orders and bulletins.
- C. The Installing Contractor shall submit with the bid the names and registration numbers of members of the firm that have a valid membership and are certified with BICSI as Registered Communications Distribution Designers (RCDD). This Contractor shall identify at least one RCDD assigned to this project in the bid.
- D. The bidding, shop drawing submittal, procurement of materials, the installation as-builts and record documents shall be reviewed and overseen by the RCDD(s) assigned to the project.
- E. The Contractor's bid, shop drawing submittals, as-builts and record documents shall bear the valid seal of the RCDD(s) assigned to this project.
- F. The Installing Contractor of the video system shall submit with the bid names and license numbers of all members of the firm that hold a valid commercial general class license with the FCC. The Contractor shall identify at least one FCC licensed technician/engineer assigned to this project with the bid.
- G. All calculations, shop drawings, testing, certification and as-built documents shall be directly supervised by the licensed technician/engineer assigned to the project.
- H. The contractor must provide a copy of the manufacturer's certification that the contractor is currently certified to install, test & warranty the proposed system prior to a bid submittal. See Section 17110, 7.5A & section 17010, 1.16A. No exception to this will be allowed.

PART 2 - PRODUCTS

Not applicable.

PART 3 - EXECUTION

3.1 INSTALLATION OF EQUIPMENT

- A. Install all equipment in strict accordance with all installation specifications set by the equipment manufacturer. Where such directions are in conflict with the Drawings and Specifications, report such conflicts to the Architect/Engineer and WSU C&IT for resolution.

3.2 WORK PERFORMED BY OTHERS

- A. The Owner will provide access point & network electronics equipment in all Communications Rooms as required.

3.3 WORK IN EXISTING BUILDINGS

- A. The Owner will provide access to existing buildings via a Project Coordinator. However, this 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 this Contractor's expense.
- C. Consult with the Owner's Project Coordinator and C&IT Project Coordinator 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 telecommunications services 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.

3.4 COORDINATION

- A. Install work to avoid interference with work of other trades including, but not limited to, architectural, mechanical and electrical trades. Remove and relocate any work that causes interference at this Contractor's expense. Disputes regarding the cause of interference will be resolved by the Owner's representative or Architect/Engineer.
- B. If there is a general contractor, The general contractor is responsible for the construction schedule. All work activities are to be coordinated with the general contractor.

3.5 CHASES AND RECESSES

- A. Chases and recesses shall be provided by the Architectural Trades, but this Contractor shall be responsible for coordinating their accurate location and size.

3.6 SLEEVES

- A. Provide and install Hilti Speed Sleeve model CP-630 or EZ path fire stop system wherever conduits or cabling pass through fire rated walls, floors or cables pass through openings in walls.
- B. Sleeves are used in standard walls & floors with no fire rating. All sleeves through the floor are to extend 4 inches above floor, unless otherwise noted. Provide escutcheons at each sleeve in finished areas and adequate spacing between sleeves to accommodate escutcheons.

3.7 CUTTING, PATCHING AND DAMAGE TO OTHER WORK

- A. Refer to General Conditions for requirements.
- B. All cutting, patching and repair work shall be done by the Contractor.

3.8 EXCAVATION AND BACKFILLING

- A. Provide all excavation, trenching, tunneling, dewatering and backfilling required for the telecommunications work. Coordinate the work with other excavating and backfilling in the same area.
- B. Refer to electrical Drawings and the architectural Specifications for excavating and backfilling methods and materials.

3.9 CLEANING

- A. All debris shall be removed daily as required to maintain the work area in a neat, orderly condition.
- B. Final cleanup shall include, but not be limited to, cleaning all telecommunications equipment spaces, devices, cover plates, and removing all scrap cable and debris from pathways.

3.10 PROTECTION AND HANDLING OF EQUIPMENT AND MATERIALS

- A. Equipment and materials shall be protected from theft, injury or damage.

- B. Protect conduit openings with temporary plugs or caps.
- C. Provide adequate storage for all equipment and materials delivered to the job site. Location of the space will be designated by the Owner's Project Coordinator or Architect. Equipment set in place in unprotected areas must be provided with temporary protection.

3.11 EXTRA WORK

- A. For any extra telecommunications work that 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. This Contractor shall proceed only after receiving a written order from the General Contractor establishing the agreed price and describing the work to be done.

3.12 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 will understand that the work herein described shall be complete in every detail.
- B. The Drawings are not intended to be scaled for rough-in measurements or to serve as shop drawings. Field measurements, necessary for ordering materials and fitting the installation to the building construction and arrangement, shall be taken by this contractor.

END OF SECTION 27 0010

SECTION 270110 - TELECOMMUNICATIONS INTERIOR PATHWAYS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Related Sections include the following:
 - 1. Division 17 Section "Telecommunications General Requirements."

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code.
- B. NFPA-297 - Guide on Principles and Practices for Communication Systems.
- C. ANSI/TIA/EIA 568-A - Commercial Building Telecommunications Cabling Standard.
- D. ANSI/TIA/EIA 569-A - Commercial Building Standard for Telecommunications Pathways and Spaces.
- E. ANSI/TIA/EIA 607 - Commercial Building Grounding and Bonding Requirements for Telecommunications.
- F. ANSI/IEEE-110-1992 - Powering and Grounding Sensitive Electronic Equipment.
- G. BICSI – Building Industry Consulting Services International.

1.3 SUBMITTALS

- A. Submit all structured cabling system raceways and supports identified in this section under provisions of Section 17010.
- B. Product Data: Provide for products specified and required.
- C. Shop Drawings: Indicate project specific part numbers, dimensions, support points, fittings and finishes.

1.4 PROJECT RECORD DOCUMENTS

- A. Submit all structured cabling system raceways and supports identified in this section under provisions of Section 17010.
- B. Accurately record equipment layout and cable layouts in all telecommunication spaces.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products to site under provisions of Section 17010.
- B. Protect products from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.6 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Verify routing and termination locations of conduits, and cable pathways prior to rough-in.

1.7 DESCRIPTION OF SYSTEMS

- A. Communications cabling systems pathways shall be installed in accordance with ANSI/TIA/EIA 569-A.
- B. Intra-building backbone cabling shall be installed in conduit, cable tray or J-hook support system.
- C. Horizontal cabling (cabling from the telecommunications room to the work area outlet) pathways shall consist of [conduit] [cable tray] [J-hooks] [under floor duct system] [raised access flooring system] [accessible ceiling space] [cellular flooring system] as indicated on Drawings and as required.
- D. Where the accessible ceiling systems [raised access flooring systems] are used as the primary pathway, cabling shall be installed [in main cable tray runs] as indicated on the Drawings, with individual work area cables routed exposed [in conduit] and supported as specified herein.

PART 2 - PRODUCTS

2.1 J-HOOKS

- A. Manufacturers:
 - 1. Erico-Caddy.
 - 2. B-Line.
- B. Horizontal cable routed exposed through ceiling space shall be supported from J-hooks.
- C. J-hooks shall be a minimum of 5/8" wide and shall have a bearing surface that complies with required bend radii of the specified cables to be supported.
- D. J-hooks shall have flared or folded edges to prevent damage when installing cables.

2.2 INNERDUCT

- A. Manufacturers:
 - 1. Carlon.
 - 2. Endot.
- B. Install inner duct through conduits and sleeves for optical fiber cabling installations.
- C. Description: UL listed, non-metallic, corrugated flexible conduit for use in plenum or riser installations as applicable. Provide each inner duct with one 1/4" W pull tape with a tensile rating of 900 lbs.

PART 3 - EXECUTION

3.1 GENERAL

- A. Where cables pass through fire rated walls, the Contractor shall provide and install Hilti Speed Sleeve model CP-630 or EZ path fire stop system. This penetration sleeve must match the fire rating of the wall. The penetration shall be sized per ANSI/TIA/EIA-569.
- B. Any other wall or floor penetrations that aren't fire rated, the Contractor shall fire-stop the penetrations, after final cable installation, using Engineer-approved materials. Fire-stopping materials shall be installed per manufacturer's recommendations and shall maintain partition rating and integrity. All fireproofing shall be applied in a neat manner with all excess material cleaned from all walls and surfaces. Contractor shall replace and re-install all fireproofing materials removed during cable installation.
- C. Contractor shall patch and repair any holes or other damage to walls or partitions and paint to match original, as applicable.
- D. The Communication Cabling Contractor shall provide plastic and/or grounding bushings, as applicable, on all conduit sleeves, stubs and conduit terminations that may have been missed by the Electrical Contractor.
- E. All cutting, patching and restoration to the original condition of walls, ceilings, floors, etc., shall be the responsibility of the Contractor.
- F. All ceiling removal and restoration required for the execution of this work shall be the responsibility of the Contractor.
- G. Any additional existing voice & data jacks demolished need to be documented. A room number, Jack number (if still there), approximate location in the room & the communication room where it terminated need to be identified. This information must be returned to C&IT IT Customer Services Telecommunications department.
- H. All cabling installed exposed in accessible ceiling systems shall be supported by cable tray or J-hooks.
- I. All J-hooks shall be supported directly from the structure above or wall mounted, as applicable, independent of ceiling framing, electrical conduit, mechanical piping and ductwork. Provide all-thread rod with 1/4" diameter or equivalent supporting means with suitable fasteners when attaching to structure or structural members. Increase size of support as required when multiple J-hooks (stacked or tree configuration) are attached to single support based on maximum loading capacity of J-hooks.
- J. J-Hooks shall be spaced 48" Minimum or 60" maximum on center.
- K. Telecommunications cabling shall be routed in continuous conduit above hard ceilings or between floors in any kind of offset condition.
- L. Communications cable pathway routing shall be coordinated with above ceiling work of other Contractors to avoid conflicts and potential sources of EMI.
- M. Do not route exposed communications pathway within 12" of lighting fixtures and electrical power feeders.
- N. Route inner duct for all fiber optic backbone cabling, in cable tray, conduit, and sleeves. Coordinate routings and quantities with Drawings.

WAYNE STATE UNIVERSITY
Harwell Field Building

PETER BASSO ASSOCIATES, INC.
PBA Project No. 2014.0202.01
Issued for Bids
April 29, 2016

END OF SECTION 27 0110

SECTION 27 0130 - COMMUNICATION EQUIPMENT SPACES SUPPORT HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Related Sections include the following:

1. Division 27 0010 Section "Telecommunications General Requirements."

1.2 SECTION INCLUDES

- A. Equipment racks.
- B. Equipment cabinets.
- C. Equipment shelves.
- D. Cable management.
- E. Backboards.
- F. Telecommunications cable runway.

1.3 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code.
- B. NFPA-75 - Protection of Electronic Computer Data Processing Equipment.
- C. NFPA-297 - Guide on Principles and Practices for communication Systems.
- D. ANSI/TIA/EIA 568-B.1,2,3 - Commercial Building Telecommunications Cabling Standard.
- E. ANSI/TIA/EIA 569-A - Commercial Building Standard for Telecommunications Pathways and Spaces.
- F. ANSI/TIA/EIA 607-A - Commercial Building Grounding and Bonding Requirements for Telecommunications.
- G. ANSI/IEEE-110-1992 - Powering and Grounding Sensitive Electronic Equipment.
- H. BICSI – Building Industry Consulting Services International.

1.4 SUBMITTALS

- A. Submit under provisions of Section 17010.
- B. Product Data: Provide for racks and all cable management hardware
- C. Shop Drawings: Indicate dimensions, support points, and finishes.
- D. Submit layout Drawings to scale of all communication rooms indicating routing of all cable runway, elevations of equipment racks indicating all equipment to be installed, and all wall penetrations.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 17010.
- B. Accurately record equipment layout and cable layouts in all telecommunication spaces.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products to site under provisions of Section 17010.
- B. Protect products from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.7 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Verify routing and termination locations of conduits, and cable pathways prior to rough-in.

PART 2 - PRODUCTS

2.1 EQUIPMENT RACKS

- A. Manufacturers:
 - 1. Homaco.
 - 2. Hubbell.
- B. Description: Nominal 19" x 84"H equipment rack, with universal EIA hole spacing for mounting equipment and accessories.
- C. Material: 6061-T6 heavy-duty aluminum or equivalent.
- D. Provide all hardware for floor mounting and anchoring.
- E. Provide one (1) equipment shelf and all mounting hardware.
- F. Provide complete ground bar kit with all required hardware
- G. Provide power plug strip mounted to equipment rack, with a minimum of 6 surge- protected outlets and 10-foot cord.

2.2 EQUIPMENT RACKS

- A. Manufacturers:
 - 1. Chatsworth Products (CPI)
 - 2. Homaco.
 - 3. Hubbell.
- B. Description: Nominal 19" x 84"H equipment rack, with universal EIA hole spacing for mounting equipment and accessories.
- C. Material: 6061-T6 heavy-duty aluminum or equivalent. 35
- D. Provide all hardware for floor mounting and anchoring.

- E. Provide one (1) equipment shelf and all mounting hardware.
- F. Provide complete ground bar kit with all required hardware
- G. Provide power plug strip mounted to equipment rack, with a minimum of 6 surge- protected outlets and 10-foot cord.

2.3 POWER STRIPS EQUIPMENT RACKS.

- A. Manufacturers:
 - 1. APC – Model APC 8841
 - 2. Tripplite – Model PDUMNV30HV2
- B. Provide one 208 volt, 30 amp, single phase power strip for each rack installed.
- C. Install one 208 volt, 30 amp, single phase power strip on each equipment rack .
- D. Mount vertical on side of rack.
- E. No Velcro mounting allowed.
- F. Plug mates with a L6-30 receptacle.
- G. Install the power strip with a 6 to 10 foot cord.
- H. Include a temperature and humidity Sensor
- I. Use factory mounting hardware on the equipment rack whenever possible.

2.4 WALL MOUNTED EQUIPMENT CABINETS

- A. Manufacturers:
 - 1. Chatsworth Products (CPI)
 - 2. Hubbell.
 - 3. Great Lakes Cabinets.
- B. Equipment cabinet, wall mounted will be nominal 24"W x 48"H x 24"D, with equivalent construction as standard floor mounted cabinet except with double hinged center section.
- C. The cabinet body shall consist of 16 gauge cold rolled steel formed and welded construction. The cabinet body sides shall have clusters of rectangular perforations to accommodate adequate ventilation for the enclosed equipment. The top and bottom of the cabinet body shall also have a circular cut with a removable cover plate for the mounting of an optional 250 cfm cooling fan. The cabinet shall be symmetrical in design to allow front and rear doors to open left or right.
- D. The rear door shall consist of 16 gauge cold rolled steel formed and welded construction with a double bent flange along the door's entire perimeter. There shall be two (2) pairs of wall mounting holes located at the upper and lower surface of the door, spaced 16" on center for mounting to studded wall construction. The top and bottom edge of the rear door shall each have three (3) through hole cut outs [3" in diameter] with removable plastic covers, along with two (2) double ring knock out holes for 1.12" or 0.88" through-hole openings. The rear door shall be symmetrical in design to allow for reverse mounting. The door shall be locking with a unique key to operate the rear door only.

- E. The front door shall be made of 16 gauge cold rolled steel formed and welded construction, with a double bent flange along the entire perimeter. The door should be available in both solid and a framed window. The window version shall have .125" thick acrylic panel secured to a reinforced steel frame. The door shall be locking with a unique operator's key, which operates the front door only.
- F. The wall mount cabinet shall be pre-configured for 19" mounting with #12-24 tapped holes 5/8", 5/8", 1/2" EIA standard hole pattern. The 19" mounting rails shall be constructed of 11 gauge cold rolled steel. Mounting rails shall also be fully adjustable from front to back of the cabinet.
- G. The entire cabinet shall be finished with a durable polyurethane powder coat, medium texture, and be available in black or office white.
- H. The wall mount cabinet shall be designed so that access to all internal components can be from the front or rear of the cabinet body by way of a dual hinge design.
- I. Weight: Load capacity of the cabinet shall be 150 lbs. Dedicated 120V cabinet installed in cabinet.
- J. Provide dedicated 120V circuit installed in cabinet.

PART 3 - EXECUTION

3.1 EQUIPMENT CABINETS

A. Free Standing Cabinets

- 1. Cabinets shall be installed in a location that allows both the front and rear door to open a full 90 degrees.
- 2. Cabinets employing cooling fans shall be installed such that there is at least 6" of clear space above the top of the fan casing.
- 3. Each free standing equipment cabinet will have a separate ground wire to the ground buss bar.

B. Wall Mount Cabinets

- 1. Wall mount cabinets shall arrive on site fully assembled and ready to install.
- 2. When mounting the cabinets to studded wall construction, the cabinet must be secured to the wall studs to assure adequate support for the enclosure and its contents.
- 3. Cabinets shall be installed in such a way as to not interfere with the use of the front door or hinged body section.
- 4. Each wall mount cabinet will have a separate ground wire to the ground buss bar.

END OF SECTION 27 0130

SECTION 27 0150 - TELECOMMUNICATIONS GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Related Sections include the following:
 - 1. Division 27 0150 Section "Telecommunications General Requirements."
 - 2. Telecommunications construction drawings.

1.2 REFERENCES

- A. ANSI/TIA/EIA-568-B.1,2,3 - Commercial Building Telecommunications Cabling Standard.
- B. ANSI/NFPA 70 - National Electrical Code.
- C. FCC Part 68 - Connection of Terminal Equipment to the Telephone Network.
- D. FCC Part 15 - Radiation Limits.
- E. FCC Part 76 - Cable Television Service.
- F. BICSI TDMM - Telecommunications Distribution Methods Manual, Latest Edition.
- G. BICSI TCIM - Telecommunications Cabling Installation Manual, Latest Edition.

1.3 PROJECT CONDITIONS

- A. Verify field measurements are as shown on Drawings.
- B. Verify suitability of all pathways prior to cable installation.

1.4 CABLING SYSTEM PERFORMANCE

- A. General:
 - 1. Cabling system performance shall meet or exceed current industry standards and/or manufacturers' specifications as specified herein.
 - 2. The cable installed in the walls, connectors, jack, patch panels, & patch cords must be the same manufacture & model that forms the complete cabling system channel. The total system shall meet the performance criteria described below.
 - 3. The cable and connector devices shall be certified compatible by the manufacturer of each component to meet the performance criteria described below. Submit manufacturer's certification with submittals.
 - 4. The referenced standards describing the performance below shall include all revisions, clarifications and bulletins to the original standard referenced as well as any standards cross-referenced.

5. The referenced standards describing the performance below shall apply to backbone cable, horizontal cabling and connecting hardware performance requirements as well as installation standards and techniques and field testing and verification of performance.
- B. A plenum category 5E (CAT5E) cabling in a 25 pair cable bundle is to be utilized for voice (telephone) building backbone riser only. Category 3 performance is defined by ANSI/TIA 568-C for 100 ohm UTP cables and associated connecting hardware whose transmission characteristics are specified up to 1 MHz.
- C. Category 6 enhanced (CAT6E) cabling shall be utilized for all voice, data, wireless access points & security camera horizontal wiring. For WSU projects, any one of the following five cat6e structured cabling system products are acceptable:
 1. Hubbell NEXTSPEED Cat 6 enhanced
 2. Superior-Essex/Ortronics NextGain Cat6EX
 3. Leviton-Berk Tek Lanmark-2000.
 4. Beldon DataTwist 600e
 5. CommScope Uniprise 7504 Cat6E

Category 6e performance is defined by the manufacturers of the above cabling products,
- D. Fiber optic cabling shall be utilized for all data building backbone riser. Fiber optic performance is defined as follows:
 1. Singlemode:
 - a. Provide nominal 9/125µm core/cladding, singlemode dispersion un-shifted fiber optic cable. The cable shall be rated for 1310nm and 1510nm and meet all performance requirements of ANSI/TIA 568-C at each transmission wavelength.
 - b. Maximum Attenuation: 0.5dB/km @ 1310nm
 - c. 0.5dB/km @ 1550nm
 - d. Bandwidth: 2GHz*km @ 1310nm
 - e. 2GH*/km @ 1550nm

1.5 CONTRACTOR QUALIFICATIONS

- A. The installing Contractor shall be certified by the cabling and connector manufacturer of the structured cabling system product selected from 1.4.C (above). A letter of certification from the manufacturer shall be included in the bid submittal. No exception to this will be allowed.

1.6 SUBMITTALS

- A. Product Data Sheets:
 1. Submittals shall be complete and bound in 3-ring binders (or similar fashion) for Engineer's approval prior to ordering equipment.
 2. The binders shall contain manufacturer's product data sheets for the specific items to be installed for this project.
 3. Contractor shall highlight or otherwise identify each specific item to be installed, by catalog number, on each product data sheet. The Contractor shall indicate specific color, style, configuration, etc., and all accessories specified and required for a complete installation.

1.7 UNIT PRICING

- A. Provide separate unit pricing included with bid for each of the following:
1. A complete workstation drop of each type of outlet indicated (e.g. A, B, C, etc.) of length 100 feet, including all cabling, connectors, faceplate, labeling, installation, termination and testing.
 2. Complete schedule C of WSU's purchasing bid package.

1.8 UTP CABLING SYSTEM WARRANTY

- A. General
1. The UTP voice and data cabling system shall be warranted by the manufacturer(s) of the components for a period of not less than 20 years from the time the installation is deemed complete.
 2. It shall be the sole responsibility of the low voltage cabling Contractor to register the project with the manufacturer(s) and meet all manufacturers' warranty requirements.
 3. It shall be the sole responsibility of the low voltage cabling Contractor shall provide Owner with test results, all manufacturers' warranty certificates with Record Documents including a site plan elevation with outside plant man holes, hand holes & conduit.
- B. Warranty Coverage
1. Product - all passive components of the cabling system shall be warranted to be free from defects in material and workmanship.
 2. Performance - all passive components, as installed, shall meet or exceed all published performance data.
 3. This will exceed TIA and ISO performance specifications for Permanent Link and Channel, as required, at all frequencies specified.
 4. Applications - the installed Permanent Link and Channel shall be warranted to support all current applications, as well as those introduced in the future, that require the specified cabling system per TIA, ISO & cabling manufacture specifications.
 5. Paint or any other material on the UTP cable voids the warranty. If this can't be removed during the installation, the effected cables will need to be replaced.
 6. Any UTP CAT6 cable or component that has been painted & / or not satisfactorily passing tests or failing to meet quality installation standards as described in the standards will be repaired or replaced as directed by C&IT Network Engineering Group at the contractors expense.
- C. Warranty Requirements
1. Provide a Permanent Link warranty for all voice drops. Provide a Channel warranty for all data drops.
 2. Warranty shall cover repair or replacement of all defective components free of charge, including all labor performed by a manufacturer-certified installer. All new or replacement components shall be furnished new. Never used, reused, reconditioned, or refurbished components shall be allowed.
 3. The installing Contractor shall be certified by the cabling and connector manufacturers as an approved and trained installer of their equipment. Submit letter of certification from the manufacturer to the engineer at time of submittal. No exception to this will be allowed.

PART 2 - PRODUCTS

2.1 INTER-BUILDING FIBER OPTIC BACKBONE

- A. Singlemode fiber optic cabling

1. Manufacturers:
 - a. Systimax
 - b. Corning
 - c. BerkTek-Ortronics
 - d. CommScope
2. Description: Nominal 9/125 μm , 24 strand or as indicated on Drawings, loose tube, all-dielectric cable, rated for outdoor use. Cable shall have water-blocking properties to prevent water penetration and fiber damage. Cable shall have maximum 12 strands per tube, and an overall Polyethylene jacket.

2.2 COPPER HORIZONTAL CABLING

- A. Manufacturers:
 1. CommScope
 2. BerkTek-Ortronics
 3. Superior-Essex
 4. Hubbell
 5. Belden
- B. Description:
 1. Horizontal cable shall be furnished with performance requirements for the system served (voice, video or data) as indicated on the drawings riser diagram.
 2. Category 6 enhanced: 23 AWG, 4-pair, 100 ohm, UTP, [CMR] [CMP], with green jacket for data & wireless access points, yellow jacket for voice cabling, purple jacket for security camera cabling. See exact products in section 10.4 C above.
 3. Voice jacks will terminate on wall mount 110 type termination blocks. Workstation, server, printer etc. data jacks will terminate in their own group of patch panels. Wireless access point & security camera data jacks will terminate in their own separate group of patch panels. All patch panels are installed in the equipment racks.

2.3 UTP JACKS AND CONNECTORS

- A. Manufacturers:
 1. CommScope UNJ600.
 2. Ortronics
 3. Leviton
 4. Hubbell
 5. Belden
- B. Modular jacks for UTP cables:
 1. 8 position, 8 conductor, non-keyed, universal modular jack, snap-in type, terminated with a 110 style pc board connector, color coded for T568A & T568B wiring.
 2. Designed to terminate 22-26 AWG solid on insulation-displacement 110-style connectors.
 3. Contacts shall be minimum 50 micron gold-plated in the contact area.
 4. Rated to match the performance of the cabling system they are installed on.
 5. Color coded for system served as indicated on the Drawings.
 6. Furnish keystones (icons) for jack identification. Keystones for voice jacks shall be white and keystones for data, wireless access points & security cameras jacks shall be [orange].

7. When installing outdoor camera, Aps, or any type of network device you must use one of the following Hi-Impact jacks and patch cords.

a. Manufacturers:

- 1) CommScope UMP610-24P or UMP610-48P.
- 2) Ortronics
- 3) Leviton
- 4) Hubbell HI6Coupler & Jack. HI603AE Patch Cord
- 5) Beldon

8. When installing outdoor cameras, Aps, or any type of network device you must use one of the following CAT6E POE compatible lightning surge protection devices part of the communication room termination.

a. Manufacturers:

- 1) ATLAN AT-2210
- 2) Phoenix Contact DT-LAN-CAT.6+ 2281007
- 3) L-COM BT-CAT6-P1-HP

2.4 UTP PATCH PANELS

A. Manufacturers:

1. CommScope UMP610-24P or UMP610-48P.
2. Ortronics
3. Leviton
4. Hubbell
5. Beldon

B. UTP Patch Panel:

1. Patch panel shall serve as data jack, security camera and wireless access point system horizontal cross connect.
2. Wireless access point & security camera data jacks will be terminated on their own patch panel separate from the workstation data jack patch panels.
3. Patch panel shall be configured for standard 19" rack mounting.
4. High density type with 24 modular jack ports for every standard rack mount unit (1.75" high).
5. Maximum 6 port groupings of replaceable modules.
6. Terminations for the "building side" cabling on 110-style insulation pc board connectors color-coded for T568B terminations.
7. Horizontal and vertical cable management hardware front and rear.
8. Performance shall meet the performance of the cabling system they are installed on.
9. Constructed of black anodized aluminum with adequate structural integrity so that panel will not deflect when center of panel is pushed with the hand.
10. Provisions for icons and labeling to comply with the labeling requirements in specification 27 0170, "Cable Plant Administration and Testing".

