

INVITATION TO BID

ITB #4279

BARTON AND SOUTH INDUSTRIAL PUMP STATIONS ELECTRICAL IMPROVEMENTS

File No. 13002
DWRP Project No. 7375-01



Due Date: Thursday, May 2, 2013 by 2:00 PM

Issued By:

City of Ann Arbor
Procurement Unit
301 E. Huron Street
Ann Arbor, MI 48104

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ADVERTISEMENT
FOR THE
BARTON AND SOUTH INDUSTRIAL PUMP STATIONS
ELECTRICAL IMPROVEMENTS
CITY OF ANN ARBOR

BID NO. ITB-4279

Sealed Bids will be received by the City of Ann Arbor Procurement Unit, 301 East Huron Street, Fifth Floor, Larcom City Hall, on or before Thursday, May 2, 2013 by 2:00 PM for the construction of Barton and South Industrial Pump Stations Electrical Improvements. Bids will be publically opened and read aloud at this time.

A pre-bid conference will be held Tuesday, April 16, 2013 at 9:00 AM at the Water Treatment Plant located at 919 Sunset Road, Ann Arbor, Michigan 48103. Attendance is highly recommended.

Work to be done includes the demolition, construction, startup, and testing of electrical improvements at the Barton Pump Station and the South Industrial Booster Station. The project will include new transformers, switchboards, soft starts, motors, instrumentation, controls and related work. Other improvements include masonry improvements, doors and windows installation, painting, concrete work, construction of a pre-engineered storage building, mechanical improvements, and all other related work.

Additional Requirements: The following requirements shall apply to the Contract for the work of this project and to all subcontracts thereunder: 1) State of Michigan Drinking Water Revolving Fund Requirements; 2) Disadvantaged Business Enterprises (DBE) Specifications and Forms; 3) Project Wage Determination (under the Davis-Bacon Act, as amended, and related statutes); 4) Equal Opportunity Clause (Executive Order 11246); 5) Debarment Certification. The successful bidder shall fully comply with all of these special provisions and shall be responsible to ensure compliance with same by all of his subcontractors.

Bid documents, specifications, and addenda, with the exception of the Plans, shall be downloaded by bidders at either of the following websites: Michigan Inter-governmental Trade Network (MITN) www.mitn.info or City of Ann Arbor Purchasing website: www.A2gov.org. It is the bidder's responsibility to verify they have obtained all information before submitting a bid.

Complete Bid Documents, detailed specifications and plans may be obtained at the office of the ENGINEER, Stantec Consulting Michigan Inc., 3754 Ranchero Drive, Ann Arbor, Michigan 48108, for a non-refundable fee of \$20.00 for Electronic Copies (CD). Hard copies are not available. The purchase of plans from Stantec is a mandatory compliance term of submission for this Bid. Bids received from Bidders who have not purchased plans from Stantec will be rejected as non-responsive. When requesting the documents, prospective Bidders shall provide the following:

1. Company Name, Contact Name and Address
2. Document Fee
3. Signed Non-Disclosure Agreement for Bidders

A complete set of Bid Documents, specifications and plans shall also be available for public viewing at the office of Stantec Consulting Michigan Inc. and at the City of Ann Arbor City Hall, First Floor Customer Service.

Each Bid shall be accompanied by a certified check, or Bid Bond by a recognized surety, in the amount of 5% of the total of the bid price. A Bid, once submitted, becomes the property of the City. In the sole discretion of the City, the City reserves the right to allow a bidder to reclaim submitted documents provided the documents are requested and retrieved no later than 48 hours prior to the scheduled bid opening.

Each Bid shall meet the requirements of the State of Michigan Drinking Water Revolving Fund Requirements and shall be accompanied by the completed Disadvantaged Business Enterprises (DBE) Good Faith Worksheets and the Debarment Certification.