2.5 FACE PLATES

- A. Manufacturers: Same as jacks and connectors, unless otherwise noted. In almost all cases in labs, stainless steel plates will be called out in lieu of plastic. Reference construction drawings.

- B. Face plates for wall mounted workstation outlets shall allow a minimum 2 and maximum of 6 positions and accept snap-in jacks, as specified.
- C. Face plates for recessed outlet boxes shall be high-strength nylon, [white] color, single-or double-gang as required and as applicable. Face plates shall be equipped with label slots, top and bottom, and clear polycarbonate covers for each label.
- D. Provide duplex mounting frames, as required, to mate and match jacks to face plates.
- E. Provide stainless steel faceplates with attachment hooks for hanging telephone device for outlets indicated as wall phone outlets.

2.6 UTP PATCH CORDS

- A. Manufacturers:
 - 1. Shall be the same manufacturer & type as the cable, jacks & patch panels installed in the building.
- B. Description:
 - 1. Provide two (2) patch cords, one of each length specified, for each data and voice port in patch panel outlet and one (2) patch cord for each data & voice port for the workstation, length as specified above.
 - 2. For the workstation room side provide cords with stranded conductors and jacketing for greater flexibility, having compatible performance as copper UTP horizontal and fully warranted, as required.
 - 3. Patch cords shall be 10'-15' in length, gray color for the workstation, 3'-7' in length, gray color for the communication room, 3' in length, green color for the access point & 3' in length, purple color for the security cameras. Coordinate possible different lengths with C&IT.

2.7 FIBER OPTIC CONNECTORS FOR BOTH INTER – BUILDING & INTRA – BUILDING CABLES

- A. Manufacturers:
 - 1. Corning Cable Systems.
- B. Singlemode fiber optic connectors shall be:
 - 1. Field installed LC type in 12/24 port panels for INTRA – BUILDING riser tie cabling between communication rooms. Provide black color connector.

2.8 FIBER OPTIC PATCH PANELS

- A. Manufacturers
 - 1. CommScope.
 - 2. Corning
 - 3. Leviton
 - 4. Ortronics

B. Description:

1. Rack-mounted, minimum 24-port patch panel with modules or panels as indicated suitable for mounting connector types as specified and as required, complete with slide-out fiber management tray and management rings and clips to maintain minimum bend radius of fibers, and lockable front and rear doors, clear, tinted-polycarbonate front door (03U and 04U panels only).
2. Provisions for icons and labeling to comply with the labeling requirements in specification 270170, "Cable Plant Administration and Testing".

2.9 COPPER SPLICING PRODUCTS

A. Manufacturers:

1. 3M – Series 2-Type FR 510 Closure.

- B. Description: Copper splice case, indoor, re-openable, sized for pair counts indicated on Drawings. Provide all hardware and accessories required to make the quantity and type of splices as indicated on the Drawings.

2.10 FIBER OPTIC SPLICE PANELS

A. Manufacturers:

1. CommScope.
2. Corning.
3. Leviton.
4. Ortronics.

- B. Description: Rack-mounted splice enclosure with splice trays, cable strain relief hardware, sliding shelf, locking front and rear doors, grommets entry points, and open-side design for easy fiber egress.

- C. Splice trays shall be for heat-shrink fusion splices and compatible with splice panel.

PART 3 - EXECUTION

3.1 GENERAL

- A. In addition to the notes contained on the Drawings, the following Contractor notes shall apply.

3.2 CABLE ROUTING

- A. Route all cables and cable raceways parallel to or perpendicular to building structure.
- B. All cables shall be installed as single continuous "home-run" pulls from connector block to connector block, or from patch panel in the telecommunications room to voice/data workstation outlet in the work area.
- C. Cable that is run above a suspended ceiling should be supported per manufacturer's recommendations, whether in approved cable tray, in conduit, or by j-hooks.

- D. All data/communication cables, not installed in conduits, shall be supported by j- hooks supported from the bar joists or trusses. No tie-raps or bundling allowed.
- E. The number of voice/data cables per hanger shall not exceed manufacture rating.
- F. The maximum spacing of cable hangers and supports shall be 60 inches or less. Level changes may require additional support. Contractor shall be responsible to replace all fire-proofing materials displaced during installation of hangers to maintain required fire rating of structure.
- G. Communication cable and infrastructure shall be independently supported.
- H. Do not support or tie-wrap any cables to ductwork, plumbing lines, fire suppression, electrical conduits, mechanical systems, or ceiling system.
- I. Do not directly lay or route voice/data cables on ductwork, piping and plumbing systems or on top of the lay-in ceiling tile.
- J. Minimum clearance distance requirements shall be observed:
 - 1. 5" (125 mm) from power lines of 2 KVA or less.
 - 2. 12" (305 mm) from high voltage lighting (including fluorescent).
 - 3. 39" (1 m) from power lines of 5 KVA or greater.
 - 4. 39" (1 m) from transformers and motors.
- K. All cable must be free of tension at both ends as well as over the length of the run.
- L. Only Velcro straps are permitted as cable bundle supports. Waterfalls from cable tray shall not pinch, bind, crimp or in any way deform or cause physical damage to the cable jacket, or alter the electrical characteristics of the voice/data cables.
- M. Contractor shall take care to assure that during and upon completion of the installation, all cables are free of kinks, sharp bends, twists, gouges, cuts or any other physical damage which may cause physical or electrical characteristic alterations to the cables. The cables must also be installed at the proper room temperature. Any of these conditions will constitute a replacement of the installed cable.
- N. Contractor to observe all minimum bend radius and tension limitations, etc., as specified by the cable manufacturer when installing the cables.
- O. Contractor shall supply neatly bundled slack loops of length 10 feet for all cabling in telecommunications spaces. Provide neatly bundled slack loop 1 foot above the ceiling at workstation end.
- P. Provide Velcro cable ties periodically in all runs and within the telecommunications spaces provide slack loops per standards and to neatly bundle cables.
- Q. Route all optical fiber cabling in inner duct. Support inner duct with j-hooks a maximum five feet on center when not routed in conduit or cable tray.

3.3 CABLE TERMINATIONS

- A. The Contractor who installs the communications cabling shall terminate & test the finished link. It is not allowed to have a non-certified electrical contractor install the communications cable & have another certified contractor terminate, test & warranty it. No exceptions to this will be

allowed. Terminate all wiring at both ends using the T568B convention. All voice and data cables shall be terminated in accordance with ANSI/TIA/EIA 568-B installation guidelines.

- B. Contractor to install all modular jack dust covers and 110 style module "stuffer" caps as per manufacturer's recommendations on all workstation outlets and patch panels.
- C. All voice (phone) cables shall terminate on rack mounted, high density, patch panels in their own patch panel separate from workstation data jack patch panels.
- D. All data cables shall be terminated on rack mounted, high density, patch panels.
- E. Wireless access point & security camera data jacks will be terminated on their own patch panel separate from the workstation data jack patch panels.
- F. All access point & camera jacks above ceiling must be orange, securely mounted and labeled. No double stick allowed.
- G. All cable terminations shall be free of stress or tension when complete.

3.4 OUTLETS

- A. Contractor shall coordinate the location of all outlets with the architectural furniture layouts and the Engineer and WSU C&IT.
- B. Contractor to furnish and install voice, data, and video jacks in face plates for flush and surface-mounted workstation outlets.
- C. Mount surface outlets securely in place in consistent locations on systems furniture. Coordinate with furniture installer.

3.5 FACE PLATES

- A. Contractor shall furnish and install faceplates on wall boxes and raceway as required and as indicated on the Drawings.
- B. Contractor shall provide standard faceplate with blank inserts for all outlets indicated as "future".

3.6 PATCH PANELS

- A. The Contractor shall provide patch panels and cable management panels in equipment racks, as required.
- B. Mount patch panel according to equipment rack elevations.

END OF SECTION 27 0150

SECTION 27 0170 – CABLE PLANT ADMINISTRATION AND 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 27 0010 Section "Telecommunications General Requirements."

1.2 REFERENCES

- A. ANSI/NFPA 70 - National Electrical Code.
- B. NFPA-297 - Guide on Principles and Practices for Communication Systems.
- C. ANSI/TIA/EIA 568-B-1,2,3 - Commercial Building Telecommunications Cabling Standard.
- D. ANSI/TIA/EIA 569-A - Commercial Building Standard for Telecommunications Pathways and Spaces.
- E. ANSI/EIA/TIA 607 - Commercial Building Grounding and Bonding Requirements for Telecommunications.
- F. ANSI/IEEE-110-1992 - Powering and Grounding Sensitive Electronic Equipment.
- G. BICSI – Building Industry Consulting Services International.

1.3 SUBMITTALS

- A. Submit under provisions of Section 270010.
- B. Product Data: Provide for all cable and device labeling apparatus.
- C. Reports: Submit final, certified test reports in bound booklet and electronic media. Include signed and dated reports certifying the test results.

1.4 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Section 270010.
- B. Accurately record equipment layout and cable layouts in all telecommunication spaces.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle Products to site under provisions of Section 16010.
- B. Protect products from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.6 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Verify routing and termination locations of conduits, and cable pathways prior to rough-in.

PART 2 - PRODUCTS

2.1 LABELS

- A. Manufacturers:
 - 1. Brady.
 - 2. Brother P-Touch.
 - 3. Equivalent by Tester manufacturer.
 - 4. Equivalent by UTP connectivity manufacturer.
- B. Description
 - 1. Machine-printed permanent glossy polyester labels for racks, cabinets, faceplates, and panels. (Brady B-422).
- C. Machine-printed, self-laminating vinyl for cabling and patch cords. (Brady B-427)

PART 3 - EXECUTION

3.1 LABELING

- A. Contractor to install all faceplate and equipment labels in accordance with manufacturer's recommendations and the specifications. All labels shall be neatly installed and shall be level with the floor and properly aligned on the faceplate.
- B. All pieces of voice and data equipment, including wires, cables, fibers and their respective terminations shall be labeled and identified in accordance with ANSI/TIA 606-B.
- C. Labels shall meet the requirements of UL 969 as outlined in the ANSI/TIA 606-B.
- D. All horizontal and backbone subsystem copper and fiber cables shall be labeled at each end. Labeling is required at intermediate points such as pullboxes and consolidation points (where appropriate).
- E. Do not install labels closer than 3" to the termination point.

- F. Patch panel labels shall be printed with the associated user data jack number. Contractor shall submit a sample of patch panel label strips to the Engineer for approval prior to installation.
- G. Numbering schemes for fiber panels, copper patch panels & voice wall 110 punch blocks will go in ascending order.
- H. Voice & data jack labeling scheme is Room Number –jack number + function. Ex: 222-V01, 222-D01, 222-V02, 222-D02, 223-V01, 223-D01, etc labeling shall be consistent at each end of cabling and at workstation outlet and patch panel or connecting block. Data jacks shall be orange located in the outlet bottom position (vertical) or the outlet right position (horizontal). Voice jacks shall be White located in the outlet top position (vertical) or the outlet left position (horizontal). All voice terminates in their own patch panel.
- I. Wireless access point jacks labeling scheme is WAP - Room Number. If the access point is in a corridor, use the closest room number. Labeling shall be consistent at each end of cabling and at WAP outlet and patch panel or connecting block. When a wireless access point is located above the ceiling a label must be placed on the ceiling grid which contains a small red dot & the wireless access point jack number.
- J. Security camera jacks labeling scheme is CAM – Last 2 octets of the IP Number. Elevated cameras must have labeling at the bottom which allows for viewing from ground level. Labeling shall be consistent at each end of cabling and at WAP outlet and patch panel or connecting block.
- K. All access point & security camera jacks will be terminated together on their own patch panel separate from the workstation data patch panels.
- L. All labels must be based on the final room numbers. Verify room numbering with Owner prior to installation of labels. Do not use room numbers that appear on construction drawings.

3.2 UTP SYSTEM TESTING

- A. Upon completion of the cable installation, the Contractor shall perform complete copper cable certification tests, according to all manufacturer's requirements for warranty and all testing required by TIA/EIA, including, but not limited to:
 - 1. Continuity checks on each cable, checking for opens and shorts.
 - 2. Cable length (Channel and Permanent Link).
 - 3. Correct pair polarity.
 - 4. Correct cable labeling at both ends.
- B. Tests shall be performed with connectors installed.
- C. Any UTP CAT6 cable or component that has been painted & / or not satisfactorily passing test or failing to meet quality installation standards as described in the specification, shall be repaired and/or replaced as directed by the Engineer at the Contractor's expense.
- D. The Contractor shall prepare complete cable test reports for all installed cables for review and acceptance by the Engineer WSU C&IT prior to acceptance of the cabling system.
- E. Category 6E UTP cable and patch cord installations shall be fully tested and verified in accordance with TIA/EIA-568-B specifications.
- F. All cable testing shall be conducted by an experienced technician using a Level III minimum Fluke Networks DTX 1800, Versiv or Engineer-approved equal for certification testing.
- G. The cable tester shall be calibrated to the type of cable being tested prior to beginning the cable certifications. It should identify each cable or jack number on the test results.

- H. Proposed calibration procedure shall be submitted to C&IT for approval.
- I. The Category 6E Horizontal Cable Certification reports shall have complete testing of channel for voice & data drops, at frequency increments up to 450MHz & set the cable length limit to 295' as indicated in ANSI/TIA-568-C and shall include the following:
 - 1. Cable/Faceplate Number -- matching faceplate numbers on patch panels
 - 2. Tester Calibration Validation Date. Has to be calibrated every year.
 - 3. Building Name & Test Date
 - 4. cable Length
 - 5. Wire-Map
 - 6. Network Tests for 100BASE-TX and 1000BASE-T
 - 7. Attenuation
 - 8. Near End CrossTalk (NEXT)
 - 9. Power-sum NEXT (PS-NEXT)
 - 10. Attenuation to Cross Talk Ratio (ACR)
 - 11. Power-sum Attenuation to Cross Talk Ratio (PS-ACR)
 - 12. Equal Level Far End CrossTalk (ELFEXT)
 - 13. Power-sum Equal Level Far End CrossTalk (PS-ELFEXT)
 - 14. Return Loss
 - 15. Propagation Delay
 - 16. Delay Skew
 - 17. Signal to Noise Ratio
- J. Upon completion, before final payment the following must be provided:
 - 1. Provide (1) electronic copy of test results in PDF file format.
 - 2. Provide the manufacture warranty certificate upon completion.
 - 3. Test date.
 - 4. Tester make, model & calibration date.
 - 5. No exception to this will be allowed.
- K. After the horizontal cable tests have been performed, the Contractor shall install the faceplate labels and modular jack dust covers.

3.3 OPTICAL FIBER SYSTEM TESTING

- A. Upon completion of the fiber cable installation, the Contractor shall perform complete fiber cable certification tests, according to all manufacturer's requirements for warranty and all testing required by TIA/EIA.
- B. Test all fiber (100%) using a power meter using the encircled flux testing criteria as stated in the TIA TSB-4979 specification or TIA 526-14-B standard, testing all cables in both directions.
- C. Provide test report and include as a minimum the following information for all cables:
 - 1. Fiber cable number
 - 2. Fiber length.
 - 3. Attenuation (loss in dB).
 - 4. Test date
 - 5. Tester make and model no.
 - 6. Tester calibration date.
- D. All cable testing shall be conducted by an experienced technician using a Microtest Simplifiber meter or equivalent tester.

END OF SECTION 27 0170

SECTION 28 10 00 - ELECTRONIC ACCESS CONTROL AND INTRUSION DETECTION

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, and Division 1 Specifications Sections, apply to this Section.

1.02 DESCRIPTION OF WORK

- A. Extent of Electronic Access Control and Intrusion Detection work is listed on drawings, schedules and exhibit "A" and may include:
- | | |
|--|--|
| 1. ADA Operators – LCN | 15. Power Controllers – Altronix |
| 2. ADA Actuators – LCN | 16. Power Supply (Glassbreak) – Altronix |
| 3. Batteries – JCI | 17. Power Supply (Lock) – Von |
| 4. Card Readers – Mercury | 18. Power Transfers – Von |
| 5. Connectors – Waldom Molex | 19. Relay – Moose |
| 6. Cylinder – Best | 20. Relay – Omron |
| 7. Electrified Exit Devices – Von Duprin | 21. Relay Sockets – Omron |
| 8. Enclosure – Hoffman | 22. Relay Sockets – Omron |
| 9. Enclosure – JCI | 23. Tamper Switches – GE |
| 10. Exit Alarms - DSI | 24. Terminal Board – JCI |
| 11. Glass Break Detectors – Honeywell | 25. Terminal Panel – Hoffman |
| 12. Magnetic Door Contact – GE | 26. Terminal Strip – Cinch |
| 13. Marker Strip – Cinch | 27. Transformer – JCI |
| 14. Motion Sensors - Kantech | |
- B. Provide all components and work as shown in the specifications and drawings, and also include all necessary components not listed as may be required to provide the required system operation.
- C. Coordinate with WSU-Police for programming of all access control and alarm monitoring input points and output points onto P2000 Access Control and Alarm Monitoring System server.
- D. Refer to the "Wayne State University Police Department Alarm / Card Access Specifications & Standards" in "Exhibit B" at the end of this section for a detailed list of system requirements.
- E. Termination of electrified door hardware shall be by security contractor with cost included under this section.
- F. Door hardware listed in this section but noted as 08 71 00 is shown for door operation clarity only and is not to be included in this bid.

- G. Coordinate with GC representative for new key core installations on all required door hardware and security devices.
- H. Point to point wiring schematics and programming configuration sheets for access control and alarm monitoring systems will be issued to the successful bidder after receipt of fully executed contract prior to project completion. Successful bidder must supply Security Consulting, Inc. with a copy of the signed contract prior to receiving documents. Bidders are not to include the cost associated with preparing these documents in their bids; however the bidders must include the labor cost to implement the work outlined within this specification.

1.03 RELATED SECTIONS / WORK

- A. Section 08 71 00 – Finish Hardware
- B. Section 08 80 00 – Glazing
- C. Section 27 11 00 – Basic Voice & Data Systems (Refer to the “Wayne State University Standards for Communication Infrastructure” to ensure compliancy with WSU C&IT requirements. See “Exhibit A” at the end of this section for a link to the document.)
- D. Section 27 15 00 – Backbone and Horizontal Cabling for Voice & Data Systems (Refer to the “Wayne State University Standards for Communication Infrastructure” to ensure compliancy with WSU C&IT requirements. See “Exhibit A” at the end of this section for a link to the document.)
- E. Section 28 31 00 – Fire System
- F. Refer to Division 26 Sections for Electrical work. All conduits, conduit pull strings, back boxes and 120VAC shall be provided and installed by electrical contractor as indicated on security drawings. Equipment cabinets shall be provided by security contractor and installed by electrical contractor as indicated on security drawings.
- G. Refer to Section 28 31 00 for Fire Detection and Alarm work. Fire system contractor shall supply (3) N.C. dry contacts programmed to open upon fire alarm, fire trouble and supervisory conditions at security panels located in MDF/IDF closet as indicated on security drawings. This is required when building is designed with a fire system control panel.
- H. WSU Computing and Network Services shall provide fiber optic port assignments, IP addresses and network configuration. Contact Mr. Pete Garabedian at (313) 577-1955 for assistance and coordination.
- I. WSU Police Department will provide administrative access rights to the JCI P2000 Access Control System Server for all control panel configurations and programming including perimeter card access, perimeter door control, input & output control and intrusion alarm programming. Contact Lt. Frank Smith @ (313) 577-6059 for assistance.

- J. Carpentry Contractor shall install final key cores at all emergency exit Chexit devices, emergency exit alarmed exit devices and all required locking hardware locations. Security Contractor shall coordinate the installation of all key cores with the GC project manager assigned to this project.

1.04 SUBMITTALS

General: Submit the following in accordance with the conditions of Contract and Division 1 Specification Sections.

- A. Product Data: Submit manufacturer's specifications and installation instructions for types of security equipment indicated.
- B. Templates: All electric hardware to be applied to metal door frames shall be made to template and packed with machine screws. Forward mortise hardware to the door contractor for application if required, and provide necessary templates promptly upon receipt of frame shop drawings.
- C. Schedule: After formal notice of award, prepare a security schedule setting forth the items proposed to be furnished for every opening and device group. Submit proper number of copies of this schedule to allow the architect to retain two copies, and to furnish one copy for the owner, plus the number of copies required by the design / builder for distribution and use (10 copies max.) The schedule shall be written in the exact format as the specification wherein the information shall provide an opening / device location description, and shall state the name of the manufacturer, type, number, and finish of each device proposed to be used.

Type the security schedule double spaced and submit on 8½ x 11 inch sheets of paper. Submittals not following this format will be returned unchecked.

- D. Shop drawings: Submit ten copies of shop drawings which include riser and wiring diagrams and other information and details required for coordinated installation with other related work.

Drawings shall be identical versions of security drawings pertaining to this section with changes and additional details and shall include the following at a minimum.

- Floor plans showing door and device locations produced on AutoCAD 2008 + and in an acceptable manner.
- Riser diagrams produced on AutoCAD 2008 + showing proposed cable runs from each door device with cable manufacturer, cable description and outside diameter clearly marked.
- Wiring diagrams produced on AutoCAD 2008 + showing all devices in system with point to point wiring between every device.

- All drawings shall be professionally and clearly produced using AutoCAD 2008 + or they will be returned unchecked.

1.05 AS-BUILT DRAWINGS

- A. Assemble three as-built job binders, indexed with the following as-built information.
- Index 1 "Security Schedule": Copy of security schedule similar to submittal schedule, but revised to indicate as-built material listing.
 - Index 2 "Data Sheets / Manuals": Copy of all data sheets and / or manuals for all devices listed in security schedule.
 - Index 3 "Configuration Sheets": Copy of configuration sheets showing all system program information relative to this project.
 - Index 4 "Floor Plans": Copy of security floor plans similar to the submittal floor plans, but revised to indicate as-built conditions.
 - Index 5 "Riser Diagrams": Copy of riser diagrams similar to submittal riser diagrams, but revised to indicate as-built conditions.
 - Index 6 "Wiring Diagrams": Copy of wiring diagrams showing all devices in system with point to point wiring between every device.

1.06 QUALITY ASSURANCE

General: Electronic Access Control and Intrusion Detection systems shall be provided by Electronic Security Systems, Inc. or a security systems integrator who meets the following requirements:

- A. Must be able to show evidence of past experience furnishing and servicing door locking hardware and electronic systems specified in this section.
- B. Must have been engaged in the business of providing, installing, servicing and maintaining similar security measures in similar environments during the past five (5) years.
- C. Meet all applicable licensing and regulatory requirements of the State of Michigan, particularly Public Act 330.
- D. Meet all applicable local jurisdiction licensing requirements.
- E. Must have a local support capacity consistent with the demands of this project and other local clients.

- F. Must have a properly staffed facility with a properly stocked equipment warehouse within a four (4) hour drive of the job site.
- G. Security Systems Integrator must be a factory direct authorized dealer and certified for all products and equipment specified in this section. Equipment procured through wholesale houses, distributors or non factory authorized security integrator will be disqualified.
- H. Electronic Access Control and Intrusion Detection Systems Contractor must be a member of local 58 or pay their employees prevailing wages to avoid job delays. Subcontract work will not be accepted.
- I. Insurance and Indemnity: Contractor must take out and maintain, during the life of this agreement insurance coverage as set forth by the owner.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Deliver equipment to job site unless otherwise required or directed, wrapped in separate packages, complete with all accessories, screws, etc. for each door, labeled and numbered for each opening.
- B. Furnish typewritten schedule with each shipment in conformity with approved schedule. Furnish receipts in duplicate, upon delivery of hardware to the project site.

PART 2 – PRODUCTS

2.01 APPROVED MANUFACTURERS

- A. Manufacturers for material, in accordance with the requirements of this Section are as follows with no substitutions allowed. This list defines the manufacturer only and does not in any way act to permit any deviation from the requirements of the Contract Documents.

1. Power Supply (Glassbreak)	Altronix
2. Power Supply (Lock)	Altronix
3. Power Controllers	Altronix
4. IC Cylinder Housings	Best
5. Terminal Strips	Cinch
6. Marker Strips	Cinch
7. Exit Alarms	DSI
8. Magnetic Door Contact	GE / Sentrol
9. Tamper Switch	GE / Sentrol
10. Hatch Contact	GE / Sentrol
11. Electric Hinge	Hager
12. Enclosures	Hoffman
13. Panels	Hoffman
14. Alarm Controller	Honeywell
15. Glassbreak Detectors	Honeywell

16. Keypads	Honeywell
17. Batteries	JCI
18. Enclosures	JCI
19. Terminal Boards	JCI
20. Transformer	JCI
21. Motion Sensor	Kantech
22. ADA Actuators	LCN
23. ADA Operators	LCN
24. Bollard Post	LCN
25. Card Reader	Mercury
26. Relays	Moose
27. Relays	Omron
28. Relay Sockets	Omron
29. Custom Back Boxes	Stellar Plastics
30. Electric Exit Devices	Von Duprin
31. Power Supply (Exit Devices)	Von Duprin
32. Power Transfer	Von Duprin
33. Connectors – Multi	Waldom Molex

2.02 ELECTRONIC ACCESS CONTROL AND INTRUSION DETECTION SYSTEMS EQUIPMENT SUPPLIER CODES

1. CBORD = WSU Internal Access Control System
2. EACAIDS = Electronic Access Control and Intrusion Detection Systems, Section and or Contractor
3. Existing = Existing equipment / hardware to remain
4. IAP = Intrusion Alarm Panels.
5. IACP = Interior Access Control Processor and Associated Terminal Panels and Power Supplies (CBORD)
6. PACP = Perimeter Access Control Processor and Associated Terminal Panels and Power Supplies (JCI)
7. WSU-DS = Wayne State University Design Services
8. WSU-Police = Wayne State University Police Department
9. WSU-OCO = Wayne State University One Card Office
10. 08 71 00 = Hardware supplied by finish hardware contractor and installed by carpentry contractor
11. 26 00 00 = Division 26 00 00 is related to all electrical sections.
12. 27 11 00 = Basic Voice & Data Systems
13. 27 15 00 = Backbone and Horizontal Cabling for Voice & Data Systems
14. 28 10 00 = Equipment supplied and installed by (EACIDS) Electronic Access Control and Intrusion Detection systems Contractor
15. 28 31 00 = Fire System Contractor

2.03 ELECTRONIC ACCESS CONTROL AND INTRUSION DETECTION SYSTEMS EQUIPMENT SETS

Security Set SS-A

Perimeter Door with Card Reader, Monitoring and ADA Capability

Single Door D01D Exterior from Vestibule 01 (HW SET: 02)
(1) 3'-0" x 7'-0" x 1 3/4" x GL/AL x GL/AL x Wide Style x DKB

RHR

24 Hour Mode: Card Required Manual Employee Entry / ADA Assisted Automated Entry upon Activation of Inbound Actuator after Presenting Valid Credential / Emergency Keyed Entry Override / REX Detected Manual Free Egress / ADA Assisted Automated Egress Upon Activation of Outbound Actuator 24 x 7 / Door D01D ADA Operator Interfaced with Door D02D ADA Operator for Sequential Operation / Door Position, Latch Bolt and Device Tamper Monitored for Forced and Held Conditions by WSU Police / Exit Device Remains Locked upon Loss of Power

Division			
<u>Item</u>	<u>Section</u>	<u>Qty</u>	<u>Description</u>
1.	08 71 00	1	Continuous Hinge IVE # 112HD x EPT x DKB
2.	08 71 00	1	Rim Cylinder BES # 1E72 x 626
3.	08 71 00	1	Final Cores
4.	08 71 00	1	Door Pull IVE # 8190-2-NO x 630
5.	08 71 00	1	Overhead Stop GLY # 900S x 613
6.	08 71 00	1	Door Seals (By Door Supplier)
7.	08 71 00	1	Door Sweep NGP # C627 x DKB
8.	08 71 00	1	Threshold NGP # 425 x AL
9.	28 10 00	1	Electric Power Transfers VON # EPT-10 x 695
10.	28 10 00	1	Electric Exit Devices VON # EL-LXRXC35A-NL-OP x 626 x 3'
11.	28 10 00	1	Power Supply VON PS914-2RS
12.	28 10 00	1	Cabinet Lock CCL # 15748-US26D-C4L-KA4T3252
13.	28 10 00	1	Cabinet Lock Brass Spacer CCL # 2540 x US4
14.	28 10 00	1	Auto Equalizer LCN # 4642 x 695
15.	28 10 00	2	Actuators LCN # 8310-853T x 630
16.	28 10 00	1	Door Contact GE # 1076D
17.	28 10 00	1	Card Reader Mercury # BR-2012T3
18.	28 10 00	1	Custom Reader Head Box w/ Rain Hood Stellar # XXX
19.	28 10 00	1	Reader Tamper Switch GE # 1035
20.	28 10 00	1	Power Supply Tamper # GE # 30121
21.	28 10 00	1	EPT Connector Sets: (Refer to Exhibit "A" Section 5.02 A.3 for Details)
22.	28 10 00	Lot	Mounting Hardware / J-Hooks / Fire Stop
23.	28 10 00	Lot	Cabling (As Indicated on Security Riser Diagram SC-R1)
24.	28 10 00	Lot	Labor to mark up and deliver power supply to electrical contractor for coordination and installation. Mark up and deliver electrified door hardware to glazing contractor for coordination and installation. Install J-hooks, back boxes, cabling and fire stop. Fish cables to device locations. Deliver, install, and terminate EPT, exit device, ADA operator, actuators, door contact, reader shroud, card reader, tamper switches, Molex connector and all associated hardware. Terminate field devices, power supply and control panel. Turn on, program, and test with WSU-Police. Perform final adjustments.

Security Set SS-B

Interior Door with ADA Capability

Single Door D02D Vestibule 01 from Display Hall 02 (HW SET: 04)
(1) 3'-0" x 7'-0" x 1 3/4" x GL/AL x GL/AL

RHR

24 Hour Mode: Manual Free Entry / ADA Assisted Automated Entry upon Activation of Inbound Actuator /
Manual Free Egress / ADA Assisted Automated Egress upon Activation of Outbound /
Door D02D ADA Operator Interfaced with Door D01D ADA Operator for Sequential
Operation

Division		Qty	Description
<u>Item</u>	<u>Section</u>		
1.	08 71 00	1	Continuous Hinge IVE # 112HD x EPT x DKB
2.	08 71 00	1	Push x Pull Unit IVE # 9190HD-2-NO x 630
3.	08 71 00	1	Overhead Stop GLY # 900S x 613
4.	28 10 00	1	Auto Equalizer LCN # 4642 x 695
5.	28 10 00	1	Actuators LCN # 8310-853T x 630
6.	28 10 00	Lot	Mounting Hardware / J-Hooks / Fire Stop
7.	28 10 00	Lot	Cabling (As Indicated on Security Riser Diagram SC-R1)
8.	28 10 00	Lot	Labor to mark up and deliver electrified door hardware to glazing contractor for coordination and installation. Install J-hooks, back boxes, cabling and fire stop. Fish cables to device locations. Deliver and install ADA operator, actuators and all associated hardware. Terminate field devices, power supply and control panel. Turn on program and test with WSU-Police. Perform final adjustments.

Security Set SS-C

Doors w/ Monitoring

Single Door D01A Exterior from Vestibule 100 (HW Set: 01)
Single Door D01B Exterior from Vestibule 100 (HW Set: 01)
Single Door D01C Exterior from Vestibule 100 (HW Set: 01)
(3) 3'-0" x 7'-0" x 1 3/4" x GL/AL x GL/AL

LHR

RHR

LHR

Day Mode: Doors Manually Dogged and Unlocked / Manual Free Entry / Manual Free Egress

Night Mode: No Normal Entry / No Keyed Entry / Doors Manually Un-dogged and locked / REX Detected Free
Egress 24 x 7 / Door Positions and Latch Bolts Monitored through P2000 Access Control System by
WSU Police

Division		Qty	Description
<u>Item</u>	<u>Section</u>		
1.	08 71 00	3	Continuous Hinges IVES # 112HD x EPT x 83" x DKB
2.	08 71 00	3	Door Pulls IVES # 8190-2-NO x 630
3.	08 71 00	3	Surface Closers LCN # 4021 x REG x 695

4.	08 71 00	3	Overhead Stops GLY # 900S x 613
5.	08 71 00	3	Door Sweeps NGP # C627 x DKB
6.	08 71 00	3	Thresholds NGP # 425 x AL
7.	28 10 00	3	Power Transfers VON # EPT-10 x 695
8.	28 10 00	3	Electric Exit Devices VON # LXRRLC35A-EO x3' x US26D
9.	28 10 00	3	Door Contact GE # 1076
10.	28 10 00	3	EPT Connector Sets (See Exhibit "A" Section 5.02 B.3 for Details)
11.	28 10 00	Lot	Mounting Hardware / J-Hooks / Fire Stop
12.	28 10 00	Lot	Cabling (As indicated on Security Riser Diagram SC-R1)
13.	28 10 00	Lot	Labor to mark up and deliver power supply to electrical contractor for coordination and installation. Mark up and deliver electrified door hardware to glazing contractor for coordination and installation. Install J-hooks, back boxes, cabling and fire stop. Fish cables to device locations. Deliver install and terminate EPT's, exit devices, door contacts, Molex connectors and all associated hardware. Terminate field devices and control panel. Turn on, program and test with WSU-Police. Perform final adjustments.

Security Set SS-D

Exterior Emergency Exit Doors w/ Local Alerts & Monitoring

Single Door D03 Exterior from North Corridor 03 (HW SET: 05)	LHR
Single Door D04 Exterior from South Corridor 04 (HW SET: 05)	RHR
(2) 3'-0" x 7'-0" x 1 3/4" GL/AL x GL/AL	

24 Hour Mode: Emergency Exit Only / No Entry / Alarm Detected Manual Free Egress / Local Audible Alert upon Egress Violation / Key Switch Controlled Exit Alarm with Bypass and Reset Functions / Door Position and Latch Bolt Monitored Remotely via JCI P2000 Access Control System by WSU-Police

Item	Division Section	Qty	Description
1.	08 71 00	2	Continuous Hinge IVES # 112HD x EPT x 83" x DKB
2.	08 71 00	2	Door Pulls IVES # 8190-2-NO x 630
3.	08 71 00	2	Surface Closer LCN # 4021 x REG x 695
4.	08 71 00	2	Overhead Stops GLY # 900S x 613
5.	08 71 00	2	Door Sweep NGP # C627 x DKB
6.	08 71 00	2	Threshold NGP # 425 x AL
7.	08 71 00	2	Exit Alarm Final Key Core
8.	28 10 00	2	Power Transfer VON # EPT-10 x 695
9.	28 10 00	2	Electric Panic Rim VON # LXRRLC98-EO x3' x US26D
10.	28 10 00	2	Exit Alarm DSI # ES4300-K4-T1
11.	28 10 00	2	Rim Cylinders BES # 1E72 x 626
12.	28 10 00	2	Door Contact GE # 1076D
13.	28 10 00	2	EPT Connector Sets (See Exhibit "A" Section 5.02 B.3 for Details)

14.	28 10 00	Lot	Mounting Hardware / J-Hooks / Fire Stop
15.	28 10 00	Lot	Cabling (As indicated on Security Riser Diagram SC-R1)
16.	28 10 00	Lot	Labor to mark up and deliver electrified door hardware to glazing contracting for coordination and installation. Install J-hooks, back boxes, cabling and fire stop. Fish cables to device locations. Deliver install and terminate EPT's, exit devices, door contacts, power supply, tamper switches, Molex connectors and all associated hardware. Terminate field devices, power supply and control panel. Turn on, program and test with WSU-Police. Perform final adjustments.

- (2) Two gang 2.5" deep flush electrical boxes to be provided and installed by electrical contractor to support above DSI exit alarms.

Security Set SS-E

Roof Hatch

Roof Hatch 08 Located in Janitor's Closet 07

Operation: Roof Hatch Position Monitored 24 x 7 by WSU-Police / For Roof Access Must Contact WSU-Police

<u>Item</u>	<u>Division Section</u>	<u>Qty</u>	<u>Description</u>
1.	28 10 00	1	Magnetic Contact GE 2505A
2.	28 10 00	1	Mounting Kit GE 1092A
3.	28 10 00	1	Engraved Plastic Instructional Signs – (Red w/ 1" High White Letters) "HATCH IS ALARMED / CONTACT WAYNE STATE POLICE @ 7-2222 FOR ACCESS"
4.	28 10 00	Lot	Mounting Hardware / J-Hooks / Fire Stop
5.	28 10 00	Lot	Cabling (As Indicated on Security Riser Diagram SC-R1)
6.	28 10 00	Lot	Labor to install all J-hooks, fire stop and cabling. Deliver and install magnetic contacts, signage and all associated hardware. Terminate, turn on, program and test for proper operation. Perform final adjustments.

Security Set SS-F

Smoke Detector, Duct Detector & Sprinkler System Auxiliary Monitoring

Operation: Upon Presence of Smoke, all Detectors Shall Emit a Local Audible Alert / Smoke Detectors Monitored Remotely 24 x 7 via P2000 Access Control System by WSU Police / Smoke Detectors Contacts Shall be Wired to Individual Input Points on P2000 Access Control System in a Supervised Configuration

<u>Item</u>	<u>Division Section</u>	<u>Qty</u>	<u>Description</u>
1.	28 31 00	11	Smoke Detectors

2.	28 31 00	11	Smoke Detector Base Plates w/ Auxiliary Contacts
3.	28 31 00	1	Duct Detector w/ Auxiliary Contact
4.	28 31 00	1	Sprinkler Gate Valve Tamper Switch
5.	28 31 00	1	Sprinkler Flow Valve Switch
6.	28 31 00	Lot	Misc. Mounting Hardware, Terminal Strips, Panel Wiring etc.
7.	28 31 00	Lot	Cabling (As Indicated on Security Riser Diagram SC-R1)
8.	28 10 00	Lot	Labor to fish cables supplied by others into control panel. Terminate input points at security system I/O board. Program smokes as priority alarms. Label control panel with date batteries are installed. Assist fire alarm contractor with testing of smoke detectors, duct detector, flow valve and tamper switch back to WSU-police. Provide WSU Design Services Project Manager with test results of all above devices.

- This is an Auxiliary Monitoring Solution Only and is Not Part of a UL Rated Fire Alarm System.
- Smoke detectors, base plates, duct detector, sprinkler system, gate valve tamper switch, sprinkler system flow valve, EOLR and cabling to be supplied, installed and terminated by section 283100 (fire alarm contractor).
- All above devices shall be labeled with individual zone numbers by section 283100. Zone numbers shall be provide by section 281000 (Electronic Access Control and Intrusion detection System Contractor)
- Section 283100 (Fire Alarm Contractor) shall work with section 281000 (Electronic Access Control and Intrusion detection System Contractor) with testing of all devices to auxiliary monitoring system at WSU Police Department.

Security Set SS-G

Perimeter Glassbreak Detection

1st Floor Building Perimeter Doors and Windows

Operation: Perimeter Glass Monitored 24 x 7 / Exit Motion Shunts Glassbreak Detector upon valid Egress

Division			
<u>Item</u>	<u>Section</u>	<u>Qty</u>	<u>Description</u>
1.	28 10 00	2	Glass Break Detectors Honeywell # FG1625T
2.	28 10 00	2	REX Motion Detectors Kantech # T-REX
3.	28 10 00	2	(1) Gang mounting Plates Kantech # T-REX-Plate
4.	28 10 00	Lot	Misc. Mounting Hardware, Terminal Strips, Panel Wiring etc.
5.	28 10 00	Lot	Cabling (As Indicated on Security Riser Diagram)
9.	28 10 00	Lot	Labor to install J-hooks, beam clamps, back boxes, cabling and fire stop. Fish cables to device locations. Deliver and install glassbreak detectors, REX motion detectors and all associated hardware. Terminate field devices, input points, and power supply. Turn on, program, and test with WSU-Police. Perform final adjustments. Provide WSU Design Services Project Manager with test results of glassbreak detector activations.

Security Set SS-1

FOCI (Fiber Optic Communication Interface)

FOCI Located Electrical / Data Closet 08

- Standalone Local Fiber Optic Communication Module w/ UPS Located Electrical / Data Closet 08
- Remote Fiber Optic Communication Module Located at Associated "Fiber Hub" Security Equipment Cabinet (Coordinate exact location with WSU-Police and WSU C&IT representatives)

Operation: Bi-Directional Communication of Access Control & Alarm Monitoring Systems with WSU Police

Division			
<u>Item</u>	<u>Section</u>	<u>Qty</u>	<u>Description</u>
1.	28 10 00	1	Fiber Equipment Cabinet Hoffman A24N20ALP
2.	28 10 00	1	Mounting Panel Hoffman # A24N20MP
3.	28 10 00	1	Fiber Card Cage w/PS RCC # CR200-P
4.	28 10 00	1	Fiber Converter RCC # DL 221/SM-RE3
5.	28 10 00	1	Fiber Converter RCC # DL 221/SM-ME3
6.	28 10 00	2	Fiber Patch Cables Radiant # JEE60SMT210
7.	28 10 00	1	UPS Supply Black Box # BK350
8.	28 10 00	1	Power Strip # UL6NEW
9.	28 10 00	1	Cabinet Lock CCL # 15748-US26D-C4L-KA4T3252
10.	28 10 00	1	Cabinet Lock Brass Spacer CCL # 2540 x US4
11.	28 10 00	2	Tamper Switch GE # 3012
12.	28 10 00	1	Double Duplex Outlet, Box, Cover
13.	28 10 00	1	Wire Trough Hoffman # A4436RT
14.	28 10 00	1	25' Cat6 Ethernet Patch Cord (Pink)
15.	28 10 00	Lot	Mounting Hardware
16.	28 10 00	Lot	Panel Equipment / Wire / Misc. Hardware
17.	28 10 00	Lot	Cabling (As Indicated on Security Riser Diagram)
18.	28 10 00	Lot	Labor to assemble and pre-wire components onto equipment mounting plate. Install J-hooks, beam clamps, communication cable and fire stop from fiber converter to CK721A control panel. Fish cables to device locations. Deliver and install equipment cabinet, mounting plate, UPS, local fiber converter, remote fiber converter, fiber patch cables and all associated hardware. Terminate and configure converters per the schematics provided by Security Consulting, Inc. Turn on, and test for proper operation. Perform final adjustments.

Security Set SS-2

PACP (Perimeter Access Control Processor)

PACP Located Electrical / Data Closet 08

Operation: Card Reader Interface / Door Control Interface / Perimeter Alarm Monitoring Interface /
Power Fail Monitoring / Low Battery Monitoring / Communication Status Monitoring /
Smoke Detector Monitoring

Card Reader Door
W / ADA & Monitoring: D01D

Manually Controlled
Door w/ Monitoring: D01A, D01B & D01C

Exit Only Doors
W / Monitoring: D03 & D04

Monitored
Roof Hatch: 08

Glassbreak
Detectors: (2) Total Openings D01A/B & D01C/D,

Smoke Detectors: (11) Total as noted on Electrical Drawing E3.1

Duct Detector: (1) as noted on Electrical Drawing E3.1

Sprinkler Tamper: (1) as noted on Electrical Drawing E3.1

Sprinkler Flow Valve: (1) as noted on Electrical Drawing E3.1

Division			
<u>Item</u>	<u>Section</u>	<u>Qty</u>	<u>Description</u>
1.	28 10 00	1	Master Controller JCI #CK721A
2.	28 10 00	2	Reader Modules JCI # S300-DIN-RDR2SA
3.	28 10 00	1	I/O Module JCI # S300-DIN-I32O16
4.	28 10 00	1	Power Supply Altronix # Maximal75E
5.	28 10 00	2	Power Controllers Altronix # PD8UL
6.	28 10 00	2	Batteries Yuasa # NP12-12
7.	28 10 00	1	Cabinet Lock CCL # 15748-US26D-C4L-KA4T3252
8.	28 10 00	1	Cabinet Lock Brass Spacer CCL # 2540 x US4
9.	28 10 00	1	Cabinet Tamper Switch GE # 3012
10.	28 10 00	1	Cabinet Hoffman #A24N24ALP
11.	28 10 00	1	Mounting Panel Hoffman # A24N24MP
12.	28 10 00	1	Wire Trough Hoffman # A6624RT
13.	28 10 00	Lot	35MM DIN Rail Omron # PFP-100N
14.	28 10 00	Lot	Mounting Hardware: J-Hooks, Bridle Rings, and Fire Stop etc.
15.	28 10 00	Lot	Panel Equipment: Wire, Terminal Strips, Relays, Relay Boards, Misc. Hardware
16.	28 10 00	Lot	Cabling (As Indicated on Security Riser Diagram)
17.	28 10 00	Lot	Labor to deliver equipment cabinet and power supply to electrical contractor and coordinate installation. Assemble and pre-wire components onto equipment

cabinet mounting panel. Run all necessary cable. Fish cables to device locations. Deliver and install mounting panel, controller, terminal boards, power controllers, batteries, tamper switches, cabinet lock and all associated hardware. Terminate and program all devices per the schematics provided by Security Consulting, Inc. Turn on and test for proper operation. Perform final adjustments. Perform walk thru and test with WSU Police. Provide test results to WSU Design Services project manager.

Security Set SS-3

Engineering and Documentation

<u>Item</u>	<u>Division</u> <u>Section</u>	<u>Qty</u>	<u>Description</u>
1.	28 10 00	Lot	Labor to engineer and produce EACAIDS schedule and AutoCAD riser diagrams, floor plan layouts, and point-to-point wiring diagrams for EACAIDS system. Provide three (3) sets of As-Built documents of EACAIDS schedule, cut sheets, manuals, riser diagrams, floor plan layouts, and wiring diagrams. One (1) year labor and material warranty.

PART 3 – EXECUTION

3.01 SYSTEM INSTALLATION REQUIREMENTS

General: Comply with manufacturer's instructions for assembly and installation of Electronic Access Control and Intrusion Detection System, controls and accessories.

1. Assemble and prewire control boxes and other like assemblies in suppliers' shop facility and test operation. Install completed assembly in field.
2. The cabinet lock listed in this specification may require the installation of spacer 2540 to keep door tight enough so tamper switch is secure. In some applications the use of multiple spacers may be required.
3. Install door control system components in locations indicated with work plumb, level, true and straight with no distortions. Secure exposed work with security fasteners.
4. Make final electrical connections to Electronic Access Control and Intrusion Detection System components.
5. Turn on and test all system components and system as a whole.
6. Terminations: Secure all multiple termination points on terminal blocks.
7. Exposed Panels: Secure all exposed panels with tamper resistant screws. Supply owner with two (2) tools for removing all tamper-resistant hardware.

8. Electronic Equipment Enclosures: Lock all terminal enclosures located in secured and non-secure areas, housing electronic components. All enclosures shall be equipped with tamper switches as indicated in specification section 2.03
9. Field AC Power: Directly hardwire all field AC power to equipment as required.
10. Perform all work required to cut, patch and mount Electronic Access Control System hardware.
11. All wiring shall be in accordance with the manufacturer's requirements and all applicable codes and standards including WSU C&IT Standards and WSU Police standards.
12. Tie-wrap all cabling and distribute cleanly to terminal strips. Systematically and logically number and mark all cabling using vinyl wire marker; document all cabling runs, distribution, splice points and terminations on the CAD generated As-built drawings.
13. Contractor to conceal all cabling in ceilings, walls, doors and side light frames where possible. All routing of surface applied raceway must be approved by the owner and painted to match surroundings.
14. Contractor to reuse cable tray raceways where applicable.
15. Identification Nameplates – The contractor shall label all control panels, terminal boxes, and major items of the installed system and/or control description and show and describe all items on the drawings. The Contractor shall provide self-adhesive (1/8" thick plastic) labels with characters sized not less than 1/4" and with a nameplate's minimum size limited to 1" x 3". The labels shall include the device identification and "Device Name". Coordinate code with cabling, as-built documentation and system programming.
16. Remove, store, protect, and re-install ceiling tiles upon completion of the work. Damaged tiles shall be replaced at Contractor's expense.
17. Contractor shall remove only amounts of sprayed fire proofing necessary to install hangers and supports to complete their scope of work. Patching of fireproofing shall be the responsibility of this contractor. Contractor shall use an installer certified in the use of sprayed resistive materials and the installation shall be in accordance with specification section 078110.
18. Contractor shall provide the Owner seven (7) calendar days notice of any system tie-ins and/or any associated work on any existing Universities system to complete this scope of work. Contractor shall further abide by associated work on any existing university system to complete this scope of work. Contractor shall further abide by all owners procedures when working on existing systems. Contractor shall complete work at the university's convenience.
19. Upon mobilizing, Contractor shall submit an initial master construction schedule outlining their complete scope of work. This schedule shall be based on owners sequencing, milestone dates and schedule. Contractor shall then update/progress their schedule and be available for discussion at each weekly foreman's meeting.

20. Contractor shall provide all required fire stop systems to complete scope of work, and shall meet all requirements outlined in specification 07841 (Through Penetration Fire Stop Systems.) Fire stoping of pipe penetrations thru non-rated and smoke walls that extend to the deck above will be by the Contractor.
21. Due to the nature of these areas, the sequence of the work must be scheduled to minimize disruptions and disturbances to the owner's operations and utilities.
22. Contractor shall be responsible for all saw cutting / core drilling, patching, and fire stopping that is required to complete their scope of work if it is not already covered in the electrical contractors section.
23. When necessary the contractor must obtain approvals, permits, and coordinate the inspection and testing of the systems with state and local governing agencies.
24. Provide all tests, data, affidavits, test results and certificates required by all governing authorities to the Design/Builder in a timely manner to facilitate Owner occupancy.
25. Contractor shall, as deemed necessary by the Owner, provide an up to date status on submittals, lead times, and expected delivery dates of the material/equipment to complete their scope of work.
26. Contractor shall be responsible for hoisting and scaffolding to complete their scope of work.
27. Contractor shall furnish access doors to be installed by others. Contractor shall, as deemed necessary by the owner, provide all necessary coordination of the installation by others.
28. This Contractor shall be responsible for his own clean-up costs and shall at all times maintain a clean and safe jobsite. Dumpsters will be provided by the General Contractor.
29. Provide and maintain an effective safety program that will be in agreement and conform to the policies in the General Contractors Health & Safety Manual for this project.
30. Contractor will promptly process the submittals to ensure timely submittal of the items in this scope of work and ordering of the same. The contractor shall comply with the attached project schedule.
31. This bidder is responsible to review the site and be familiar with all existing conditions within and around the project including local conditions and requirements.
32. This Contractor shall be responsible to coordinate all required on-site testing, inspection and quality assurance requirements. This Contractor shall be responsible for conformance to all federal and local codes, regulations, testing, and inspection requirements as required for beneficial occupancy by the Owner. Secure and provide all inspections and permits required. Complete all certification of items as specified by the Contract Specifications, and the code and governing bodies. Testing is performed with the Owner.

3.02 ADJUSTMENTS, CLEANING, FINISHING AND PROTECTION

- A. Clean exposed and semi-exposed surfaces. Touch-up shop applied finishes restoring damaged or soiled areas.
- B. Operate Electronic Access Control and Intrusion Detection Systems including controls through all modes of operation and make final adjustments as necessary to ensure proper functioning.
- C. Instruction: Instruct personnel in complete operation of system through all modes.