The successful Bidder will be required to furnish satisfactory performance and labor and material bonds in the amount of 100% of the bid price and satisfactory insurance coverage. The successful Bidder will also be required to sign and submit the Non-Disclosure Agreement for Contract Award.

Precondition for entering into a Contract with the City of Ann Arbor is compliance with Chapter 112 of Title IX of the Code of the City of Ann Arbor. The successful Bidder may also be required to comply with Chapter 23 of Title I of the Code of the City of Ann Arbor. Further information is outlined in the Contract Documents.

After the time of opening, no Bid may be withdrawn for a period of 120 days. The City reserves the right to accept any Bid, to reject any or all Bids, to waive irregularities and/or informalities in any Bid, and to make the award in any manner the City believes to be in its best interest.

Technical questions regarding this project may be submitted in writing to the Consulting Engineer, Stantec Consulting, Attn: Glen Wiczorek, PE via email at glen.wiczorek@stantec.com. Questions by telephone call are prohibited. Technical Questions directed to the Owner are prohibited. The deadline for questions shall be 5:00 PM on Wednesday, April 24, 2013. Questions will not be received after this date.

Any further information on bid documents may be obtained from the Procurement Office, (734) 794-6500.

CITY OF ANN ARBOR PROCUREMENT UNIT

NOTICE OF PRE-BID CONFERENCE

A pre-bid conference for this project will be held on Tuesday, April 16, 2013 at 9:00 AM at the City of Ann Arbor Water Treatment Plant located at 919 Sunset Road, Ann Arbor, Michigan 48103. A site visit will follow the pre-bid conference to allow potential bidders the opportunity to view the project site.

Attendance at this conference is highly recommended. Administrative and technical questions regarding this project will be answered at this time. The pre-bid conference is for information only. Any answers furnished will not be official until verified in writing by the Financial Service Area, Procurement Unit. Answers that change or substantially clarify the bid will be affirmed in an addendum.

In addition to the pre-bid conference, prospective Bidders shall have the opportunity to visit the Barton Pump Station site on Tuesday, April 23, 2013 from 9:00 AM to 11:00AM at the Barton Pump Station. An additional visit to the South Industrial Pump Station will not be available. The purpose of this site visit will be to allow Bidders the opportunity to further view the Barton Pump Station project site. A second pre-bid conference will not be repeated at this time. This will be the only additional time that the Barton Pump Station site will be made available for Bidders prior to the bid due date.

INSTRUCTIONS TO BIDDERS

General

Work to be done under this Contract is generally described through the detailed specifications and must be completed fully in accordance with the contract documents. All work to be done under this Contract is located in or near the City of Ann Arbor.

The City shall make available to all prospective Bidders, prior to receipt of the Bids, access to the area in which the work is to be performed. Advance notice should be given to the Administering Service Area/Unit in cases where access to the site must be arranged by the City.

Any Bid which does not conform fully to these instructions may be rejected.

Preparation of Bids

Bids should be prepared providing a straight-forward, concise description of the Bidder's ability to meet the requirements of the ITB. Bids shall be written in ink or typewritten. No erasures are permitted. Mistakes may be crossed out and corrected and must be initialed and dated in ink by the person signing the Bid.

Bids must be submitted on Page Numbers ITB 1-3 and on the "Bid Forms" provided with each blank properly filled in. If forms are not fully completed it may disqualify the bid.

Each person signing the Bid certifies that he/she is the person in the Bidder's firm/organization responsible for the decision as to the fees being offered in the Bid and has not and will not participated in any action contrary to the terms of this provision.

Questions or Clarification on ITB Specifications

All questions regarding this ITB shall be submitted via email. Emailed questions and inquires will be accepted from any and all prospective Bidders in accordance with the terms and conditions of the ITB.

All questions shall be due on or before Wednesday, April 24, 2013, by 5:00 PM and should be addressed as follows:

Specification/Scope of Work questions emailed to glen.wiczorek@stantec.com

Bid Process and HR Compliance questions emailed to KLancaster@a2gov.org.