3.03 TRAINING

- A. The Contractor shall include two (4 hour) training sessions for the Owner's personnel on the operation and maintenance of the Electronic Access Control and Intrusion Detection Systems
- B. The training courses shall be taught by a qualified representative at the Owner's location.
- C. The Contractor is responsible for providing all training materials. The owner will be responsible for providing the training room facilities at the Owner's location.
- D. The Contractor shall furnish the Owner two (2) copies of all systems manuals.
- E. System manuals shall contain the system block diagram, basic system operation outline, equipment owner's manuals, test reports, equipment service and repair manuals, system layout, date of installation and contact person and phone number.

3.04 WARRANTY

- A. The Contractor shall warrant the completed system wiring and equipment to be free from inherent mechanical and electrical defects for a period of two (2) years from the date of final acceptance by the Owner.
- B. All proposed warranties shall be provided, as a minimum, from 8:00 AM – 4:30 PM Monday through Friday with response provided with four (4) business hours from the time of notification

3.05 ALTERNATE PRICING

N/A

PART 4 – Exhibits

4.1 Exhibit "A"

- A. VISIT THE FOLLOWING LINK FOR A COPY OF THE WSU STANDARDS FOR COMMUNICATIONS AND INFRASTRUCTURE

<http://computing.wayne.edu/docs/wsu-communications-standards.pdf>

4.2 Exhibit "B"

A.

Wayne State University Police Department Alarm/Card Access Specification's & Standards

This document only provides general system requirements and product standards. Every project has unique characteristics and requirements necessary to properly secure the building. Modification of submitted security system proposals may be required upon further review by the W.S.U. Police Department.

Revision date 4/29/2016

1.01 Overview

WSU Police uses JCI (Johnson Controls Inc.) Cardkey Pegasys 2000 Access Control and Alarm Monitoring software to monitor all alarms and control building access on our campus wide system. Systems at any University building on or off campus must be compatible with Pegasys 2000 and should communicate with the server at WSU Police. Currently, the compatible controller is the JCI Cardkey CK721A network controller.

2.01 System Controllers

ACP (Access Control Processor): Each building is equipped with a CK721A ACP. The ACP is the main control processor for each building and stores all the pertinent data for that respective building i.e. card holders, monitor points, output control points, time schedules etc. The ACP interfaces with multiple terminal boards (e.g. reader boards, input boards, and output boards) and also communicates directly with the P2000 Server.

- A. Card reader, alarm input and output control boards will be from the JCI Cardkey S300 series of terminal boards.
- B. The S300-DIN-I8O4 or S300-DIN-I32O16 input x output boards are designed to monitor both supervised and non-supervised devices. Each board can be configured and terminated for supervision to support critical device, such as the reporting of Fire Alarm, Fire Trouble and Fire Supervisory alarms to WSU PD and should be programmed as Terminal 1 inputs 1, 2 & 3 respectively. Non-supervised devices that may be connected to these boards include but not limited to perimeter doors, roof hatches, roof doors, environmental alarm devices, glassbreak detectors, motion detectors, water detectors etc. Each building on campus is required to have at minimum (1) S300-DIN-I8O4 input board configured to report supervised alarms.
- D. The S300-DIN-I8O4 or S300-DIN-I32O16 input x output control board is also utilized to control devices remotely (e.g. unlocking perimeter doors on time schedules, resetting glass break detectors, shunting alarm points during business hours).
- E. The S300-DIN-RDR2SA is a two reader board and is required for every one or two card readers. The S300-DIN-RDR2SA is the interface between the card reader and the CK721A network controller.

- F. The S300-DIN-RDR8SA is an 8 reader board and is typically used when the number of readers for a particular building exceeds 6 readers total. The S300-DIN-RDR8SA is the interface between the card reader and the CK721A network controller.
- F. A 12v/7Ah gel cell battery must be provided with every equipment cabinet containing a power supply for controllers or terminal boards.

3.01 Communication

- A. All building security systems are to communicate to the P2000 Server via the University Fiber Optic Backbone dedicated for security. The fiber backbone is arranged in a hub and spoke configuration with (9) fiber hub locations. Each hub is associated with a number of end buildings. These buildings are equipped with multi-mode fiber between the end building and the respective fiber hub. All hubs are arranged in a self-healing ring configuration utilizing single mode fiber with a primary and secondary path to WSU Police.
- B. Radiant Communications DL221-SM-RE3 fiber converters will be used and will have APC300 Back-UPS or similar protection. The UPS will contain a 12v/7 Ah battery with Fasten connectors.
- C. Locations without University Fiber Optic Backbone, will have to communicate to the P2000 Server via a fractional T-1 line or if the location is close enough to another location with fiber connectivity then via a microwave link. Consult the WSU Police Alarm System Administrator for specifics.

4.01 Inputs and Monitoring Requirements

- A. Most University facilities are designed for authorized users to enter 24/7, therefore system design must have perimeter security using door switches shunted for request to exit (RX) and glass break protection rather than motion detection.
- B. Perimeter security will monitor all doors for both door position and latch position.
- C. Use electrified Von Duprin rim/panic device. The use of electric strikes is prohibited unless there is no other option available as these devices are not reliable over the long haul.
- D. Use RX switches mounted inside Von Duprin rim/panic device. The use of overhead motion detectors to shunt door alarms on doors is not acceptable.
- E. All security devices will be monitored for tampering, including all card readers, all alarm control keypads, all motion sensors and all glass break sensors. Tamper alarms for security devices will be wired to separate input points than their respective security device's input point.
- F. All panels and equipment cabinets containing alarm circuits, terminals, termination strips, fiber converter, etc. will be monitored for tampering and power failure. Non-Cardkey cans will use GE 3012-N tamper switches. Power fail circuits must be configured to monitor for extended power

loss, not power “bumps”. Circuit/device protection (fuses) must be included and designed to expedite troubleshooting of the alarm system.

5.01 Card Reader Requirements

- A. The standard card reader for perimeter access is Mercury Security Model MS-BR20-0W-T3. This is a track 3 magnetic stripe card reader. Card readers will be equipped with GE Sentrol 1035W magnetic switches and will be installed and lubricated per manufacturers’ specification. Each card reader is to control (unlock) only one door. Any card reader exposed directly to the elements must be protected by a weatherized rain hood positioned for card reader ease of use and removal for servicing.

5.02 Door Hardware Requirements

- A. **Perimeter Card Reader Doors to be equipped as follows:**
 - 1. Doors must be fitted with Von Duprin Rim exit devices. Concealed and/or surface vertical rod exit devices are not permitted. Exit devices are to be fitted with EL (Electric Latch Retraction) functionality, RX (Request to Exit) monitoring switch, LX (Latch Bolt) monitoring switch and LC (Low Current) - rated contacts. All rim/panic devices shall be mounted to doors per Allegion specifications which include using 10x24x1” pan head Phillips-type machine screws with holes drilled and tapped to accommodate said machine screws. Case covers and end caps shall be secured with the Phillips-type screws provided with the rim device. Use Molex receptacle (mfg. part # 03-06-1062) with female pin connectors (mfg. part# 02-06-1103-C) where cable from EPT enters exit device. Use Molex receptacle (mfg. part # 03-06-2061) with male pin connectors (mfg. part # 02-06-2103-C) on exit device solenoid and switch wires. EPT wires transmitting power should be doubled up at both frame and exit device side to accommodate high current loads.
 - 2. EL exit devices are to be powered with Von Duprin PS914-2RS power supply only. Not more than two EL devices shall be connected to a single PS914-2RS.
 - 3. Von Duprin EPT-10 (Electric Power Transfer) to be used for the transferring of power and data signals from door frame to door. Use Molex receptacle (mfg. part # 03-06-1062) with female pin connectors (mfg. part# 02-06-1103-C) where cable from door frame meets EPT. Use Molex receptacle (mfg. part # 03-06-2061) with male pin connectors (mfg. part # 02-06-2103-C) on door frame side of EPT wires. Molex connectors used on exterior door EPT must be lubricated with dielectric lubricant (white petrolatum) and must be wrapped in electrical tape to protect pin connectors and wire from exposure to moisture.
 - 4. DSM (Door Switch Monitor) Sentrol 1078 1” diameter concealed magnetic door switch to be installed on all monitored doors. Doors to be monitored on a schedule. Consult WSU Police alarm system administrator for specific times.

- a. Mercury Security Model MS-BR20-0W-T3 Magnetic Stripe card reader to be installed. This is a track 3 magnetic stripe card reader. Card readers will be equipped with magnetic tamper switch GE Sentrol 1035W. Reader will be installed and lubricated per manufacturers' specifications. Each card reader is to control (unlock) only one door. Any card readers exposed directly to the elements must be protected by a weatherized rain hood positioned for card reader ease of use and removal for servicing.
- b. When ADA Auto Operators exist they must be interfaced to access control system/electrified hardware. Exterior ADA actuators must be disabled whenever the electrified hardware is locked and enabled only after the card and PIN have been presented at the reader to allow access.

B. Routinely used Non Card Reader Pedestrian Doors to be equipped as follows:

1. Doors must be fitted with Von Duprin Rim exit devices. Concealed and/or surface vertical rod exit devices are not permitted. Exit devices to be fitted with EL (Electric Latch Retraction) functionality, RX (Request to Exit) monitoring switch, LX (Latch Bolt) monitoring switch and LC (Low Current)-rated contacts. All rim/panic devices shall be mounted to doors per Ingersoll-Rand specifications which include using 10x24x1" pan head Phillips-type machine screws with holes drilled and tapped to accommodate machine screws. Case covers and end caps shall be secured with the Phillips-type screws provided with the rim device. Use Molex receptacle (mfg. part # 03-06-1062) with female pin connectors (mfg. part# 02-06-1103-C) where cable from EPT enters exit device. Use Molex receptacle (mfg. part # 03-06-2061) with male pin connectors (mfg. part # 02-06-2103-C) on exit device solenoid and switch wires. EPT wires transmitting power should be doubled up at both frame and exit device side of EPT to accommodate high current loads.
2. EL exit devices are to be powered with Von Duprin PS914-2RS power supply only. Not more than two EL devices shall be connected to a single PS914-2RS.
3. Von Duprin EPT-10 (Electric Power Transfer) to be used for the transferring of power and data signals from door frame to door. Use Molex receptacle (mfg. part # 03-06-1062) with female pin connectors (mfg. part# 02-06-1103-C) where cable from door frame meets EPT and where cable enters rim device. Use Molex receptacle (mfg. part # 03-06-2061) with male pin connectors (mfg. part # 02-06-2103-C) on door frame side of EPT and on wires leading to rim device's switches. Molex connectors used on exterior door EPT must be lubricated with dielectric lubricant (white petrolatum) and must be wrapped in electrical tape to protect pin connectors and wire from exposure to moisture.
4. DSM (Door Switch Monitor) Sentrol 1078 1" diameter concealed magnetic door switch to be installed on all perimeter doors. Doors to be monitored on a schedule; consult WSU Police alarm system administrator for specific times.

C. Emergency Exit Doors to be equipped as follows:

1. Doors must be fitted with Von Duprin Rim exit devices. Concealed and/or surface vertical rod exit devices are not permitted. Exit devices to be fitted with RX (Request to Exit) monitoring switch, LX (Latch Bolt) monitoring switch and LC (Low Current) - rated contacts. All rim/panic devices shall be

mounted to doors per Allegion specifications which include using 10x24x1" pan head Phillips- type machine screws with holes drilled and tapped to accommodate said machine screws. Case covers and end caps shall be secured with the Phillips type screws provided with the rim device. Use Molex receptacle (mfg. part # 03-06-1062) with female pin connectors (mfg. part# 02-06-1103-C) where cable from EPT enters exit device. Use Molex receptacle (mfg. part # 03-06-2061) with male pin connectors (mfg. part # 02-06-2103-C) on exit device solenoid and switch wires. EPT wires transmitting power should be doubled up at both frame and exit device side of EPT to accommodate high current loads.

2. Von Duprin EPT-10 (Electric Power Transfer) to be used for the transferring of power and data signals from door frame to door. Use Molex receptacle (mfg. part # 03-06-1062) with female pin connectors (mfg. part# 02-06-1103-C) where cable from door frame meets EPT and where cable enters rim device. Use Molex receptacle (mfg. part # 03-06-2061) with male pin connectors (mfg. part # 02-06-2103-C) on door frame side of EPT and on wires leading to rim device's switches. Molex connectors used on exterior door EPT must be lubricated with dielectric lubricant (white petrolatum) and must be wrapped in electrical tape to protect pin connectors and wire from exposure to moisture.
3. DMA (Door Management Alarm) Design Security Inc. DSI 4200-K4-T1 Local audible exit alarm with output control capability. DMA to be wall mounted on gang back box. DMA to be powered via hardwired DC power source from ACP (Access Control Processor) auxiliary power supply location. RX, LX and DSM to be interfaced with DMA. DMA audible alert to activate upon egress. Audible alert to auto-reset 30 seconds after door secures. Consult WSU Police alarm system administrator for specific DMA configuration.
4. DSM (Door Switch Monitor) Sentrol 1078 1" diameter concealed magnetic door switch to be installed on all perimeter doors. Doors to be monitored on a schedule. Consult WSU Police alarm system administrator for specific times.

D. Roof and Mechanical Room Doors to be equipped as follows:

1. DSM (Door Switch Monitor) Sentrol 1078 1" diameter concealed magnetic door switch to be installed on all perimeter doors. Doors to be monitored on a schedule. Consult WSU Police alarm system administrator for specific times.
2. Custom Signage shall be installed at roof hatch indicating the hatch is armed and to contact WSU Police before opening.

E. Perimeter Overhead Doors to be equipped as follows:

1. DSM (Door Switch Monitor) Sentrol 2205AL x 1912L surface-mounted overhead magnetic door switch to be installed on all perimeter overhead doors. Doors to be monitored on a schedule. Consult WSU Police alarm system administrator for specific times.
2. Custom Signage shall be installed at roof hatch indicating the hatch is armed and to contact WSU Police before opening.

F. Roof Hatches to be equipped as follows:

1. DSM (Door Switch Monitor) Sentrol 2505A x 1912L surface-mounted, magnetic door switch to be installed on all roof hatches. Roof hatches are to be monitored on a schedule. Consult WSU Police alarm system administrator for specific times.
2. Custom Signage shall be installed at roof hatch indicating the hatch is armed and to contact WSU Police before opening.

5.03 Perimeter Building Protection

All perimeter glass accessible from grade or some other nearby elevated platform (e.g. overhangs, canopies, half story roofs, second story roofs, adjacent buildings, trees, etc.) are to be protected with Glassbreak Sensors or PIR Motion Sensors. Perimeter monitoring devices are interfaced with the building ACP input and output boards and are monitored and controlled by WSU Police via the P2000 Server. All perimeter sensors are connected to individual inputs on JCI I/O boards. WSU Police must have the ability to shunt, arm and disarm all perimeter sensors via outputs on the JCI I/O boards. Consult with WSU Police alarm system administrator for specific intrusion alarm programming configurations. Acceptable sensors are as follows:

- A. GB (Glassbreak Sensor) GE Sentrol Shatterbox II model 5775N glassbreak sensors to be used where protecting perimeter windows is necessary. Where multiple glass break sensors are located in close proximity to each other, they must be wired to a nearby centrally-located junction box. The glass break sensors must be wired in series with each other to said junction box with a single cable pair wired to the JCI I/O board. This configuration reduces the number of required inputs. The junction box must contain termination strips and associated components required for proper monitoring and control of the sensors. Junction boxes must be documented on CAD drawings as a single zone and include all termination points, cable colors, cable types, etc. Sensors wired in a daisy chain configuration are not acceptable. A dedicated output on the JCI I/O board controlled by WSU Police is required to remotely reset power to sensors after activation.
- B. VGS (Vestibule Glassbreak Sensor) Honeywell FG1625T glassbreak sensor to be used in conjunction with T-REX REX motion sensors when protecting entryway vestibule glass doors. VGS sensors must be home run to the JCI I/O board and not part of a zone configuration. Motion sensor shall shunt glassbreak sensor when pedestrians are exiting the building.
- C. MD (PIR Motion Sensor) Visonic SRN-2000 PIR Motion Sensors. PIR sensors are only acceptable when interior spaces are not occupied after normal business hours and building is armed by scheduled output from P2000 Server.

6.01 Intrusion Alarms for Interior Rooms & Office Suites

Intrusion alarms are implemented for the protection of personnel and property on interior office suites, animal labs, distance learning labs, computer labs etc. The intrusion alarms are managed locally by the end users and monitored remotely by WSU Police. Intrusion alarms consist of the following devices:

- A. Use Ademco/Honeywell Vista -128B controller with Ademco/Honeywell 6160 keypad to control internal alarms on any internal suite or alarmed areas. WSUPD must have ability to arm/disarm intrusion alarm with P2000 server. Use GE3012-N tamper switch on keypad and equipment cabinets.
- B. All intrusion alarms must be equipped with a Honeywell 4204 relay module. The 4204's outputs will interface directly to JCI S300-DIN-I804 or S300-DIN-I32O16 input/output boards via a hardwire connection and will report four general alarm conditions: Intrusion, Low Battery, Tamper, and Keypad Armed. (Note: Large systems may require additional zone reporting and therefore additional 4204 relay boards).
- C. An output from a JCI I/O board will be hardwired to the keyswitch input of the Honeywell Vista 128B controller. The output shall be programmed to allow WSUPD the ability to disarm the intrusion alarm system from the P2000 server when necessary.
- D. DSM (Door Switch Monitor) Use Sentrol 1078 1" diameter magnetic door switch.
- E. GB (Glassbreak Detector) Use Ademco Flex Guard V-Plex model FG1625SN glass break sensors.
- G. MD (PIR Motion Detector) Use Honeywell DT 7500 SN Dual TEC motion sensors when using V-PLEX polling loop or Visionic SRN-2000 motion sensors when used in a home run configuration.
- H. A 12v/7Ah gel cell battery must be provided with every Vista 128B controller.
- I. A separate equipment cabinet must be provided to properly house Honeywell 4204 relay interface boards, Honeywell loop extenders (when necessary), terminal strips, timers, transformers, 120 VAC receptacles, etc. Cabinet must also include GE3012-N tamper switch and cabinet lock 4T3252.

7.01 Miscellaneous System Requirements:

- A. Non Card Reader doors, should unlock via electrified Von Duprin rim/panic device and output controls.
- B. Equipment Cabinet/Terminal Cabinets locks: Use # 237 cam lock for JCI Cardkey panels, and CCL # 15748-US26D-C4L-KA4T3252 for terminal cabinets. Terminal Cabinet Locks may require Brass Spacer CCL # 2540 x US4 for proper operation of tamper switch.
- C. No splicing of wire runs allowed; all wire runs shall be complete runs without wire nuts, splices or splice boxes. Wire and cables to card readers, magnetic door switches and between EPT must be soldered and shrink wrapped to protect cables.
- D. Surface-mounted cable runs of any kind are not permitted; all cable runs will be concealed.

8.01 As-Built and Riser Drawing Requirements:

- A. As-built drawings must be provided, and must include cable designations, wire type, gauge and color.
- B. As-built drawings must detail model and/or part number of devices being used and include an illustrated parts list
- C. As-built drawings must also detail interconnection wiring between terminal boards as well as the location, address and switch settings of terminal boards.
- D. As-built drawings must detail CK721A wiring and communication path. As-built drawings must detail support hardware (e.g. power supply, UPS, and fiber converters).
- E. Riser drawings must show elevation detail of doors, glassbreak detectors, card readers and other devices.
- F. As-built and riser drawings must be sized on 42 inch by 30 inch paper.

9.01 Cable Requirements

Application	Wire Type
1. Fiber converter to Cardkey panel	24 AWG x 4 Pair – Solid Jacketed Copper Plenum CAT – 5
2. Fire & Fire Trouble inputs to board	18 AWG x 1 Pair - Solid Jacketed Fire Rated Plenum
3. Auto operator or temp probe to board	22 AWG x 4 Cond. w/ Stranded Flexible Jacketed Plenum
4. Cabinet tamper / glass break reset	22 AWG x 2 Cond. w/Stranded Flexible Jacketed Plenum
5. Auto operator buttons or input	18 AWG X 2 Cond. w/Stranded Flexible Jacketed Plenum
6. Power to Vista 128BP glassbreak to Terminal strips	22 AWG X 6 Cond. w/Stranded Shielded Flexible Jacketed Plenum
7. Data	24 AWG x 1 Pair w/Overall Braided Shield Plenum
8. Rim device alarm to terminal strips	22 AWG x 2 Pair w/Stranded Overall Braided Shield Plenum
9. Input board from various devices	22 AWG x 1 Pair w/Stranded Overall Braided Shield Plenum
10. Rim device to power boosters	14 AWG x 2 with Stranded Flexible Jacketed Plenum
11. Terminal strips to alarm boards	22 AWG x 4 Pair Stranded Shielded Jacketed Plenum
12. Card reader to RDR2 board	22 AWG x 8 Cond. w/Overall Shielded Jacketed Plenum

13. Power to ALK / DMA

18 AWG x 1 Pair Stranded Jacketed Plenum

End of Section
28 23 00

SECTION 28 23 00 - VIDEO SURVEILLANCE SYSTEM (VSS)

PART 1- GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract and Division 1 Specifications Sections apply to this Section.

1.2 DESCRIPTION OF WORK

- A. Extent of Video Surveillance System is listed on drawings and schedules and includes:
1. Indoor Fixed Vandal Resistant IP Cameras
 2. Camera Licenses
 3. Network Video Recorder
 4. Video Management Software
 5. Mount Boxes / Connectors & Fittings
 6. Ceiling / Brackets & Adapters
 7. Patch Cords
- B. Provide all components and work as shown in the specifications and drawings, and also include all necessary components not listed as may be required to provide the correct system operation.
- C. Section 271300 shall furnish and install all network drops required to support CCTV system
- D. Section 271300 shall furnish and install all associated data cabling, connectors, patch panel, terminations, testing, and cable certification to support (1) IP camera.
- E. Coordinate with WSU-C&IT representative to collect system information for initial configuration through final system turn on and test. Compile checklist to verify that all devices have been tested and report properly on system server.
- F. Document video surveillance system programming on configuration sheets, and assist WSU-C&IT with entering the new device data into the NVR.
- G. Generate CCTV Master Spreadsheet containing camera brand, model #, type, frame rate, resolution, record schedule, motion detection, MAC address, IP address, power source, network switch address, network switch port, MDF/IDF room #, and all other pertinent information for each camera.

1.3 RELATED SECTIONS

- A. Section 27 11 00 – Basic Voice & Data Systems (Refer to the “Wayne State University Standards for Communication Infrastructure” to ensure compliancy with WSU C&IT requirements. See Exhibit A at the end of this section for a link to the document.)

- B. Section 27 15 00 – Backbone and Horizontal Cabling for Voice & Data Systems (Refer to the “Wayne State University Standards for Communication Infrastructure” to ensure compliancy with WSU C&IT requirements. See Exhibit A at the end of this section for a link to the document.)

1.4 REFERENCES

- A. The Codes and Regulations listed below form a part of this specification to the extent referenced. Work shall be performed in accordance with the applicable international, federal, state, and local codes or standards current at the commencement of installation. The following list summarizes applicable standards including but not limited to.
 - 1. UL 294, UL 1076, ULC
 - 2. CE
 - 3. FCC – Part 15, Part 68
 - 4. NFPA 70, NEC
 - 5. IEEE, RS 170 variable standard
- B. Where more than one code or regulation is applicable, the more stringent shall apply.
- C. Cable and equipment installation, identification and termination shall be performed in accordance to the applicable codes above.

1.5 DEFINITIONS

- A. CCTV = Closed Circuit Television
- B. GUI = Graphical User Interface
- C. LAN = Local Area Network
- D. IP = Internet Protocol
- E. NVR = Network Video Recorder
- F. PoE = Power over Ethernet
- G. WAN = Wide Area Network
- H. VSS = Video Surveillance System
- I. VMS = Video Management System
- J. WSU-C&IT = Wayne State University Computer and Information Technology
- K. WSU-DS = Wayne State University Design Services
- L. WSU-Police = Wayne State University Police Department

1.6 SUBMITTALS

General: Submit the following in accordance with the conditions of Contract and Division 1 Specifications Sections.

- A. Product Data: Submit manufacturer’s specifications and installation instructions for types of VSS equipment indicated.

- B. Schedule: After formal notice of award, prepare a VSS schedule setting forth the items proposed to be furnished for every video system device location. Submit proper number of copies of this schedule to allow the architect to retain two copies and to furnish one copy for the owner, plus the number of copies required by the design / builder for its distribution and use (8 copies max.) The schedule shall be written in the exact format as the specification wherein the information shall provide the camera device location description, and shall state the name of the manufacturer, and type and number of each device proposed to be used.

Type the security schedule double spaced, and submit on 8 ½ x 11 inch sheets of paper. Submittals not following this format will be returned unchecked.

- C. Shop Drawings: Submit (8) copies of shop drawings which include floor plan layouts, riser diagrams, wiring diagrams and other information and details required for coordinating installation with other related work.

Drawings shall be identical versions of VSS drawings pertaining to this section with changes and additional details and shall include the following at a minimum:

- a. Floor plans showing camera and device locations marked legibly and in an acceptable manner.
- b. Riser diagrams showing proposed cable runs from each camera with cable manufacturer, cable description and outside diameter clearly marked.
- c. Wiring diagrams showing all devices in system with point to point wiring between every device.

All drawings shall be professionally and clearly produced using AutoCAD 2008 + or they will be returned unchecked.

1.7 AS-BUILT DRAWINGS

- A. Assemble three as-built job binders, indexed with the following as-built information.
1. Index 1 "VSS Schedule": Copy of VSS schedule similar to submittal schedule, but revised to indicate as-built material listing.
 2. Index 2 "Data Sheets / Manuals": Copy of all data sheets and / or manuals for all devices listed in VSS schedule.
 3. Index 3 "Floor Plans": Copy of VSS floor plans similar to the submittal floor plans, but revised to indicate as-built conditions.
 4. Index 4 "Riser Diagrams": Copy of riser diagrams similar to submittal riser diagrams, but revised to indicate as-built conditions.
 5. Index 5 "Wiring Diagrams": Copy of wiring diagrams showing all devices in system with point to point wiring between every device.

1.8 QUALITY ASSURANCE

General: Video Surveillance System shall be provided and installed by a Security Systems Integrator, who is a factory direct Certified Integrator for each of the specified products and who also meets the following requirements:

- A. Insurance and Indemnity: The contractor must take out and maintain, during the life of this agreement, insurance coverage as set forth by owner.
- B. Must have been engaged in the business of providing, installing, servicing, and maintaining similar VSS measures in similar environments during the past five (5) years.
- C. Must be able to show evidence of past experience furnishing and servicing video surveillance systems specified in this section.
- D. Must meet all applicable licensing and regulatory requirements of the State of Michigan, particularly Public Act 330.
- E. Must meet all applicable local jurisdiction licensing requirements.
- F. Must have a local support capacity consistent with the demands of this project and other local clients.
- G. Must have a properly staffed facility with a properly stocked equipment warehouse within a one (1) hour drive of the job site.
- H. Video Surveillance Systems Contractor must be a member of Local 58 to avoid job delays. Subcontract work will not be accepted.
- I. Must purchase all equipment directly from manufactures listed. Contractors who intend to procure equipment through wholesale houses, distributors, or other security integrators will be disqualified.

1.9 DELIVERY, STORAGE AND HANDLING

- A. Deliver equipment to job site unless otherwise required or directed, wrapped in separate packages, complete with all accessories and fasteners for each camera, labeled, and numbered for each camera location.
- B. Furnish typewritten schedule with each shipment in conformity with approved schedule. Furnish receipts in duplicate upon delivery of equipment to the project site.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Manufacturers and models specified in this Section shall be as listed herein with no substitutions allowed.
 - 1. Indoor Fixed Vandal Resistant IP Cameras – Axis
 - 2. Network Video Recorder / Server - NICE
 - 3. Video Management Software – NICE
 - 4. IP Camera Licenses – NICE
 - 5. Recessed Mounting Kit - Axis

2.2 VIDEO SURVEILLANCE SYSTEM EQUIPMENT SETS

Video Surveillance System equipment sets list components supplied under this section.

Set SS-A

Indoor Flush Ceiling Mounted Static Cameras

IP Camera Located Display Hall 02 (As Indicated on Security Floor Plan SC-F1)

Operation: Digital Video Recorded on NICE NVR at WSU-C&IT / Video Monitored and Controlled from WSU-Police

Division			
<u>Item</u>	<u>Section</u>	<u>Qty.</u>	<u>Description</u>
1.	28 23 00	1	1 Megapixel Vandal Res. Color Dome IP Camera Axis # P-3364-V
2.	28 23 00	1	Recessed Mounting Kit # Axis T94K01L
3.	28 23 00	1	Tamper Switch (Suitable for Specified Camera)
4.	28 23 00	1	2' Camera Cat 6 Patch Cords (Purple)
5.	27 15 00	1	Single Port Mounting Boxes for Cat 6 RJ-45 Modular Jacks
6.	27 15 00	1	Cat 6 RJ-45 Modular Jacks (Purple)
7.	27 15 00	Lot	Cat6 Plenum Cable (As Indicated on Security Riser Diagram SC-R1)
8.	28 23 00	Lot	Monitoring Cable (As Indicated on Security Riser Diagram SC-R1)
9.	28 23 00	Lot	Mounting hardware / J-Hooks / Beam Clamps / Fire Stop
10.	28 23 00	Lot	Labor to coordinate installation of camera data cabling with section 271300. Fish cables to device locations. Document all pertinent camera information on CCTV system master spreadsheet. Deliver, assemble, and install mount bracket, camera, patch cord, junction box, tamper switch, and all associated hardware. Patch each camera into owner-supplied PoE network switch. Terminate, turn on, and program IP address, MAC address, camera name descriptors, motion detection patterns and recording schedules. Test cameras for proper operation. Perform final adjustments.

Set SS-B

Electrical Closet 08

Division			
<u>Item</u>	<u>Section</u>	<u>Qty.</u>	<u>Description</u>
1.	27 15 00	1	24 Port PoE Managed Ethernet Switch
2.	27 15 00	1	24 Port Patch Panel
3.	27 15 00	1	Cat 6 RJ-45 Modular Jacks (Purple)
4.	27 15 00	1	Cable Management Duct
5.	27 15 00	1	Patch Panel to Switch Cat 6 Patch Cords (Purple)
6.	28 23 00	Lot	Wire Tags
7.	28 23 00	Lot	Velcro Tie Wraps Purple

8.	28 23 00	Lot	Mounting hardware
9.	28 23 00	Lot	Labor to coordinate installation of above items 1-4 with section 271300 contractor. Route patch cords neatly through cable management duct. Dress down and tag cables at patch panel.

Set SS-C

VMS (Video Management System)

NVR (Network Video Recorder / Server) shall be installed at 5925 Woodward and configured by WSU-C&IT Representative.

VMS (Video Management Software / NICE) currently resides with WSU-C&IT.

Division			
<u>Item</u>	<u>Section</u>	<u>Qty.</u>	<u>Description</u>
1.	Existing	1	VMS Enterprise Software Package NICE
2.	WSU-DS	1	Network Video Recorder / Server Dell # XXX
3.	WSU-DS	1	Single IP Camera License NICE # XXX
4.	28 23 00	Lot	Labor to coordinate with WSU-DS project manager and WSU-C&IT representative for procurement of NVR server and NICE camera license.

Set SS-D

Engineering and Documentation

<u>Item</u>	<u>Supplier</u>	<u>Qty</u>	<u>Description</u>
1.	28 23 00	Lot	Labor to engineer and produce VSS schedule and AutoCAD riser diagrams, floor plan layouts, and point-to-point wiring diagrams for VSS system. Provide three (3) sets of "As-Built" documents of VSS schedule, cut sheets, manuals, riser diagrams, floor plan layouts, and wiring diagrams. One (1) year labor and material warranty.

PART 3 – EXECUTION

3.1 SYSTEM INSTALLATION REQUIREMENTS

- A. General: Comply with manufacturer's instructions for assembly and installation of video surveillance system equipment.
 - 1. Install video surveillance system components in locations indicated with work plumb, level, true, and straight with no distortions. Secure exposed work with security fasteners.
 - 2. Coordinate with Owner's representative as required to provide a complete functional system.

3. Make final electrical connections to video surveillance system components.
4. Turn on and test all system components and system as a whole.
5. Secure all multiple termination points on terminal blocks.
6. Secure all exposed panels with tamper resistant screws. Supply owner with two (2) tools for removing all tamper-resistant hardware.
7. Directly hardwire all field AC power to equipment as required.
8. Perform all work required to cut, patch, and mount video surveillance system equipment.
9. All wiring shall be in accordance with the manufacturers' requirements and all applicable codes and standards.
10. Tie-wrap all cabling and distribute cleanly. Systematically, and logically number and mark all cabling using vinyl wire markers. Document all cabling runs, distribution, and terminations on the "As-built" drawings.
11. VSS Communications Contractor to conceal all cabling in ceilings and walls or in a manner acceptable to the owner.
12. Contractor shall remove only amounts of sprayed fire proofing necessary to install hangers and supports to complete their scope of work.
13. Upon mobilizing, contractor shall submit an initial master construction schedule outlining their complete scope of work. This schedule shall be based on owners and general contractors sequencing, milestone dates, and schedule. Contractor shall then update their schedule and be available for discussion at weekly meetings.
14. Contractor shall provide all required fire stop systems to complete scope of work, and shall meet all requirements outlined in specifications' "Through Penetration Fire Stop Systems."
15. Contractor shall be responsible for all saw cutting, core drilling, patching, and fire stopping that is required to complete their scope of work unless otherwise specified.
16. When necessary the contractor must obtain approvals, permits, and coordinate the inspection and testing of the system with state and local governing agencies.
17. Provide all tests, data, affidavits, test results, and certificates required by the owner in a timely manner to facilitate owner occupancy.
18. Contractor will promptly process the submittals to ensure timely submittal of the items in this scope of work and ordering of the same.

19. Contractor shall, as deemed necessary by the owner, provide an up to date status on submittals, lead times, and expected delivery dates of the material/equipment to complete their scope of work.
20. Contractor shall be responsible for hoisting and scaffolding to complete their scope of work.
21. Contractor shall be responsible for their own clean-up costs and shall at all times maintain a clean and safe jobsite. Dumpsters will be provided by general contractor.
22. Provide and maintain an effective safety program that will be in agreement and conformity with the policies in the general contractor's health and safety manual.
23. Contractor is responsible for re-viewing the site and being familiar with all existing conditions pertaining to the project including local conditions and requirements.
24. Contractor shall be responsible for coordinating all required on-site testing, inspection, and quality assurance requirements. This contractor shall be responsible for conformance to all federal and local codes, regulations, testing, and inspection requirements as required for beneficial occupancy by the owner. Secure and provide all inspections and permits required. Complete all certification of items required by the contract specifications, and the code and governing bodies.

3.2 LABELING

- A. It is important that both labeling and color coding be applied to all video infrastructure components. Labeling with the unique identifier will identify a particular component. Proper color coding will quickly identify how that component is used in the overall systems infrastructure of the facility.
- B. Labeling
 1. Labels are generally of either the adhesive or insert type. All labels must be legible, resistant to defacement, and maintain adhesion to the application surface.
 2. Outside plant labels shall be totally waterproof, even when submerged.
 3. All labels shall be machine printed.
 4. Labels applied directly to a cable shall have a clear vinyl wrapping applied over the label and around the cable to permanently affix the label.
 5. Other types of labels, such as tie-on labels, may be used. However, the label must be appropriate for the environment in which it is used, and must be used in the manner intended by the manufacture.

3.2 ADJUSTMENTS, CLEANING, FINISHING AND PROTECTION

- A. Clean exposed and semi-exposed surfaces. Touch-up shop applied finishes to restore damaged or soiled areas.
- B. Operate video surveillance system including controls through all modes of operation and make final adjustments as necessary to ensure proper functionality.
- C. Instruct personnel in complete operation of system through all modes.

3.3 TRAINING

- A. Contractor shall include 8 hours of training sessions for the owner's personnel on the operation and maintenance of the video surveillance system equipment specified.
- B. Training courses shall be taught by a qualified representative at the owner's location.
- C. Contractor is responsible for providing all training materials. The owner will be responsible for providing the training room facilities at the owner's location.
- D. Contractor shall furnish for the owner four (4) copies of the systems manuals.
- E. System manuals shall contain the system block diagram, basic system operation outline, test reports, equipment service, repair, and owner's manuals, system layout, date of installation, and contact person and phone number.

3.4 WARRANTY

- A. The Contractor shall warrant the CCTV cameras and associated equipment to be free from inherent mechanical and electrical defects for a period of 24 months from the date of final acceptance by the owner.
- B. All proposed warranties shall be provided, as a minimum, from 8:00 AM – 4:30 PM Monday through Friday with response provided within four (4) business hours from the time of notification

3.5 ALTERNATE ADDS

N/A

PART 4 – Exhibits

4.1 Exhibit "A"

- A. VISIT THE FOLLOWING LINK FOR A COPY OF THE WSU STANDARDS FOR COMMUNICATIONS AND INFRASTRUCTURE

<http://computing.wayne.edu/docs/wsu-communications-standards.pdf>

Harwell Field Building
Wayne State University
080-232104

Silveri Architects
BIDS 04-29-16

End of Section
28 23 00

SECTION 28 3100 - FIRE ALARM

PART 1 - GENERAL	1
1.1 RELATED DOCUMENTS	1
1.2 SUMMARY	1
1.3 DEFINITIONS	1
1.4 SYSTEM DESCRIPTION	1
1.5 PERFORMANCE REQUIREMENTS	2
1.6 SUBMITTALS	2
1.7 QUALITY ASSURANCE	3
PART 2 - PRODUCTS	3
2.1 MANUFACTURERS	3
2.2 SYSTEM SMOKE DETECTORS	3
2.3 ADDRESSABLE INTERFACE DEVICE	4
2.4 WIRE AND CABLE	5
PART 3 - EXECUTION	5
3.1 EQUIPMENT INSTALLATION	5
3.2 WIRING INSTALLATION	5
3.3 IDENTIFICATION	6
3.4 FIELD QUALITY CONTROL	6
3.5 WARRANTY	7

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Related Sections include the following:
 - 1. Division 26 Section "Electrical General Requirements."

1.2 SUMMARY

- A. This Section includes design and installation of a new fire alarm system

1.3 DEFINITIONS

- A. FACP: Fire alarm control panel.
- B. LED: Light-emitting diode.
- C. NICET: National Institute for Certification in Engineering Technologies.
- D. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.4 SYSTEM DESCRIPTION

- A. Noncoded, addressable system; multiplexed signal transmission dedicated to fire alarm service only.

- B. Fire alarm system shall consist of the following:

1. System smoke detection in areas identified on plans

1.5 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 72.
- B. A complete functional system meeting the requirements of this specification, including alarm initiating devices and notification appliances at locations and ratings to meet the requirements of the Authorities Having Jurisdiction and all applicable codes shall be provided.
- C. Coordinate and avoid conflicts with casework, markerboards, feature walls, and other areas where fire alarm devices would interfere with furnishings, finishes, etc.
- D. No additional charges for work or equipment required for a code compliant system approved by the Authority Having Jurisdiction will be allowed.
- E. Obtain and refer to mechanical drawings for smoke damper locations, smoke rated transfer openings, and air handling equipment CFM's. Provide smoke detection as required by applicable codes.
- F. Premises protection includes type Group B.

1.6 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings:
1. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire alarm system design.
 - b. Fire alarm certified by NICET, minimum Level III.
 2. System Operation Description: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.
 3. Device Address List: Include address descriptions that will appear on the FACP display.
 4. System riser diagram with device addresses, conduit sizes, and cable and wire types and sizes.
 5. Wiring Diagrams: Power, signal, and control wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Show wiring color code.
 6. Duct Smoke Detectors: Performance parameters and installation details for each detector, verifying that each detector is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 7. Ductwork Coordination Drawings: Plans, sections, and elevations of ducts, drawn to scale and coordinating the installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, the detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
 8. Floor Plans: Indicate final outlet locations showing address of each addressable device. Show device layout, size and route of cable and conduits.
- C. Qualification Data: For Installer.
- D. Field quality-control test reports.

- E. Operation and Maintenance Data: For fire alarm system to include in emergency, operation, and maintenance manuals. Comply with NFPA 72, Appendix A, recommendations for Owner's manual. Include abbreviated operating instructions for mounting at the FACP.
- F. Submittals to Authorities Having Jurisdiction: In addition to distribution requirements for submittals specified in Division 1 Section "Submittals," make an identical submittal to authorities having jurisdiction. To facilitate review, include copies of annotated Contract Drawings as needed to depict component locations. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Architect for review.
- G. Documentation:
 - 1. Approval and Acceptance: Provide the "Record of Completion" form according to NFPA 72 to Owner, Architect, and Authorities Having Jurisdiction.
 - 2. Record of Completion Documents: Provide the "Permanent Records" according to NFPA 72 to Owner, Architect, and authorities having jurisdiction. Format of the written sequence of operation shall be the optional input/output matrix.
 - a. Hard copies on paper to Owner, Architect, and Authorities Having Jurisdiction.
 - b. Electronic media may be provided to Architect.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Work of this Section be performed by a UL-listed company.
- C. Installer Qualifications: Personnel certified by NICET as Fire Alarm Level III.
- 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. FACP and Equipment:
 - a. Siemens Building Technologies, Inc.; a Cerberus Division.
 - b. SimplexGrinnell LP; a Tyco International Company.
 - c. National Time & Signal.
 - d. System Sensor.

2.2 SYSTEM SMOKE DETECTORS

- A. General Description:
 - 1. UL 268 listed, operating at 24-V dc, nominal.
 - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

3. Multipurpose type, containing the following:
 - a. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
 - b. Piezoelectric sounder rated at 88 dBA at 10 feet according to UL 464.
 - c. Heat sensor, combination rate-of-rise and fixed temperature.
4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection of building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status.

B. Photoelectric Smoke Detectors:

1. Sensor: LED or infrared light source with matching silicon-cell receiver.
2. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.

C. Duct Smoke Detectors:

1. Photoelectric Smoke Detectors:
 - a. Sensor: LED or infrared light source with matching silicon-cell receiver.
 - b. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.
2. UL 268A listed, operating at 24-V dc, nominal.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.
4. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. The fixed base shall be designed for mounting directly to the air duct. Provide terminals in the fixed base for connection to building wiring.
 - a. Weatherproof Duct Housing Enclosure: UL listed for use with the supplied detector. The enclosure shall comply with NEMA 250 requirements for Type 4X.
5. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type. Indicating detector has operated and power-on status. Provide remote status and alarm indicator and test station where required.
7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.
8. Each sensor shall have multiple levels of detection sensitivity.
9. Sampling Tubes: Design and dimensions as recommended by manufacturer for the specific duct size, air velocity, and installation conditions where applied.
10. Relay Fan Shutdown: Provide two (2) sets of contacts rated to interrupt fan motor-control circuit.

2.3 ADDRESSABLE INTERFACE DEVICE

- A. Description: Microelectronic monitor module listed for use in providing a system address for listed alarm-initiating devices for wired applications with normally open contacts.

2.4 WIRE AND CABLE

- A. Wire and cable for fire alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.
- B. Fire alarm wire and cable shall be as specified by the system manufacturer including conductor gage, conductor quantity, conductor twists and shielding required to meet NFPA class and style performance specified.
- C. Signaling Line Circuits and other power limited fire alarm circuits (PLFA):
 - 1. PLFA circuits installed in conduit or raceway: U.L. Listed type FPL
 - 2. PLFA circuit cable installed exposed in accessible ceiling spaces, risers and elsewhere: U.L. Listed type FPLP.
 - 3. PLFA circuits installed where 2 hr rating is required to meet the survivability requirements of NFPA 72: Circuit integrity cable, NFPA 70 Article 760, Classification CI, UL listed as Type FPL, FPLR or FPLP as required, and complying with requirements in UL 1424 and in UL 2196 for a 2-hour rating.
- D. Non-Power-Limited Fire Alarm Circuits (NPLFA):
 - 1. NPLFA circuits installed in conduit: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
 - a. Low-Voltage Circuits: No. 16 AWG, minimum.
 - b. Line-Voltage Circuits: No. 12 AWG, minimum.
 - 2. NPLFA circuit cable installed exposed in ceiling spaces, risers and elsewhere: Multi-conductor cable, U.L Listed type NPLFP.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. Smoke or Heat Detector Spacing:
 - 1. Smooth ceiling spacing shall not exceed 30 feet
 - 2. Spacing of heat detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas, shall be determined according to Appendix A in NFPA 72.
- B. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.
- C. Duct Smoke Detectors: Comply with NFPA 72. Install sampling tubes so they extend the full width of the duct.

3.2 WIRING INSTALLATION

- A. Install wiring according to the following:
 - 1. NECA 1.
 - 2. TIA/EIA 568-A.
- B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceways and Boxes."

1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring Method:

1. Fire alarm circuits shall consist of multi-conductor cables installed in accessible ceiling spaces.
2. Where ceilings consist of exposed construction, fire alarm multi-conductor cable shall be installed on top of joists, beams etc. and shall be concealed from view. Where the structural elements do not allow for the cable to be installed in a concealed fashion, then install the cable in conduit.
3. Install fire alarm cable in conduit in mechanical rooms, loading docks and similar service spaces.
4. Drops to surface mounted devices shall be installed in conduit or surface raceway. No exposed cable shall be visible below the ceiling. Where the ceiling is exposed, route the conduit or raceway up to the structural member that will conceal the cable.
5. Drops to devices recessed in partition walls shall be installed in conduit.
6. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
7. Signaling Line Circuits: Power-limited fire alarm cables may be installed in the same cable or raceway as signaling line circuits, if the system manufacturer permits it.

- D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

- E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

- F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Electrical Identification."
- B. Install instructions frame in a location visible from the FACP.
- C. Paint power-supply disconnect switch red and label "FIRE ALARM."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
- C. Perform the following field tests and inspections and prepare test reports:
 1. Before requesting final approval of the installation, submit a written statement using the form for Record of Completion shown in NFPA 72.

2. Perform each electrical test and visual and mechanical inspection listed in NFPA 72. Certify compliance with test parameters. All tests shall be conducted under the direct supervision of a NICET technician certified under the Fire Alarm Systems program at Level III.
 - a. Include the existing system in tests and inspections.
3. Visual Inspection: Conduct a visual inspection before any testing. Use as-built drawings and system documentation for the inspection. Identify improperly located, damaged, or nonfunctional equipment, and correct before beginning tests.
4. Testing: Follow procedure and record results complying with requirements in NFPA 72.
 - a. Detectors that are outside their marked sensitivity range shall be replaced.
5. Test and Inspection Records: Prepare according to NFPA 72, including demonstration of sequences of operation by using the matrix-style form in Appendix A in NFPA 70.

3.5 WARRANTY

- A. All newly installed equipment shall be warranted by the contractor for a period of one year following acceptance. The warranty shall include parts, labor, prompt field service, pickup and delivery.

END OF SECTION 28 3100

SECTION 22 11 13 - SITE CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. CAD files will be made available for use in construction staking. Contact the engineer regarding applicable fee and requirements for signing of the CAD File Transfer Agreement.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Protecting existing trees, shrubs and other vegetation to remain.
 - 2. Removing existing trees, shrubs and other vegetation.
 - 3. Clearing and grubbing.
 - 4. Stripping and stockpiling topsoil.
 - 5. Removing above-grade and below-grade site improvements.
 - 6. Disconnecting, capping or sealing, and abandoning site utilities in place or removing site utilities.
 - 7. Temporary erosion and sedimentation control measures.
- B. Related Sections include the following:
 - 1. Division 31 2000 Section "Earth Moving" for soil materials, excavating, backfilling, and site grading.
 - 2. Division 32 9200 Section "Turf and Grasses" for finish grading including preparing and placing planting soil mixes and testing of topsoil material.

1.3 DEFINITIONS

- A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

- B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.4 MATERIAL OWNERSHIP

- A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site unless otherwise noted on the plans.

1.5 SUBMITTALS

- A. Photographs or videotape, sufficiently detailed, of existing conditions of trees and plantings, adjoining construction, and site improvements that might be misconstrued as damage caused by site clearing.
- B. Record drawings, according to Division 01 7700 Section "Closeout Procedures."
 - 1. Identifying and accurately locating capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.6 QUALITY ASSURANCE

- A. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 3100 Section "Project Management and Coordination."

1.7 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by owner or authorities having jurisdiction.
- B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract. Contractor is to confirm that this authority has been obtained before beginning work on adjoining property.
- C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

- D. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- E. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 31 2000 Section "Earth Moving."
 - 1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site. Contractor is responsible for doing an independent earthwork computation and including all necessary import and/or export of materials in their bid.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction. If said points will be disturbed, establish new points prior to removal.
- B. Locate and clearly flag trees and vegetation to remain or to be relocated.
- C. Protect existing site improvements to remain from damage during construction.
 - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to requirements of authorities having jurisdiction and the sediment and erosion control drawings, whichever is more stringent.
- B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.
- C. Remove erosion and sedimentation controls only after all areas are restored and stabilized.

3.3 TREE PROTECTION

- A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.
 - 1. Do not store construction materials, debris, or excavated material within fenced area.
 - 2. Do not permit vehicles, equipment, or foot traffic within fenced area.
 - 3. Maintain fenced area free of weeds and trash.
- B. Do not excavate within tree protection zones, unless otherwise indicated.
- C. Where excavation for new construction is required within tree protection zones, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.
 - 1. Cover exposed roots with burlap and water regularly.
 - 2. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
 - 3. Coat cut faces of roots more than 1-1/2 inches in diameter with emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
 - 4. Backfill with soil as soon as possible.
- D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Architect.

3.4 UTILITIES

- A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.
 - 1. Verify that utilities have been disconnected and capped before proceeding with site clearing.
- B. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.
 - 1. Arrange with utility companies to shut off indicated utilities.
 - 2. Owner will arrange to shut off indicated utilities when requested by Contractor.
- C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's written permission.
- D. Excavate for and remove underground utilities indicated to be removed.

- E. Removal of underground utilities is included in Division 33 Sections "Common Work Results for Utilities." for covering site utilities.

3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.
 - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
 - 2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.
 - 3. Grind stumps and remove roots, obstructions, and debris extending to a depth of 18 inches below exposed subgrade.
 - 4. Use only hand methods for grubbing within tree protection zone.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
 - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.
 - 1. Remove subsoil and nonsoil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 1. Stockpile topsoil material in locations approved by the Owner or Architect.

3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

3.8 DISPOSAL

- A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, other vegetation and waste materials including trash and debris, and legally dispose of them off Owner's property.
 1. Burning of materials on project property is prohibited.

****END OF SECTION****

SECTION 31 10 12 - FINE GRADING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Attention is directed to Bidding and Contract Requirements, and General and Supplemental Requirements which are hereby made a part of this section.
- B. CAD files will be made available for use in construction staking. Contact the engineer regarding applicable fee and requirements for signing of the CAD File Transfer Agreement.

1.2 SUMMARY

- A. Work included: All labor, materials, necessary equipment and services to complete the Fine Grading work, as indicated on the drawings, as specified herein or both, except as for items specifically indicated as not in contract on the plans.
- B. Related work specified elsewhere:
 - 1. Division 31 2000 Section "Earth Moving."
 - 2. Division 32 9200 Section "Turfs and Grasses."

1.3 SITE INSPECTION

- A. The Contractor shall visit the site and acquaint himself with all existing conditions. The Contractor shall be responsible for his own subsurface investigations, as necessary, to satisfy requirements of this Section. All subsurface investigations shall be performed only under time schedules and arrangements approved in advance by the landscape Architect or Owner's Representative.

1.4 UTILITIES

- A. Before starting site operations verify that the earlier Contractors have disconnected all temporary utilities which might interfere with the fine grading work.
- B. Locate all existing, active utility lines traversing the site and determine the requirements for their protection. Preserve in operating condition all active utilities adjacent to or transversing the site that are designated to remain.
- C. Observe rules and regulations governing respective utilities in working under requirements of this section. Adequately protect utilities from damage, remove or relocate as indicated, specified or required. Remove, plug or cap inactive or abandoned utilities encountered in excavation. Record location of active utilities.

- D. Contact "Miss Dig" for existing utilities survey confirmation.

1.5 QUALITY ASSURANCE

- A. Requirements of all applicable building codes and other public agencies having jurisdiction upon the work.
- B. Primary emphasis should be given to the aesthetic appearance and functioning of berming and swales, as directed by the Landscape Architect or Owner's Representative. The Contractor shall employ skilled personnel and any necessary equipment to insure that finish grading is smooth, aesthetically pleasing, drains well and is ideal for receiving sod and plant materials.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Existing Soil:
 - 1. Strip existing topsoil for new construction unless otherwise directed by Owner's Representative, free from debris, sod, biodegradable materials and other deleterious materials. The Contractor shall insure that all existing soil has sufficient percolation and surface drainage to support grasses and plant material and that extreme compaction occurs only in areas to receive paving.
 - 2. In areas to receive seed, verify that soil is scarified to depth of 3 inches and that soil contains enough organic matter to support and encourage rooting of seeded lawn.

PART 3 - EXECUTION

3.1 EXAMINATION

- B. Job Conditions
 - 1. Dust control: Use all means necessary to prevent dust from construction operations from being a nuisance to adjacent property owners and from damaging finish surfaces on adjacent building, paving, etc. Methods used for dust control are subject to approval by the Architect or Owner's Representative.
 - 2. Burning: On-site burning will not be permitted.
 - 3. Protection: Use all means necessary to protect curbs, gutters, sprinklers, utilities and vegetation designated to remain, and, in the event of damage, immediately make all repairs, replacements and dressings to damaged plants necessary to the approval of the Landscape Architect. Contractor shall incur all cost for the replacement of damaged objects and vegetation.

3.2 SCHEDULING

- A. Schedule all work in a careful manner with all necessary consideration for adjoining property owners and the public.
- B. Coordinate schedule with other Contractors to avoid conflicts with their work.

3.3 EXCAVATION

- A. Excavate where necessary to obtain subgrades, percolation and surface drainage as required.
- B. Materials to be excavated are unclassified.
- C. Remove entirely any existing obstructions after approval by the Architect's or Owner's Representative.
- D. Remove from site and dispose of debris and excavated material not required.

3.4 GRADING

- A. The Contractor shall establish finished grades as shown on the construction plans and as directed by the Architect, including areas where the existing grade has been disturbed by other work.
- B. Finished grading shall be smooth, aesthetically pleasing, drain well and ready to receive sod and other plant material to full satisfaction of the Owner's Representative, Architect and Construction Manager.

3.5 COMPACTION

- A. Compact each layer of fill in designated areas with approved equipment to achieve a maximum density at optimum moisture, AASHTO T 180 - latest edition.
 - 1. Under buildings, roadways, curbs, walks and other paved areas: compaction shall be to 95% of maximum density.
 - 2. Under landscaped area, compaction shall not exceed 85% of maximum density.
- B. No backfill shall be placed against any masonry or other exposed building surface until permission has been given by the Owner's Representative, and in no case until the masonry has been in place seven days.
- C. Compaction in limited areas shall be obtained by the use of mechanical tampers or approved hand tampers. When hand tampers are used, the materials shall be deposited in layers not more than four inches thick. The hand tampers used shall be suitable for this purpose and shall have a face area of not more than 100 square inches. Special precautions shall be taken to prevent any wedging action against masonry or other exposed building surfaces.

3.6 CORRECTION OF GRADE

- A. Bring to required grade levels areas where settlement, erosion or other grade changes occur. Adjust grades as required to carry drainage away from buildings and to prevent ponding around the buildings and on pavements.
- B. Remove all rock or objectionable material larger than 1 inch in any direction prior to commencing landscaping.
- C. Contractor shall be responsible for stabilizing grades by approved methods prior to landscaping, and shall be responsible for correction of grades as mentioned above, and clean up of any wash outs or erosion.

****END OF SECTION****

SECTION 31 1018 - SOIL EROSION CONTROL

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. CAD files will be made available for use in construction staking. Contact the engineer regarding applicable fee and requirements for signing of the CAD File Transfer Agreement.

1.2 SUMMARY

- A. The work under this Section includes, but not limited to all work necessary for effective soil erosion control in conformance with Part 91, Act 451, PA 1994, the Soil Erosion and Sedimentation Control Act, Michigan Department of Natural Resources Environmental Protection Act guidelines and all pertinent local enforcing agency rules and regulations, having jurisdiction.

B. Related Sections include the following:

- 1. Division 31 2000 Section "Earth Moving."

1.3 STANDARDS

- A. General: Perform all work under this Section in accordance with all pertinent rules and regulations, including, but not necessarily limited to those mentioned above and these Specifications.
- B. Conflicts: Where provisions of pertinent rules and regulations conflict with these Specifications, the more stringent provisions shall govern.

PART 2 - PRODUCTS

2.1 SEED, FERTILIZER, MULCH

- A. Refer to other Specification Section in Part 3.

PART 3 - EXECUTION

3.1 GENERAL

- A. Standards: Provide all materials and promptly take all actions necessary to achieve effective erosion control in accordance with the Soil Erosion and Sedimentation Control Act, Michigan Department of Natural Resources guidelines, local enforcing agency guidelines and these

Specifications.

- B. Site evaluation: Prior to start of the Work, conduct a field evaluation of the site along with representatives of the Engineer/Architect and the local enforcing agency.
- C. Permits: Contractor is responsible for obtaining all pertinent permits including a Soil Erosion Control Permit if required from the county or local enforcing agency. Submit the NPDES Notice of Coverage when the soil erosion permit is received if not already done.

3.2 SEEDING AND MULCHING

- A. General
 - 1. All bare soil, unless otherwise required by the Contract Documents, shall be seeded, fertilized and mulched to create a protected condition. Use seed mix as indicated on the plans (if different seed mixes are indicated on the civil and landscape plans, the mix indicated on the landscape plans shall override). Critical areas shall be sodded as approved by the Engineer/Architect and as shown on the plans.
 - 2. Seeding and mulching shall be performed immediately upon completion of a phase or section of the Work or as approved by the Engineer/Architect.
 - 3. In all cases, seeding and mulching shall be performed within thirty (30) calendar days from the time the area was first disturbed.
 - 4. During any period of time which the soil is unprotected, provide erosion control structures as necessary to minimize erosion and to keep any eroded soils on the site and out of ditches, rivers, storm sewers and wetlands.
 - 5. Refer to the plans for notes regarding the use of turf reinforcement matting and/or mulch blankets (on all slope exceeding 1 vertical to 10 horizontal).
- B. Seed: Seed shall be applied uniformly at a minimum rate of 48 pounds per acre.
- C. Fertilizer: Fertilizer shall be applied uniformly at a minimum rate of 250 pounds per acre.
- D. Mulch: Mulch shall be uniformly applied at a rate of two (2) tons per acre, or equal, on all seeded areas that have a slope of less than 1 vertical to 10 horizontal. Refer to note A5. above for additional slope stabilization requirements.

3.3 DITCH AND RIVERS

- A. When reasonably possible, banks of ditches and rivers disturbed under this Work shall be protected within 24 hours of disturbance, but in no case shall banks be left unprotected more than 7 calendar days.

3.4 STEEP SLOPES

A. Emulsion

1. On slopes greater than 10%, use erosion control blankets or turf reinforcement matting to hold seed in place. Refer to plan notes.

B. Other methods: Chemical self-adhering mulch and other mulch anchoring methods may be used as approved by the Engineer/ Architect.

3.5 SITE IMPROVEMENTS CONSTRUCTION

A. During construction of the site improvements conform to the following general rules:

1. Minimize the amount of earth disturbed at any one time.
2. Establish a construction sequence which includes adequate erosion control.
3. Provide ground cover, even if only temporary, so as to stabilize an area and minimize erosion.
4. As much as practicable, direct storm water away from the construction area. Direct diverted storm water to any stable area.
5. Collect runoff from the site in sediment basins, traps or through filters.
6. Establish an inspection and maintenance schedule, paying special attention to the beginning of the various stages of construction. Employ a certified storm water operator and keep a log of the soil erosion and sedimentation control measures in accordance with the NPDES requirements.
7. Keep in mind that the primary objective is to keep the soil on the site.
8. Once final stabilization of the site is complete, and the governing agency has granted its approval, remove all temporary erosion control structures.
9. Control site runoff during all periods of site construction to ensure that excess surface runoff does not reach adjacent properties. This is especially critical during stages when the land has been stripped but not yet graded.

3.6 CLEANING

- A. Perform cleaning of all areas affected by work under this section and leave the site in a neat and tidy state. Contractor shall keep Adjacent Roads clean and free of debris.

****END OF SECTION****

SECTION 31 2000 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. All earthwork operations shall confirm to the current Michigan Department of Transportation standards and specifications.
- C. CAD files will be made available for use in construction staking. Contact the engineer regarding applicable fee and requirements for signing of the CAD File Transfer Agreement.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Preparing sub-grades for slabs-on-grade, walks, pavements, lawns and grasses, and exterior plants.
 - 2. Excavating and backfilling for buildings and structures.
 - 3. Sub-Base Course constructed on top of rough grading completed by site work trades.
 - 4. Blotter and/or Capillary Break Courses constructed as leveling course(s) on top of the Sub-Base for building slab-on-grade.
 - 5. Drainage course for slabs-on-grade.
 - 6. Sub-base course for concrete walks and pavements.
 - 7. Sub-base and base course for asphalt paving.
 - 8. Subsurface drainage backfill for walls and trenches.
 - 9. Excavating and backfilling for utility trenches.
 - 10. Excavating and backfilling trenches for buried mechanical and electrical utilities and pits for buried utility structures.
- B. Related Sections include the following:
 - 1. Divisions 21, 22, 23, 26, 27, and 28 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.
 - 2. Division 31 Section "Site Clearing" for temporary erosion and sedimentation control measures, site stripping, grubbing, stripping and stockpiling topsoil, protecting trees to remain, and removal of above- and below-grade improvements and utilities.
 - 3. Division 32 Section "Turf and Grasses" for finished and fine grading, including preparing and placing topsoil for plantings for lawns.
 - 4. Division 33 Section "Storm Sewers, Underdrains, and Drainage Structures" for storm drainage system.

1.3 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
 - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Course placed between the subbase course and hot-mix asphalt paving.
- C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.
- D. Blotter Course: Fine graded granular material placed directly beneath the concrete floor slab.
- E. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- F. Capillary Break Course: Fine graded granular material placed directly beneath the floor slab vapor barrier that minimizes upward capillary flow of pore water.
- G. Drainage Course: Layer supporting slab-on-grade used to minimize capillary flow of pore water.
- H. Engineered Fill: Fill placed and compacted to densities specified herein, in a controlled manner using lift thickness limited herein, monitored and tested by the Testing Agency or independent Geotechnical Inspector.
- I. Excavation: Removal of material encountered above sub-grade elevations and to lines and dimensions indicated.
- J. Fill: Soil materials used to raise existing grades.
- K. Rock: Rock material in beds, ledges, un-stratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. or more in volume.
- L. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- M. Sub-base Course: Coarse graded granular material placed over Sub-Grade.
- N. Sub-grade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below sub-base, drainage fill, or topsoil materials. Grade surface resulting from the building pad construction work.
- O. Undercutting: Necessary excavation of poor quality soils which occur below the existing topsoil and any uncontrolled fill soils as described in the Geotechnical Investigation.

- P. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.4 SUBMITTALS

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.
- B. Product Data: For the following:
 - 1. Each type of plastic warning tape.
 - 2. Drainage fabric.
 - 3. Separation fabric.
- C. Test Reports: Testing Agency shall submit the following reports directly to the architect and shall copy the contractor:
 - 1. Analysis of soil materials, whether procured on or off site, and including fill, backfill, and borrow materials.
 - 2. Verification of each footing subgrade.
 - 3. In-place density test reports.
 - 4. Moisture-density relationship test reports.
 - 5. Compressive strength or bearing test reports.
- D. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
 - 1. Classification according to ASTM D 2487 of each on-site and/or borrow soil material proposed for fill and backfill.

1.5 QUALITY ASSURANCE

- A. Testing Agency Services:
 - 1. The Construction Manager/Owner will secure and pay for the services of a qualified, independent geotechnical engineer to classify existing soil materials, to recommend and to classify proposed borrow materials when necessary, to verify compliance of materials with specified requirements, and to perform required field and laboratory testing. Geotechnical engineer shall be acceptable to the architect and the owner and shall be licensed to practice in the state in which the project is located.
- B. Pre-excavation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.6 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect or Owner and then only after arranging to provide temporary utility services according to requirements indicated.
 - 1. Notify Architect and Owner not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Architect's or Owner's written permission.
 - 3. Contact utility-locator service for area where Project is located before excavating.
- B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials without additional cost to Owner when sufficient satisfactory soil materials are not available from excavations. Contractor is responsible for doing an independent earthwork calculation and including any import of appropriate fill material required to bring the site to the proposed grades.
- B. Satisfactory Soil Material (ASTM D 2487): Free of stones larger than 2 inches in any dimension, trash, debris, organic material and other objectionable material and classified as follows:
 - 1. GW (well-graded gravel).
 - 2. GP (poorly graded gravel).
 - 3. GM (silty gravel).
 - 4. GC (clayey gravel).
 - 5. SW (well-graded sand).
 - 6. SP (poorly graded sand).
 - 7. SM (silty sand).
- C. Unsatisfactory Soil Material (ASTM D 2487):
 - 1. SC (clayey sand).
 - 2. CL (lean clay).
 - 3. ML (silt).
 - 4. OL (organic clay).
 - 5. OL (organic silt).
 - 6. CH (fat clay).
 - 7. MH (elastic silt).

8. OH (organic clay).
 9. OH (organic silt).
 10. PR (peat).
- D. Backfill and Fill: Satisfactory soil materials.
- E. Sub-base Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; generally either an MDOT Class II sand or 21AA gravel will meet this requirement. Refer to the plans for specific requirements.
- F. Blotter Course or Capillary Break Course: Naturally or artificially graded mixture of natural or crushed sand; ASTM D 2940; generally an MDOT Class II sand.
- G. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; generally either an MDOT Class II sand or 21AA gravel will meet this requirement. Refer to the plans for specific requirements.
- H. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; generally either an MDOT Class II or Class III sand or 21AA gravel will meet this requirement.
1. Clean granular fill meeting MDOT Class II or Class III grading requirements.
 2. On-site soils within the excavation that are free from organic matter and debris, such as most of the fill and native soils encountered may be used as engineered fill if approved by the geotechnical engineer and if tight moisture controls can be implemented and placement occurs under favorable weather conditions.
 3. Import fill as required to make-up volumes necessary to raise the building site.
- I. Bedding: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; generally either an MDOT 3G, 5G, 6A, or 34R will meet this requirement. Bedding requirements of the agencies having jurisdiction over the utility installation take precedence over these specifications.
- J. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; generally either an MDOT 6A or 34R will meet this requirement. Refer to the plans for specific requirements.
- K. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.
- L. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.
- M. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 ACCESSORIES

- A. Drainage Fabric: Nonwoven geotextile, specifically manufactured as a drainage geotextile; made from polyolefins, polyesters, or polyamides; with minimum properties determined according to ASTM D 4759 and referenced standard test methods.
- B. Separation Fabric: Woven geotextile, specifically manufactured for use as a separation geotextile; made from polyolefins, polyesters, or polyamides; with minimum properties determined according to ASTM D 4759 and referenced standard test methods.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
- B. Preparation of sub-grade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 31 Section "Site Clearing."
- C. Provide erosion-control measures approved by agency having jurisdiction to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- D. Protect and maintain erosion and sedimentation controls, which are specified in Division 31 Section "Site Clearing," during earthwork operations.
- E. Provide protective insulating materials to protect sub-grades and foundation soils against freezing temperatures or frost.

3.2 DEWATERING

- A. Do not proceed with excavation until dewatering submittals have been made and dewatering systems installed as specified elsewhere in the Project Manual.
- B. Prevent surface water and ground water from entering excavations, from ponding on prepared sub-grades, and from flooding Project site and surrounding area.
- C. Protect sub-grades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXPLOSIVES

- A. Explosives: Do not use explosives.

3.4 EXCAVATION, GENERAL

- A. General: Excavation includes the removal of any materials necessary to achieve the required sub-grade elevations and includes reuse or disposal of such materials.
- B. Unnecessary Excavation: The expense of excavation of materials outside of limits indicated or ordered in writing by the architect and the correction thereof to the satisfaction of the architect shall be borne by the contractor.
 1. Unnecessary excavation under footings: Either deepen footings to bear on actual sub-grade elevation without changing top elevations or place concrete fill up to required elevation, as required by the architect.
 2. Unnecessary excavation other than under footings: Either place compacted fill or otherwise correct conditions, as required by the architect.
- C. Sub-Grade: All site work and building pad construction to elevation at underside of Sub-Base, Blotter and/or Capillary Break Courses and Floor Slab on Grade.
- D. Approval of Sub-grade: Notify the Testing Agency when required elevations have been reached.
 1. When required by the architect due to the unforeseen presence of unsatisfactory materials or other factors, perform additional excavation and replace with approved compacted fill material in accordance with the architect's or geotechnical engineer's instructions.
 2. Payment for unforeseen additional work will be made in accordance with established unit prices or, if none, in accordance with provisions for changes in the work. No payment will be made for correction of sub-grades improperly protected against damage from freeze-thaw or accumulation of water, or for correction of otherwise defective sub-grades.
- E. Excavation Stabilization: Slope faces of excavations to maintain stability in compliance with requirements of governing authorities. Do not use shoring and bracing where faces can be sloped.

3.5 EXCAVATION FOR STRUCTURES

- A. Do not proceed with excavations for building structures until Subgrade Preparation operations are complete and tested.
- B. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
 - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
 - 2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.
- C. Undercut foundation excavations as required to remove uncontrolled fill soils, buried topsoil and poor quality natural soils as described in the Geotechnical Investigation.
 - 1. In the area of Boring Numbers 21 and 23 thru 29 where unacceptable fill soils consisting of fine sands, silty clays and topsoil were encountered at shallower depths ranging from 1 to 4 feet below the existing ground surface, the unacceptable fill soils must be removed a minimum of 5 feet beyond the perimeter of the building.
 - 2. Lay back excavations at the minimum ratio of 1-1/2 Horizontal to 1 Vertical to maintain stable sides and suitable backfill sub-base.
 - 3. Stabilize bottom of excavation with 1 to 3 inch size crushed concrete or stone.
 - 4. Choke off crushed material with a thin layer of dense graded crushed aggregate or crushed concrete such as material meeting MDOT 21AA.
 - 5. Place engineered fill to densities utilizing lift thicknesses each specified herein to the bottom of footing elevation.
 - 6. Extend engineered fill outward from each side of the foundation a minimum of the fill thickness and outward beyond the building perimeter foundations a minimum of 10 feet.
- D. Coordinate excavations with construction of foundations to allow concreting on the same day in order to minimize disturbance of the sub-grade.
 - 1. Protect the sub-grade as necessary with a mud (lean concrete) mat after inspection and bearing capacity verification.
 - 2. Refer to Article 3.12 for Soil Moisture Control.
- E. Coordinate excavations with Dewatering operations as required to allow construction of foundations to dry.

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and sub-grades.

3.7 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate utility trenches to indicated gradients, lines, depths, and elevations.
 - 1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
- B. Excavate utility trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.
 - 1. Clearance: 12 inches each side of pipe or conduit.
- C. Utility Trench Bottoms: Excavate and shape utility trench bottoms in accordance with the plans and standard details.
 - 1. Excavate utility trenches a minimum 6 inches deeper than bottom of pipe elevation to allow for bedding course (excavate deeper as required by the regulating agency). Hand excavate for bell of pipe. Remove projecting stones and sharp objects along trench subgrade. Provide bedding course per the plan notes and/or details.

3.8 SUBGRADE INSPECTION

- A. Perform mass earthwork operations to remove all existing topsoil and other organic materials in their entirety within the footprint of the proposed building and pavement areas.
- B. Buried objects should be removed in their entirety.
- C. Notify Testing Agency when excavations have reached required subgrade elevations.
- D. Proof-roll sub-grade in the presence of the Testing Agency to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 1. Completely proof-roll sub-grade in one direction repeating proof-rolling in direction perpendicular to the first direction. Limit vehicle speed to 3 mph. 5 complete passes shall be made in each of two perpendicular directions.
 - 2. Proof-roll sub-grade with heavy pneumatic-tired equipment or loaded 10-wheel, tandem-axle truck weighing not less than 25 tons.
 - 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by the Testing Agency, and replace with engineered fill as directed.

- E. If Testing Agency determines that unsatisfactory soil is present, continue excavations and replace with compacted backfill or fill materials as directed.
 - 1. Additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
- F. Reconstruct sub-grades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities.

3.9 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill may be used at no additional cost to the Owner.

3.10 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
 - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
 - 1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
 - 2. Surveying locations of underground utilities for Record Documents.
 - 3. Testing and inspecting underground utilities.
 - 4. Removing concrete formwork.
 - 5. Removing trash and debris.
 - 6. Removing temporary shoring and bracing, and sheeting.
 - 7. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- B. Place backfill on subgrades free of mud, frost, snow, or ice.
- C. Backfill with MDOT Class II sand engineered fill.
- D. Cap the upper 18 inches of foundation wall engineered fill with clay fill, compacted to a minimum of 95 percent of the maximum dry density as determined by the Modified Proctor test.

3.12 UTILITY TRENCH BACKFILL

- A. Place and compact bedding course on utility trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- B. Place and compact initial backfill of sub-base material, free of particles larger than 1 inch, to a height of 12 inches over the utility pipe or conduit. All pipe backfill to be done according to the details shown on the plans or the requirements of the regulating agency.
- C. Fill voids with approved backfill materials while shoring and bracing, and as sheeting is removed.
- D. Backfill with MDOT Class II sand engineered fill.
- E. Cap the upper 18 inches of foundation wall engineered fill with clay fill, compacted to a minimum of 95 percent of the maximum dry density as determined by the Modified Proctor test.

3.13 SOIL FILL

- A. Preparation: Remove vegetation, topsoil, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface before placing fills.
- B. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- C. Place and compact fill material in layers to required elevations as follows:
 - 1. Under grass and planted areas, use satisfactory soil material.
 - 2. Under walks and pavements, use satisfactory soil material as long as the geotechnical engineer deems the material to be suitable and the compaction requirements can be met.
 - 3. Under steps and ramps, use engineered fill.
 - 4. Under building slabs, use engineered fill.
 - 5. Behind walls, use engineered drainage fill.
 - 6. Under footings and foundations, use engineered fill.
 - 7. Over excavated areas, use engineered fill or lean concrete.
- D. Place fill soils on sub-grades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate sub-grade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
 - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
 - 2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698 and ASTM D 1557:
 - 1. Under structures, building slabs, steps, and pavements, scarify and re-compact top 12 inches of existing sub-grade and each layer of backfill or fill soil material at 95 percent.
 - 2. Under walkways, scarify and re-compact top 6 inches below sub-grade and compact each layer of backfill or fill soil material at 95 percent.
 - 3. Under lawn or unpaved areas, scarify and re-compact top 6 inches below sub-grade and compact each layer of backfill or fill soil material at 88 percent.
 - 4. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.16 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
 - 1. Provide a smooth transition between adjacent existing grades and new grades.
 - 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish sub-grades to required elevations within the following tolerances:

1. Lawn or Unpaved Areas: Plus or minus 1 inch.
 2. Walks: Plus or minus 1 inch.
 3. Pavements: Plus or minus 1/2 inch.
- C. Grading inside Building Lines: Finish sub-grade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.
- D. Contractor shall confirm that the proposed grades shown on the plans will not create a ponding water condition (i.e. an unintended low spot or pavement grades of less than 1%).

3.17 SUB-SURFACE DRAINAGE

- A. Drainage Piping: Specified in Division 33 Section "Sub-drainage."
- B. Sub-surface Drain: Place sub-surface drainage geotextile around perimeter of sub-drainage trench. Place a 6-inch course of filter material on sub-surface drainage geotextile to support sub-drainage pipe. Encase sub-drainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in sub-surface drainage geotextile, overlapping sides and ends at least 6 inches.
1. Compact each filter material layer to 95 percent of maximum dry unit weight according to ASTM D 698.
- C. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final sub-grade, in compacted layers 6 inches thick. Overlay drainage backfill with 1 layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
1. Compact each filter material layer to 95 percent of maximum dry unit weight according to ASTM D 698.
 2. Place and compact impervious fill over drainage backfill in 6-inch- thick compacted layers to final subgrade.

3.18 SUB-BASE

- A. Install separation fabric on prepared sub-grade according to manufacturer's written instructions, overlapping sides and ends.
- B. Under pavements and walks, place sub-base course on separation fabric according to fabric manufacturer's written instructions if fabric is called for on the plan or deemed necessary by the geotechnical engineer.
- C. Under pavements and walks, place base on prepared sub-base or sub-grade as follows:

1. Place base course material over sub-base.
 2. Compact sub-base and base courses at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.
 3. When thickness of compacted sub-base or base course exceeds 6 inches, place materials in equal layers, with no layer more than 6 inches thick or less than 3 inches thick when compacted.
- D. Pavement Shoulders: Place shoulders along edges of sub-base and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each sub-base and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.19 BASE COURSES

- A. Prior to installing base course, Testing Agency will confirm suitable moisture content of sub-grade surface.
- B. If necessitated by the construction schedule, coordinate installation of vapor barrier specified in Division 3 Cast-In-Place Concrete prior to installing base course.
- C. Compact base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.20 DRAINAGE COURSE

- A. Place drainage course on sub-grades free of mud, frost, snow, or ice.
- B. On prepared sub-grade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
 1. Compact drainage course to required cross sections and thickness to no less than 95 percent of maximum dry unit weight according to ASTM D 698.
 2. When compacted thickness of drainage course exceeds 6 inches, place materials in equal layers, with no more than 6 inches thick or less than 3 inches thick when compacted.
- C. If indicated on the plans, place drainage fabric on prepared sub-grade according to manufacturer's written instructions, overlapping sides and ends.

3.21 BLOTTER COURSE

- A. Prior to installing blotter course, Testing Agency will confirm suitable moisture content of sub-grade surface.
- B. If necessitated by the construction schedule or the specification of moisture sensitive floor coverings, coordinate installation of vapor barrier specified in Division 3 Cast-In-Place Concrete prior to installing blotter course.
- C. Compact base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.22 CAPILLARY BREAK COURSE

- A. Place capillary break course on prepared sub-base free of mud, frost, snow, or ice.
- B. Place and compact capillary break course as follows:
 - 1. Compact capillary break course to required cross sections and thickness to no less than 95 percent of maximum dry unit weight according to ASTM D 698.
 - 2. When compacted thickness of capillary break course exceeds 6 inches, place materials in equal layers, with no more than 6 inches thick or less than 3 inches thick when compacted.

3.23 FIELD QUALITY CONTROL

- A. Construction Manager/Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.
- B. Allow Testing Agency to inspect and test sub-grades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.
- C. Footing Sub-grade: At footing sub-grades, allow testing of each soil stratum to be performed by the Testing Agency to verify design bearing capacities. Subsequent verification and approval of other footing sub-grades will occur at the direction of the Testing Agency.
 - 1. Testing Agency will test soil bearing capacity at building foundations and structures in accordance with the Geotechnical Investigation.
 - 2. Sides of building foundation excavations for earth-formed concrete.
 - a. All sides of earth formed foundations must be within 1/2 inch of vertical from the bottom of footing excavation to the proposed top of footing.

- b. Any foundation excavations which do not meet this tolerance shall be rejected and reconstructed using conventional formwork.
 - c. Testing Agency inspector shall be present for all foundations constructed using the earth-formed method.
 - d. Inspector shall be responsible for confirming the acceptability of the excavation and given the authority to reject non-conforming work.
 - e. Inspection reports shall accurately indicate all locations for which foundations have been constructed utilizing the earth-formed method.
- D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
 - 1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every 1000 sq. ft. or less of paved area or building slab, but in no case fewer than 3 tests.
 - 2. Foundation Wall Backfill: At each compacted backfill layer, at least 1 test for each 50 feet or less of wall length, but no fewer than 2 tests.
 - 3. Trench Backfill: At each compacted initial and final backfill layer, at least 1 test for each 150 feet or less of trench length, but no fewer than 2 tests.
- E. When Testing Agency reports that sub-grades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; re-compact and retest until specified compaction is obtained.

3.24 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Refer to Article 3.15 for Soil Moisture Control.
- C. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
- D. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
 - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.
- E. Protect all existing trees, bushes, plants, etc. indicated to remain during construction activities.

3.25 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.
 - 1. Do not burn materials on the Owner's property.

****END OF SECTION****

SECTION 32 1313 - CEMENT CONCRETE PAVEMENTS, CURBS AND GUTTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. All paving materials and construction methods shall conform to the current standards and specifications of the Michigan Department of Transportation. Where these specifications are less stringent than the requirements of MDOT, the MDOT standards shall govern.

1.2 SUMMARY

- A. This Section includes exterior cement concrete pavement for the following:
 - 1. Sidewalks and platforms.
- B. Related Sections include the following:
 - 1. Division 31 1415 Section "Pavement Markings."
 - 2. Division 31 2000 Section "Earth Moving" for subgrade preparation, grading and subbase course.

1.3 PERFORMANCE REQUIREMENTS

- A. Refer to MDOT's current Standard Specifications for Construction.

1.4 SUBMITTALS

- A. Submit aggregate and concrete mix designs for review. Contractor shall confirm that the materials provided meet the required specifications, and provide material certification to the engineer. Material certification shall state that the products meet or exceed the requirements indicated on the plans and the requirements of the regulating authority.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer with at least three (3) years in business who has completed pavement work similar in material, design, and extent to that indicated for this Project.

- B. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products complying with ASTM C 94 requirements for production facilities and equipment and approved by authorities having jurisdiction or the DOT of the state in which Project is located.
 - 1. Manufacturer must be certified according to the National Ready Mix Concrete Association's Plant Certification Program.
- C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 to conduct the testing indicated, as documented according to ASTM E 548.
- D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant and each aggregate from one source.

1.6 PROJECT CONDITIONS

- A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.
- B. Do not place concrete when base surface temperature is less than 40 degrees F (4 degrees C) or surface is wet or frozen.

PART 2 - PRODUCTS

2.1 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.
 - 1. Use flexible or curved forms for curved conditions.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces.

2.2 STEEL REINFORCEMENT

- A. Plain-Steel Welded Wire Fabric: ASTM A 185, fabricated flat sheets, unfinished.
- B. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed billet steel, unfinished.
- C. Epoxy-Coated Reinforcement Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, deformed bars.
- D. Steel Bar Mats: ASTM A 184/A 184M; with ASTM A 615/A 615M, Grade 60, deformed bars; assembled with clips.

- E. Joint Dowel Bars: Plain steel bars, ASTM A 615/A 615M, Grade 60. Cut bars true to length with ends square and free of burrs.
- F. Epoxy-Coated Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, plain steel bars.
- G. Tie Bars: ASTM A 615/A 615M, Grade 60, deformed.
- H. Hook Bolts: ASTM A 307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against pavement form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.
- I. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement bars, welded wire fabric, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete or fiber-reinforced concrete of greater compressive strength than concrete.
- J. Epoxy Repair Coating: Liquid two-part epoxy repair coating, compatible with epoxy coating on reinforcement.

2.3 CONCRETE MATERIALS

- A. General: Use the same brand and type of cementitious material from the same manufacturer throughout the Project. All material to meet current MDOT specifications.

2.4 CURING MATERIALS

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry where indicated on Contract Documents.
- B. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
- C. Clear Waterborne Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

2.5 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
 - 1. Thickness: ½ inch minimum and thicker where indicated.
- B. Coloring Agent: Where indicated, ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.
 - 1. Color: n/a

- C. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery with emery aggregate containing not less than 50 percent aluminum oxide and not less than 25 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.
- D. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- E. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class and grade to suit requirements.

2.6 CONCRETE MIXES

- A. Prepare design mixes, proportioned according to ACI 211.1 and ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes.
- B. Use a qualified independent testing agency for preparing and reporting proposed mix designs for the trial batch method.
- C. Proportion mixes to provide concrete for driveways, roads, parking lots, curbs and gutters with the following properties:
 - 1. Compressive Strength (28 Days): 3500 psi, unless otherwise indicated.
 - 2. Maximum Water-Cementitious Materials Ratio: 45% by weight.
 - 3. Maximum Aggregate Size: 1.5 inch (38 mm).
- D. Sidewalks and platforms provide 3500 psi.
- E. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement according to ACI 301 requirements for concrete exposed to deicing chemicals.
- F. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content of 5.0 to 8.5 percent.
- G. Use appropriate treatment per MDOT specifications where concrete will be placed under freezing conditions. Obtain approval of architect prior to placing concrete in freezing conditions.
- H. Coloring Agent: Where indicated, add coloring agent to mix according to manufacturer's written instructions.

2.7 CONCRETE MIXING

- A. Ready-Mixed Concrete: Comply with requirements and with ASTM C 94 and ASTM C 1116.

1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
- B. Project-Site Mixing: Comply with requirements and measure, batch, and mix concrete materials and concrete according to ASTM C 94. Mix concrete materials in appropriate drum-type batch machine mixer.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Proof-roll prepared subbase surface to check for unstable areas and verify need for additional compaction and repair as required.
- B. Verify that grades are correct.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations.
- B. Clean forms after each use and coat with form release agent to ensure separation from concrete without damage.

3.3 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating reinforcement and with recommendations in CRSI's "Placing Reinforcing Bars" for placing and supporting reinforcement.
- B. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- C. Install welded wire fabric in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- D. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap to adjacent mats.

3.4 JOINTS

- A. General: Construct construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.
- B. At all locations where new concrete abuts existing concrete, building wall, or supported slabs, place expansion joint and joint sealant.
- C. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour, unless pavement terminates at isolation joints.
 - 1. Provide preformed galvanized steel or plastic keyway-section forms or bulkhead forms with keys, unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
- D. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where required.
 - 1. Terminate joint filler 1 inch below finished surface to allow placement of joint sealant.
 - 2. Joint sealant is required for all projects even if not indicated on the plans.
- E. Expansion Joints: Place 1 inch (25 mm) wide expansion joints at maximum 40 foot intervals, if not indicated on drawings. Joints to be full depth of pavement. Place joint sealant at all expansion joints.
- F. Install dowel bars and support assemblies at joints if indicated on the plans. Lubricate or asphalt-coat one-half of dowel length to prevent concrete bonding to one side of joint.
- G. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas. Construct ¼ inch wide contraction joints for a depth equal to at least one-third of the concrete thickness. Maximum spacing of contractions joints shall be 8'.
 - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 3/8-inch (10-mm) radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.
 - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
 - 3. Doweled Contraction Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.
- H. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to the following radius.
 - 1. Radius: 3/8 inch (10 mm).

3.5 CONCRETE PLACEMENT

- A. Inspection: Before placing concrete, inspect and complete formwork installation, reinforcement steel, and items to be embedded or cast in. Notify other trades to permit installation of their work.
- B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- C. Do not add water to concrete during delivery, at Project site, or during placement.
- D. Consolidate concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures to consolidate concrete according to recommendations in ACI 309R.
- E. Cold-Weather Placement: Comply with ACI 306.1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators, unless otherwise specified and approved in mix designs.
- F. Hot-Weather Placement: Place concrete according to recommendations in ACI 305R when hot-weather conditions exist.

3.6 CONCRETE FINISHING

- A. General: Wetting of concrete surfaces during screeding, initial floating, or finishing operations is prohibited.
- B. Float Finish: Float surface with power-driven floats, or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots, and fill low spots.
 - 1. Area Paving: Light broom, texture perpendicular to pavement direction.
 - 2. Curbs and Gutters: Light broom, texture parallel to pavement direction.
 - 3. Direction of Texturing: Parallel to pavement direction.
 - 4. Inclined Vehicular Ramps: Heavy broomed perpendicular to slope.
 - 5. Place sealer on exposed concrete surfaces immediately after finishing. Apply in accordance with manufacturer's instructions.
- C. Provide detectable warning surface at all handicap ramps to meet ADA requirements in accordance with ANSI sections 406.13 and 705.

3.7 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and follow recommendations in ACI 305R for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions.
- C. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:
 - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
 - 2. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions.

3.8 PAVEMENT TOLERANCES

- A. Comply with tolerances of ACI 117 and as follows:
 - 1. Elevation Variation: 1/4 inch.
 - 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
 - 3. Surface Variation: Gap below 10-foot- long, unlevelled straightedge not to exceed 1/4 inch.
 - 4. Maximum cross slope for walks, ramps, platforms: 2%
 - 5. Maximum longitudinal walk slopes not requiring landings and handrails: 5%
 - 6. Maximum longitudinal ramp slopes: 8.33% (1 on 12 slope)

3.9 PAVEMENT MARKING

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.
- B. Allow concrete pavement to cure for 28 days and be dry before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce pavement markings of dimensions indicated with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

1. If indicated on the plans, spread glass beads uniformly into wet pavement markings at a rate of 6 lb/gal.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspection agency to sample materials, perform tests, and submit test reports during concrete placement according to requirements specified.
- B. Testing Services: Testing shall be performed according to the following requirements:
 1. Compression Test Specimens: ASTM C 31/C 31M; one set of four standard cylinders for each compressive-strength test. Cylinders shall be molded and stored for laboratory-cured test specimens unless field-cured test specimens are required.
 2. Compressive-Strength Tests: ASTM C 39; one set for each day's pour of each concrete class exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. One specimen shall be tested at 7 days and two specimens at 28 days; one specimen shall be retained in reserve for later testing if required.
- C. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 24 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing agency, concrete type and class, location of concrete batch in pavement, design compressive strength at 28 days, concrete mix proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- D. Additional Tests: Testing agency shall make additional tests of the concrete when test results indicate slump, air entrainment, concrete strengths, or other requirements have not been met. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42, or by other methods as directed.

3.11 REPAIRS AND PROTECTION

- A. Remove and replace concrete pavement that is broken, damaged, or defective, or does not meet requirements as directed by the Architect.
- B. Remove and replace concrete sidewalks and/or ramps that do not comply with maximum slopes indicated in Section 3.8A above.
- C. Protect concrete from damage. Exclude traffic from pavement for at least fourteen (14) calendar days after placement.

****END OF SECTION****

SECTION 32 1373 - CONCRETE PAVING JOINT SEALANTS

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. All paving materials and construction methods shall conform to the current standards and specifications of the Michigan Department of Transportation. Where these specifications are less stringent than the requirements of MDOT, the MDOT standards shall govern

1.2 SUMMARY

- A. General – all expansion joints are to receive joint sealant. Contraction and other joints receive sealant only if indicated on the plan.
- B. This Section includes the following:
 - 1. Expansion and contraction joints within cement concrete pavement.
 - 2. Joints between cement concrete and asphalt pavement.
- C. Related Sections include the following:
 - 1. Division 32 Section "Asphalt Paving" for constructing joints between concrete and asphalt pavement.
 - 2. Division 32 Section "Cement Concrete Pavements" for constructing joints in concrete pavement.

1.3 SUBMITTALS

- A. Product Data, shop drawing submittals are not required. Contractor shall confirm that the materials provided meet the required specifications, and provide material certification to the engineer. Material certification shall state that the products meet or exceed the requirements indicated on the plans and the requirements of the regulating authority.

1.4 QUALITY ASSURANCE

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

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.
- B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.6 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer.
 - 2. When joint substrates are wet or covered with frost.
 - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 - 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Products: Use products meeting MDOT's current specifications.

2.2 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.
- B. Colors of Exposed Joint Sealants: Gray.

2.3 COLD-APPLIED JOINT SEALANTS

- A. Type NS Silicone Sealant for Concrete: Single-component, low-modulus, neutral-curing, nonsag silicone sealant complying with ASTM D 5893 for Type NS.
 - 1. Products:

- a. Crafc0 Inc.; RoadSaver Silicone.
 - b. Dow Corning Corporation; 888.
 - c. Approved equal.
- B. Type SL Silicone Sealant for Concrete and Asphalt: Single-component, low-modulus, neutral-curing, self-leveling silicone sealant complying with ASTM D 5893 for Type SL.
 - 1. Products:
 - a. Crafc0 Inc.; RoadSaver Silicone SL.
 - b. Dow Corning Corporation; 890-SL.
 - c. Approved equal.

2.4 HOT-APPLIED JOINT SEALANTS

- A. Elastomeric Sealant for Concrete: Single-component formulation complying with ASTM D 3406.
 - 1. Products:
 - a. Crafc0 Inc.; Superseal 444/777.
 - b. Meadows, W. R., Inc.; Poly-Jet 3406.
 - c. Approved equal.
- B. Sealant for Concrete and Asphalt: Single-component formulation complying with ASTM D 3405.
 - 1. Products:
 - a. Koch Materials Company; Product No. 9005.
 - b. Koch Materials Company; Product No. 9030.
 - c. Meadows, W. R., Inc.; Sealtight Hi-Spec.
 - d. Approved equal.

2.5 JOINT-SEALANT BACKER MATERIALS

- A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.
- B. Round Backer Rods for Cold- and Hot-Applied Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
- C. Backer Strips for Cold- and Hot-Applied Sealants: ASTM D 5249; Type 2; of thickness and width required to control sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

- D. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

2.6 PRIMERS

- A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install backer materials of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of backer materials.
 - 2. Do not stretch, twist, puncture, or tear backer materials.

3. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.
 - D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 1. Place sealants so they directly contact and fully wet joint substrates.
 2. Completely fill recesses provided for each joint configuration.
 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
 - E. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 1. Remove excess sealants from surfaces adjacent to joint.
 2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions, unless otherwise indicated.
 - G. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.
- 3.4 CLEANING
- A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.
- 3.5 PROTECTION
- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations with repaired areas are indistinguishable from the original work.

****END OF SECTION****

SECTION 32 9200 - TURFS AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Seeding.
 - 2. Turf Renovation.
 - 3. Sodding.

- B. Related Sections:

- 1. Division 31 Section "Site Clearing" for topsoil stripping and stockpiling.
 - 2. Division 31 Section "Earth Moving" for excavation, filling and backfilling, and rough grading.
 - 3. Division 32 Section "Fine Grading" for final grades for planting.

1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Manufactured Soil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- C. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.
- D. Subgrade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill immediately beneath planting soil.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture stating the botanical and common name and percentage by weight of each species and

variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.

- C. Certification of Bio-Retention Area Seed: From seed vendor for each bio-retention-seed monostand or mixture stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
- D. Product Certificates: For fertilizers, signed by product manufacturer.
- E. Qualification Data: For landscape Installer.
- F. Material Test Reports: For imported topsoil.
- G. Planting Schedule: Indicating anticipated planting dates for each type of planting.
- H. Maintenance Instructions: Recommended procedures to be established by Contractor for the Owner for maintenance of lawns during a calendar year. Submit before expiration of required maintenance periods.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful lawn establishment.
 - 1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when planting is in progress.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- C. Topsoil Analysis: Furnish soil analysis by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; location exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of topsoil.
 - 1. Report suitability of topsoil for lawn growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce a satisfactory topsoil.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.

- B. Sod: Harvest, deliver, store, and handle sod according to requirements in TPI's "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in its "Guideline Specifications to Turfgrass Sodding."

1.7 SCHEDULING

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
 - 1. Spring Planting: April 1st and June 1st.
 - 2. Fall Planting: September 15th and October 15th.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

1.8 LAWN MAINTENANCE

- A. Begin maintenance immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:
 - 1. Seeded Lawns: 60 days from date of Substantial Completion.
 - a. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established, continue maintenance during next planting season.
 - b. A minimum of two (2) lawn cuttings (MANICURED LAWN ZONES ONLY) will be completed before the owner takes over maintenance.
- B. Maintain and establish lawn by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.
 - 1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch. Anchor as required to prevent displacement.
- C. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawn uniformly moist to a depth of 4 inches.
 - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
 - 2. Water lawn at a minimum rate of 1 inch per week.

- D. Mow lawn as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 40 percent of grass height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
 - 1. Mow grass to 2 inches height.
- E. Lawn Postfertilization: Apply fertilizer after initial mowing and when grass is dry.
 - 1. Apply Type B fertilizer to lawns approximately 30 days after seeding at a rate equal to 1.0 lb. of actual nitrogen per 1,000 sq. ft. (140 lbs./acre). Apply with a mechanical rotary or drop type distributor. Thoroughly water into soil. (Provide 3 applications)
- F. Weed Control: If an infestation of weeds or crab grass develops prior to acceptance of the lawn, the Contractor shall treat the infestation by hand weeding or chemical control. The chemical control shall be furnished and installed by the contractor as recommended by the manufacturer and approved by the Landscape Architect. At least two weeks shall elapse after chemical control is applied before a request or inspection for acceptance is made to the Landscape Architect.
- G. Apply fungicides and insecticides as required to control diseases and insects.
- H. Coordinate with Section 02940 Landscape Maintenance and Warranty Standards.

PART 2 - PRODUCTS

2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed shall be provided from one of the following suppliers
 - 1. Lesco (248) 689-5005
 - 2. Rhino Seed & Supply (800) 482-3130
 - 3. Michigan State Seed Solutions (800) 647-8873
- C. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
 - 1. General Seeded Lawn Areas (for lawn restoration areas only):
 - a. 50 percent Kentucky Bluegrass, a minimum of (3) three cultivars
 - b. 50 percent Perennial Ryegrass, a minimum of (2 or 3) two or three cultivars.

2.2 TURFGRASS SOD

- A. Turfgrass Sod: Certified Number 1 Quality/Premium, including limitations on thatch, weeds, diseases, nematodes, and insects, complying with TPI's "Specifications for Turfgrass Sod Materials" in its "Guideline Specifications to Turfgrass Sodding." Furnish viable sod of uniform density, color, and texture, strongly rooted, and capable of vigorous growth and development when planted.
- B. Turfgrass Species: Sod of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:
 - 1. Full Sun: Kentucky bluegrass (*Poa pratensis*), a minimum of three cultivars

2.3 TOPSOIL

- A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.
 - 1. Topsoil Source: Import topsoil or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from agricultural land, bogs or marshes.

2.4 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:
 - 1. Class: Class T, with a minimum 99 percent passing through No. 8 sieve and a minimum 75 percent passing through No. 60 sieve.
- B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, with a minimum 99 percent passing through No. 6 sieve and a maximum 10 percent passing through No. 40 sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. Aluminum Sulfate: Commercial grade, unadulterated.
- E. Perlite: Horticultural perlite, soil amendment grade.
- F. Agricultural Gypsum: Finely ground, containing a minimum of 90 percent calcium sulfate.
- G. Sand: Clean, washed, natural or manufactured, free of toxic materials.

2.5 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1/2-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
 - 1. Organic Matter Content: 60 percent of dry weight.
 - 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
- B. Peat: Finely divided or granular texture, with a pH range of 6 to 7.5, containing partially decomposed moss peat, native peat, or reed-sedge peat and having a water-absorbing capacity of 1100 to 2000 percent.
- C. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.6 PLANTING ACCESSORIES

- A. Selective Herbicides: EPA registered and approved, of type recommended by manufacturer for application.

2.7 FERTILIZER

- A. Granular, non-burning product composed of not less than 50% organic slow acting, guaranteed analysis professional fertilizer.
 - 1. Type A: Starter fertilizer containing 11% nitrogen, 23% phosphoric acid, and 10% potash by weight or similar approved composition.
 - 2. Type B: Top dressing fertilizer containing 31% nitrogen, 3% phosphoric acid, and 10% potash by weight or similar approved composition.
 - a. Apply Type A fertilizer at initial sowing of seed and a Type B fertilizer application 4 weeks after initial germination.
 - b. (Provide a min. one (1) Type A fertilizer application and three (3) Type B fertilizer applications)

2.8 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic; free of plant-growth or germination inhibitors; with maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.
- D. Asphalt Emulsion: ASTM D 977, Grade SS-1; nontoxic and free of plant-growth or germination inhibitors.

2.9 EROSION-CONTROL MATERIALS

- A. Erosion-Control Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.
- B. Erosion-Control Fiber Mesh: Biodegradable twisted jute or spun-coir mesh, a minimum of 0.92 lb/sq. yd., with 50 to 65 percent open area. Include manufacturer's recommended steel wire staples, 6 inches long.

2.10 PLANTING SOIL MIX

- A. Planting Soil Mix: Mix topsoil with the following soil amendments in the following quantities:

PLANTING BEDS:

- 1. Three parts well-drained screened organic imported topsoil to one part clean imported sand to one part Canadian sphagnum peat moss, to one part natural compost (weed-free).

LAWNS:

- 2. Manicured Lawns shall use screened stock-piled topsoil from specified on-site location.

2.11 SEEDING

- A. General: Provide grasses for seeding.

2.12 MATERIALS

- A. Topsoil for Seeding Lawn Areas.
- B. Seed: Fresh, clean and new crop seed mixture. Mixed by approved methods.

- C. Composed of the following varieties, mixed to the specified proportions by weight and tested to minimum percentages of purity and germination.

- D. Seed Mixture: Proportioned by weight as indicated below:

1. Type 1: Lawns

- a. Seed Mixture: Proportioned by weight as indicated below:

<u>All Sports Mix</u>	<u>Proportion</u>	<u>Minimum Purity</u>	<u>Minimum Germination</u>
Kentucky Bluegrass	10%	95%	80%
Turf Type Tall Fescue	75%	95%	80%
Perennial Ryegrass	15%	95%	80%

- a. Spread at a rate of 4-5 lbs./1000 sf.
b. No noxious weed seeds permitted.

- E. Fertilizer: 13-25-12. Granular, non-burning product composed of not less than 50% organic slow acting, guaranteed analysis, professional fertilizer.
- F. Ground Limestone: Used if required by soil test report. Containing not less than 85% of total carbonates and ground to such fineness that 50% will pass through a 100 mesh sieve and 90% will pass through a 20% mesh sieve.
- G. Granulated sulfur 0-0-0-90 to lower pH. Use if determined by soil tests to be necessary. Apply per soil test recommendations at specified rate.
- H. Straw Mulch: Used in crimping process only. Clean oat or wheat straw well seasoned before bailing, free from mature seed-bearing stalks or roots of prohibited or noxious weeds.
- I. Water: Free of substance harmful to seed growth. Hoses or other methods of transportation furnished by Contractor. Test for excess Alkalinity, if necessary.
- J. Wood Cellulose Fiber Mulch: Degradable green dyed wood cellulose fiber or 100% recycled long fiber pulp, free from weeds or other foreign matter toxic to seed germination and suitable to hydra-mulching.
1. AVAILABLE MANUFACTURER AND TYPE:
2. CONWED HYDROMULCH: CONWED CORP., ST. PAUL, MN
3. CELLIN HYDROMULCH: CELLIN MFG. INC., LORTON, VA
- K. Paper Mulch: Degradable paper mulch, free of foreign debris. Do not use on slopes over 30%. Available manufacturer and type NU Wool Hydro Mulch, Jennison, MI.

- L. Tackifier: Liquid concentrate diluted with water forming a transparent 3-dimensional film like crust permeable to water and air and containing no agents toxic to seed germination.
 - 1. AVAILABLE MANUFACTURER AND TYPE:
 - 2. FINN HYDROSTIK, FAIRFIELD, OH
 - 3. POLYING DLR: CELITE INC., CLEVELAND, OH

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive lawns and grass for compliance with requirements and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
 - 1. Protect adjacent and adjoining areas from hydro-seeding overspray.
- B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 LAWN PREPARATION

- A. Limit lawn subgrade preparation to areas to be planted.
- B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 4 inches Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
 - 1. Thoroughly blend planting soil mix off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil mix.
 - a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
 - b. Mix lime with dry soil before mixing fertilizer.
 - 2. Spread lawn planting soil mix to a depth of 3 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

- C. Unchanged Subgrades: If lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations, prepare surface soil as follows:
 - 1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
 - 2. Loosen surface soil to a depth of at least 6 inches.
 - 3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
 - 4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.
- D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/4 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future.
- E. Moisten prepared lawn areas before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- F. Restore areas if eroded or otherwise disturbed after finish grading and before planting.

3.4 SODDING

- A. Lay sod within 24 hours of harvesting. Do not lay sod if dormant or if ground is frozen or muddy.
- B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
 - 1. Lay sod across angle of slopes exceeding 1:3.
 - 2. Anchor sod on slopes exceeding 1:6 with wood pegs or steel staples spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.
- C. Saturate sod with fine water spray within two hours of planting. During first week, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below sod.

3.5 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.

1. Do not use wet seed or seed that is moldy or otherwise damaged.
- B. Sow seed at the rate of 4-5 lb/1000 sq. ft. as indicated per specified seed mix.
- C. Rake seed lightly into top 1/8 inch of topsoil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes exceeding 1:6 with erosion-control fiber mesh and 1:4 with erosion-control blankets installed and stapled according to manufacturer's written instructions.
- E. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose depth over seeded areas. Spread by hand, blower, or other suitable equipment.
1. Anchor straw mulch by crimping into topsoil with suitable mechanical equipment.

3.6 TURF RENOVATION

- A. Renovate existing lawn.
- B. Renovate existing lawn damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
 1. Reestablish lawn where settlement or washouts occur or where minor regrading is required.
- C. Remove sod and vegetation from diseased or unsatisfactory lawn areas; do not bury in soil.
- D. Remove topsoil containing foreign materials resulting from Contractor's operations, including oil drippings, fuel spills, stone, gravel, and other construction materials, and replace with new topsoil.
- E. Mow, dethatch, core aerate, and rake existing lawn.
- F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
- G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.
- H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.
- I. Apply soil amendments and initial fertilizers required for establishing new lawns and mix thoroughly into top 4 inches of existing soil. Provide new planting soil to fill low spots and meet finish grades.
- J. Apply seed and protect with straw mulch as required for new lawns.

- K. Water newly planted areas and keep moist until new lawn is established.

3.7 MULCHING

- A. Place straw mulch on seeded areas within twenty-four (24) hours after seeding.
- B. Place straw mulch uniformly in a continuous blanket at a rate of 2-1/2 tons per acre or two (2) 50 lb. bales per 1,000 sq. ft. of area. A mechanical blower may be used for straw mulch application when acceptable to the Architect.
- C. Crimp straw into soil by use of a "crimper." Two (2) passes in opposite direction required.

3.8 SLIT SEEDING (OPTIONAL METHOD)

- A. Lawn to be professionally slit seeded by using equipment designed for this purpose. Recommended brands: Brilliant, Jacobsen or Olathe.

3.9 HYDROSEEDING (OPTIONAL METHOD)

- A. Use a hydromulcher (sprayer) and apply mixture(s) at the following rate. Mix in accordance with manufacturer's recommendations.
- B. Apply hydroseed slurry to indicated areas. Use tackifier only on erosion prone areas. Apply fertilizer with hydro mix.

Seed:	At specified seeding rates (300 pounds per acre)
Fertilizer:	400 pounds per acre
Tackifier:	60 gallons per acre
Wood Cellulose Fiber Mulch:	2000 pounds per acre

- C. Care must be taken not to get hydroseed materials on buildings, walks, roadways, plant beds, etc.

3.9 SATISFACTORY LAWNS

- A. Satisfactory Seeded Lawn: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. (0.92 sq. m) and bare spots not exceeding 4 by 4 inches.

3.10 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

- B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period and remove after lawn is established.
- C. Remove erosion-control measures after grass establishment period.

****END OF SECTION****

SECTION 32 9220 – TOPSOIL (LANDSCAPING)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Extent of Topsoil Work is shown on drawings and by provisions of this section.
- B. Topsoil for lawn work shall be as stripped from site or provided by contractor from off-site sources free of herbicides.
- C. Related work specified elsewhere:
 - 1. Division 32 9210 Section "Lawns and Grasses."

1.3 QUALITY ASSURANCE

- A. Testing and Inspection: For supplied or stockpiled topsoil. Performed by a qualified independent testing laboratory, under the supervision of a registered professional engineer, specializing in soils engineering. Obtain samples from interior of stockpiled topsoil.
- B. Soil originating from corn fields shall not be used unless the fields have not grown corn for a minimum of two (2) years. Soil testing must verify the levels of dangerous elements in the soil. Soil testing results shall be reviewed by the Landscape Architect prior to topsoil being delivered to the site.
- C. Provide and pay for testing and inspection during topsoil operations. Laboratory, inspection services and Soils Engineer shall be acceptable to the Landscape Architect.
 - 1. Recommended testing laboratory:
A & L Agricultural Laboratories, Inc.
3505 Conestoga Drive
Fort Wayne, IN 46808
(219) 483-4759
- D. Test representative material samples for proposed use.
- E. Topsoil: (Supplied and Stockpiled – See Materials 2.1)

1. pH factor
 2. Lime requirement
 3. Mechanical analysis (P.K. Ca. mg) and cation ratios
 4. Percentage of organic content and loss of ignition
 5. Soil series classification
 6. Clay content
 7. Herbicide residue
- F. Recommendations on type and quantity of additives required to establish satisfactory pH factor and supply of nutrients to bring nutrients to satisfactory level for planting.
- G. Submit test reports.

1.4 PROJECT CONDITIONS

- A. Known underground and surface utility lines are indicated on the drawings.
- B. Protect existing trees, plants, lawns and other features designated to remain as part of the landscaping work.
- C. Promptly repair damage to adjacent facilities caused by topsoil operations.
- D. Promptly notify the Landscape Architect of unexpected sub-surface conditions.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Topsoil: Supplied or stockpiled topsoil proposed for use must meet testing criteria results specified and conform to adjustments as recommended by soil test and Landscape Architect.
- B. Existing Topsoil: Existing topsoil from on-site stockpile shall be utilized. All processing, screening, cleaning and preparation of this stored topsoil to render it acceptable for use is the responsibility of the Contractor.
- C. Provide additional topsoil as required to complete job. Topsoil must meet testing criteria results specified. All processing, cleaning and preparation of this stored topsoil to render it acceptable for use is the responsibility of this Contractor.
- D. Supplied or stockpiled topsoil shall be fertile, friable and representative of local productive soil, capable of sustaining vigorous plant growth and screened free of clay lumps, subsoil, noxious weeds or other foreign matter such as stones greater than 1" in diameter in any dimension, roots, sticks and other extraneous materials not frozen or muddy. pH of existing or supplied soil to

range between 5.0 and 7.5. Adjusted to not more than 7.0 by additives as required by soil test. Topsoil shall contain not less than 3% and not greater than 10% organic matter. Clay content as determined by Bouyoucous Hydrometer Test shall range between 5 and 15 percent. Mechanical analysis as follows:

PASSING	RETAINED ON	PERCENTAGE
1" Screen	100%	
1" Screen	¼" screen (gravel)	Not more than 3%
¼" Screen	No. 140 USS Mesh Sieve	40-60%
No. 140 USS	Percentage based on dry weight of the samples	30-35% (Very fine sand, silt and clay)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine rough grades and installation conditions. Do not start topsoil work until unsatisfactory conditions are corrected.

3.2 FINISH GRADING

- A. Perform topsoiling within contract limits, including adjacent transition areas, to new elevations, levels, profiles, and contours indicated. Provide uniform levels and slopes between new elevations and existing grades.
- B. Grade surfaces to assure areas drain away from building structures and to prevent ponding and pockets of surface drainage.
- C. Lawn Areas: Supply and spread topsoil to a minimum uniform depth of 4" or as noted. Incorporate into existing subsoil by disc, rototill or other approved method to a minimum 6" depth. No layering of soils is to exist after tilling. Remove clumps larger than 1" in diameter.
- D. Grade lawn areas to a smooth, free draining even surface with a loose, moderately coarse texture ready to accept seed or sod.
- E. For trees, shrubs, ground cover beds and backfill for beds see Trees, Plants and Ground Cover Section.
- F. Provide earth crowning where indicated on drawings.

- G. Crowning/mounding to be free flowing in shape and design, as indicated, and to blend into existing grades gradually so that toe of slope is not readily visible. Landscape Architect to verify final contouring before planting.
- H. Regardless of finish grading elevations indicated, it is intended that grading be such that proper drainage of surface water will occur and that no low areas are created to allow ponding. Contractor to consult with Owner or Landscape Architect regarding minor variations in grade elevations before rough grading is completed.

3.3 LAWN ESTABLISHMENT

- A. Establish dense lawn of permanent grasses, free from lumps and depressions. Any area failing to show uniform germination to be reseeded; continue until dense lawn established. Damage to seeded area resulting from erosion to be repaired by Contractor. Scattered bare spots over 5 percent now allowed.
- B. In event contractor does not establish dense lawn during germination period, return to project to refertilize and reseed to establish dense lawn.
- C. Should the seeded lawn become largely weeds after germination, Contractor is responsible to kill the weeds and reseed the proposed lawn areas to produce a dense turf, as specified.

3.4 CLEANING

- A. Upon completion of topsoiling operations, clean areas within contract limits, remove tools and equipment. Site shall be clear, clean, free of debris and suitable for site work operations.

END OF SECTION 32 9220

SECTION 32 9400 – LANDSCAPE MAINTENANCE AND WARRANTY STANDARDS

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. The requirements of this section include a one (1) year warranty period from date of acceptance of installation.
- B. Related work specified elsewhere:
 - 1. Division 32 9210 Section "Lawns and Grasses."
 - 2. Division 32 9215 Section "Trees, Shrubs, Plants and Ground Covers."

1.3 ACCEPTANCE OF INSTALLATION

- A. At the completion of all landscape installation, or pre-approved portions thereof, the Landscape Contractor shall request in writing an inspection for acceptance of installation in which the Landscape Contractor, Landscape Architect and Owner's Representative shall be present. After this inspection a "Punch List" will be issued by the Landscape Architect and/or Owner's Representative. The Landscape Architect and/or Owner's Representative shall re-inspect the project and issue a written statement of acceptance of installation and establish the beginning of the project warranty period.
- B. It is the responsibility of the Landscape Contractor to make the above written request for inspection of installation in a timely fashion. If there is plant material loss prior to the Landscape Contractor's written request for inspection of installation, the Landscape Contractor shall make all replacements of this dead material at no additional cost. These replacements are not considered to be the required one (1) replacement of dead plant material by the Landscape Contractor during the one (1) year project warranty period, as outlined below.
- C. Landscape work may be inspected for acceptance in parts agreeable to Owner's Representative and Landscape Architect provided work offered for inspection is complete, including maintenance as required.
- D. For work to be inspected for partial acceptance, Contractor shall provide a drawing outlining work completed, and supply a written statement requesting acceptance of this work completed to date.

1.4 PROJECT WARRANTY

- A. The project warranty period begins upon written acceptance of the project installation by Landscape Architect and Owner's Representative.
- B. The Landscape Contractor shall guarantee trees, shrubs, ground cover bed, and seeded or sodded areas through construction and for a period of one (1) year after date of acceptance of installation against defects including death and unsatisfactory growth, except for defects resulting from neglect by Owner, abuse or damage by others, or unusual phenomena or incidents which are beyond Landscape Contractor's control.
- C. The cost of replacements is at the Contractor's expense. Warranty all replacement plants for one (1) year after installation acceptance. Every plant that is replaced under warranty shall again be guaranteed for one (1) full year from date of Owner's acceptance.
- D. Warranty: One (1) year from date of Owner's acceptance.

1.5 MAINTENANCE

- A. Arrange with the Owner's Representative to walk the site monthly during the warranty period to review the maintenance standards. Written minutes of this meeting shall be furnished to the Owner and the Landscape Architect.
- B. To insure guarantee standards, the following maintenance procedures shall be executed during construction and for the full project warranty period.
- C. Maintenance of Trees, Shrubs, and Ground Covers:
 - 1. Landscape Contractor shall be responsible for replacement of any plant materials that are dead or in the opinion of the Landscape Architect are in an unhealthy or unsightly condition, or having lost natural shape, resulting from dieback, excessive pruning or inadequate or improper maintenance as part of the guarantee. Prior to any replacements Landscape Contractor shall review individual plants in question with Landscape Architect and determine the reason for plant demise. The replacement shall be guaranteed for 1 year (same as initial plantings). A plant shall be replaced as many times as necessary until it lives for a minimum of one (1) year.
 - 2. Replacements must meet specifications i.e. quality, species of plant material and planting procedures to receive approval of replacement materials by Landscape Architect.
 - 3. Costs for replacements are assumed part of bid quotations and therefore will not result in an additional cost to Owner or Landscape Architect.
 - 4. Areas damaged as result of replacement operations are to be restored by Contractor at no cost to the Owner or Landscape Architect.
 - 5. The contractor shall be responsible for watering all plantings through the warranty period and shall keep guy wires taut, raise tree balls which settle, furnish and apply sprays as necessary to keep the plantings free of disease and insects until the end of the warranty

period. All evergreens shall be watered thoroughly in the fall to insure they do not go into the winter dry. Arrange with Owner's Representative to walk the site monthly during warranty period to review maintenance standards. Remove and replace trees, shrubs, or other plants and materials promptly. Make replacements during following normal planting schedule. Replace trees and shrubs which are in doubt, unless, in opinion of Owner's Representative and Landscape Architect it is advisable to extend warranty period for a full-growing season. Remove all stakes, guy wires, tree wrap paper, dead twigs and branches from tree and plant materials at the end of this warranty period. Keep planting beds free of weeds during guarantee period.

D. Maintenance of Sodded Lawn Areas:

1. Water sod thoroughly as required to establish proper rooting.
2. The Contractor shall establish a dense lawn of permanent grasses free from lumps and depressions. Repair, rework and resod all areas that have washed out or are eroded. Replace undesirable or dead areas with new sod.
3. Mow lawn areas as soon as lawn top growth reaches a 3" height. Cut back to 2" height. Repeat mowing as required to maintain specified height. Not more than 40% of grass leaf shall be removed at any single mowing.
4. The Contractor shall provide a minimum of two cuttings of the lawn or more as necessary until the inspection and acceptance of installation by the Owner's Representative and Landscape Architect. When the lawn reaches 3 inches in height it shall be cut to 2 inches in height. Contractor shall notify the Owner's Representative and Landscape Architect in writing one (1) week in advance of the final lawn cutting to allow the Owner and the Landscape Architect to inspect the lawns and schedule Owner's maintenance work.
5. The Owner assumes cutting responsibility following the acceptance of installation by the Owner's Representative and the Landscape Architect.
6. After acceptance of installation, and for the duration of the project warranty period, the Landscape Contractor shall continue all other maintenance procedures including fertilizing and weeding, and other operations such as rolling, regrading, replanting, and applying herbicides, fungicides, insecticides as required to establish a smooth, acceptable lawn free of eroded or bare areas.
7. Apply three (3) applications of Type "B" fertilizer once in every seven to eight (7-8) week intervals. These applications shall be in addition to fertilizer applied for the soil preparation. The first application shall be applied on or about thirty (30) days after seeding. Contractor to time the applications in conjunction with anticipated rain. If initial seeding takes place in late fall, begin fertilizing applications very early at onset of the following spring season.
8. At conclusion of project warranty period and after reviewing written final acceptance by Owner's Representative and Landscape Architect, the Owner shall assume all lawn maintenance responsibilities.

E. Maintenance of Seeded Lawn Areas:

1. The Contractor shall establish a dense lawn of permanent grasses, free from lumps and depressions or any bare spots, none of which is larger than one foot of area up to a

maximum of 3% of the total seeded lawn area. Any part of the seeded lawn that fails to show a uniform growth and/or germination shall be reseeded until a dense cover is established.

2. If seeded in fall or if not considered acceptable at that time, continue maintenance the following spring until acceptable lawn is established.
3. The Contractor shall provide a minimum of two (2) cuttings of the lawn or more as necessary until the inspection and acceptance of installation by the Owner's Representative and Landscape Architect. When the lawn reaches 3 inches in height, it shall be cut to 2 inches in height.
4. The Owner assumes cutting responsibilities following the acceptance of installation by the Owner's Representative and the Landscape Architect.
5. After acceptance of installation, and for the duration of the project warranty period the Landscape Contractor shall continue all other maintenance procedures including fertilizing and weeding, and other operations such as rolling, regarding, replanting, and applying herbicides, fungicides, insecticides as required to establish a smooth, acceptable lawn free of eroded or bare areas.
6. Repair, rework, and re-seed all areas that have washed out, and eroded, or do not substantially germinate.
7. At conclusion of project warranty period and after receiving written final acceptance by Owner's Representative and Landscape Architect, the Owner shall assume all seeded lawn maintenance responsibilities.

1.6 FINAL ACCEPTANCE

- A. At the conclusion of the project warranty period, the Landscape Contractor shall request a project inspection for final acceptance in which the Landscape Contractor, Landscape Architect and Owner's Representative shall be present. After this inspection a "Punch List" will be issued by the Landscape Architect. Upon completion of all punch list items, the Landscape Architect and Owner's Representative shall reinspect the project and issue a written statement of final acceptance. Upon final acceptance the Owner assumes all maintenance responsibilities for the landscape of the project.

END OF SECTION 32 9400

SECTION 33 4100 STORM SEWERS, UNDERDRAINS AND DRAINAGE STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification sections, apply to work of this section. Where these specifications differ from the local or City's standard detail sheets, the detail sheets shall govern.

1.2 SUMMARY

- A. The work under this Section includes, but is not necessarily limited to, the furnishing and installation of all storm sewers, underdrains and drainage structures and leads and connections as indicated on the Drawings, herein specified and as necessary for the proper and complete performance of this Work for foundations and underslab areas.
 - 1. Storm Sewer Pipe
 - 2. Perforated Underdrain Pipe
 - 3. Castings
 - 4. Manhole Sections and Steps
 - 5. Catch Basin
 - 6. Brick and Concrete Block Masonry
- B. Related Sections may include, but not be limited to, the following:
 - 1. Division 31 2000 Section "Earth Moving" for excavation and backfill.

1.3 QUALITY ASSURANCE

- A. Use only personnel completely trained and experienced in installation of the materials.
- B. Compliance to City/Township Codes and all other agencies having jurisdiction shall govern material and installation procedures.

1.4 SUBMITTALS

- A. Shop Drawings: Shop drawing submittals are not required for storm sewer materials. Contractor is expected to conform to the plans, specifications, and details for this work. Submit material certificates in lieu of shop drawings. Material certificates shall be signed by manufacturer and contractor certifying that each material item complies with or exceeds requirements.

1.5 PRODUCT HANDLING

- A. Protection: Use all means necessary to protect the materials before, during and after installation.
- B. Replacements: In the event of damage, immediately make all necessary repairs and replacements acceptable to the Engineer and at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 STORM SEWER PIPE

- A. General: Storm sewer pipe material shall be as indicated on the plans. If indicated on the plans, pipe materials shall conform to the following requirements.
- B. Reinforced Concrete Pipe
 - 1. Reinforced concrete pipe shall conform to ASTM C-76.72A, Type III & Type IV.
 - 2. Joints shall be premium rubber joint as acceptable to the Engineer unless otherwise specified on the drawings.
- C. Corrugated Polyethelene Tubing (CPT)
 - 1. Corrugated Polyethelene Tubing (CPT) shall conform to ASTM F405 and shall be perforated with sock where indicated on the plans.
 - 2. Joints shall be secured with a factory made snap-on or screen-on coupler for 4" and 6" diameter. Joints for 8" diameter and larger shall be a factory made coupler ties, bolts or screws on.

2.2 PERFORATED UNDERDRAIN PIPE (PE or CPP)

- A. General
 - 1. Perforated underdrain pipe shall be perforated, corrugated polyethelene pipe.
 - 2. The pipe shall have a factory installed geotextile pipe wrap.
 - 3. Perforation shall meet the requirements of AASHTO M 278.
- B. Polyethylene Pipe (PE): Polyethylene pipe and fittings shall be standard strength and conform to ASTM F 405 and AASHTO M 252.
- C. Polyvinyl Chloride Pipe (PVC): Polyvinyl Chloride pipe and fitting shall be standard strength and conform to ASTM F 800.
- D. Geotextile Pipe Wrap: Geotextile pipe wrap shall weigh at least 3.5 ounces per square yard and shall conform to AASHTO M 288. It shall not be ripped or torn. The minimum tensile strength shall be 100 pounds.

2.5 CASTINGS

- A. General: All castings shall be of cast iron, conforming to ASTM A 48 unless otherwise indicated. Conform to details and notes indicated on the plans. Where details or notes are not indicated, conform with the following requirements.

- B. Manhole frames and covers: Material shall be MDOT Type A with perforated covers.
- C. Catch basins and inlet castings: Catch basin and inlet castings shall be MDOT Type K when located in curbs and gutter, MDOT Type E in non-paved locations, and MDOT Type A when located in paved areas.

2.6 MANHOLE SECTIONS

- A. Manhole walls
 - 1. Standard manhole walls shall be Precast concrete units conforming to ASTM C 478, or be concrete block masonry.
- B. Manhole bases: Manhole bases shall be precast concrete units of the dimensions indicated on the Drawings.

2.7 MANHOLE STEPS

- A. Manhole steps shall be of cast iron conforming to ASTM A 48 or equal, and shall meet pertinent safety rules and regulations.

2.8 CATCH BASINS

- A. Construct catch basins of brick, block, masonry, or Precast units. Precast concrete catch basin units, if used, shall have reinforcing steel conforming to ASTM C 76 II, Wall B.

2.9 INLETS

- A. Construct inlets of brick, block, masonry, or Precast units. Precast inlet units, if used, shall have reinforcing steel conforming to ASTM C 76 II, Wall B.

2.10 CLEANOUTS

- A. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.

2.11 MORTAR

- A. Mortar for brick masonry or plastering manholes shall be made of one part Portland cement to two parts sand, and materials and mixing shall correspond, in general, to Division 04 2000 Section "Unit Masonry."

2.12 BRICK

- A. Brick Work shall meet the requirements of Medium Brick of ASTM C 13.

2.13 CONCRETE BLOCK MASONRY

- A. Concrete block masonry shall conform to ASTM C 139.

2.14 OTHER MATERIALS

- A. All other materials not specifically described but required for a complete and proper installation of the work of this Section, shall be new, first quality of their respective kinds, and as selected by the Contractor subject to review by the Engineer.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

- A. Inspection
 - 1. Verify that all work under this Section may be installed in accordance with all pertinent codes and regulations, the original design and the reference standards.
 - 2. All materials shall be inspected immediately before installation, and if found defective, immediately removed from the site.
- B. Discrepancies
 - 1. In the event of discrepancy, immediately notify the Engineer.
 - 2. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.

3.2 EARTHWORK

- A. All earthwork required for the performance of the work of this Section shall be installed in accordance with Division 31 2000 Section "Earth Moving."

3.3 INSTALLATION

- A. General: Install all pipe and fittings in strict accordance with the manufacturer's recommendations as acceptable to the Engineer and other authorities having jurisdiction.
- B. Handling
 - 1. Distribute pipe and materials at the site as required, care to prevent damage to the pipe and materials.
 - 2. Use proper tools and implements for safely handling and installing the pipe and other materials.
 - 3. Protect the pipe and other materials from falling to the ground or into the trench.
 - 4. Protect distributed pipe and materials from the public and passing vehicles.

C. Laying pipe

1. Lay all pipe true to line and grade with pipe ends abutting each other and the bell end facing the direction of laying.
2. Use laser alignment equipment to establish and maintain proper line and grade, unless otherwise directed.
3. Correct any deviation from line and grade at no additional cost to the Owner.
4. Protect workers at all times from cave-in and other hazardous conditions.

D. Joints: Inspect each joint immediately after being completed and, if defective, shall be corrected before any more pipe is laid.

E. Concrete encasement

1. Place concrete encasements in locations and to the form and dimensions indicated.
2. Concrete for encasements shall be Class SE with that below the pipe dry mixed.
3. Take particular care to place the concrete under the pipe, and lay pipe in fresh concrete so that a complete support of the pipe will be made. Encasement at the sides and top may be placed after the concrete under this pipe has been set.

F. Manholes

1. Construct manholes as indicated on the Drawings and Specifications.
2. Take special care in forming the channels in the concrete bottom and use wooden templates or half sewer pipe for this work.
3. Plaster masonry work and castings as indicated on the Drawings.
4. In precast concrete manholes, the bottom section shall have cast openings of sufficient size to receive the sewer pipe. If such openings are not provided, the bottom portion may be constructed of masonry work from the concrete base to at least 6" above the top of the largest pipe entering the manhole and Precast sections placed from the masonry to the desired top elevation.
5. All the annular space between the sewer pipe and the opening in the manhole section shall be filled with brick and/or masonry to provide a waterproof seal.
6. Place the manhole casting on a minimum of 3 courses of masonry brick and a maximum of 5 courses of manhole brick. Install bricks radially. Precast concrete adjusting rings may be used in place of brick.
7. Mortar joints have to be smooth tooled joints.

G. Catch basins and inlets

1. Construct catch basins and inlets as indicated on the Drawings and Specifications.
2. Place catch basin and inlet castings on a minimum of 3 courses of manhole brick and a maximum of 5 courses of manhole brick. Install brick radially. Precast concrete adjusting rings may be used in place of brick.

H. Trench bracing: Install trench bracing in accordance with safety and other pertinent rules and regulations, and Division 31 Section "Earth Moving."

- I. Erosion control and sedimentation: Contractor to provide erosion control to minimize introduction of sedimentation into the system.

3.4 CLEANING

- A. Prior to acceptance of storm sewers, underdrains, manholes and drainage structures, thoroughly clean those structures and remove all dirt and debris of whatever nature from inside sewer pipes, manholes and the like, and leave the site in a neat and clean condition.

END OF SECTION 33 4100