Addenda

If it becomes necessary to revise any part of the ITB, notice of the Addendum will be posted to Michigan Inter-governmental Trade Network (MITN) www.mitn.info and/or City of Ann Arbor web site www.A2gov.org for all parties to download.

Each Bidder must in its Bid, to avoid any miscommunications, acknowledge all addenda which it has received, but the failure of a Bidder to receive, or acknowledge receipt of; any addenda shall not relieve the Bidder of the responsibility for complying with the terms thereof.

The City will not be bound by oral responses to inquiries or written responses other than written addenda.

Bid Submission

All Bids are due and must be delivered to the City of Ann Arbor Procurement Unit on or before Thursday, May 2, 2013 by 2:00 PM. Bids submitted late or via oral, telephonic, telegraphic, electronic mail or facsimile **will not** be considered or accepted.

Each Bidder must submit one (1) original Bid and two (2) Bid copies in a sealed envelope clearly marked: **ITB 4279 – Barton and South Industrial Pump Stations Electrical Improvements.**

Bids must be addressed and delivered to:

City of Ann Arbor
Procurement Unit, 5th Floor
301 East Huron Street
P.O. Box 8647
Ann Arbor, MI 48107

All Bids received on or before the Due Date will be publicly opened and recorded immediately. No immediate decisions are rendered.

Hand delivered bids will be date/time stamped/signed by the Procurement Unit at the address above in order to be considered. Normal business hours are 9:00 a.m. to 3:00 p.m. Monday through Friday. The City will not be liable to any Bidder for any unforeseen circumstances, delivery or postal delays. Postmarking to the Due Date will not substitute for receipt of the Bid. Each Bidder is responsible for submission of their Bid.

Additional time for submission of bids past the stated due date and time will not be granted to a single Bidder; however, additional time may be granted to all Bidders when the City determines in its sole discretion that circumstances warrant it.

Award

The City intends to award a Contract(s) to the lowest responsible Bidder(s). On multi-divisional contracts, separate divisions may be awarded to separate Bidders. The City may also utilize alternatives offered in the Bid Forms, if any, to determine the lowest responsible Bidder on each division, and award multiple divisions to a single Bidder, so that the lowest total cost is achieved for the City. For unit price bids, the contract will be awarded based upon the unit prices and the lump sum prices stated by the bidder for the work items specified in the bid documents, with consideration given to any alternates selected by the City. If the City determines that the unit price for any item is materially different for the work item bid than either other bidders or the general market, the City, in its sole discretion, in addition to any other right it may have, may reject the bid as not responsible or non-conforming.

The acceptability of major subcontractors will be considered in determining if a Bidder is responsible. In comparing Bids, the City will give consideration to alternate Bids for items listed in the bid forms.

Qualifications

The City will evaluate Proposals based on cost as well as experience. Contractors that have not included the required list of similar work experience, resumes for project manager and superintendent, and associated references in Section 5 of the Bid Form may have their bid rejected.

It shall be required that the General Contractor self-perform 50% of the Work (based upon the Lump Sum Base Bid fee). Self-performed Work shall not include administrative costs, overhead, profit, management, on-site supervision and all other construction management. The General Contractor shall indicate self-performed Work on Section 4 – Major subcontractors, page BF-4 by identifying as such. The General Contractor shall certify compliance with this requirement and complete the Certification for Self-Performed Work included in Bid Form Section 6. At the City’s request, the Bidder shall provide supporting documentation during the bid phase demonstrating compliance with this requirement. Additional documentation during the construction phase (i.e. payrolls, etc.) shall also be provided at the City’s request.

As part of the proposal, Bidders shall provide documentation that the Bidder’s company has at least 10 years of experience performing construction of major electrical improvements at water and wastewater facilities. Bidders shall also submit, for the proposed Project Manager and Superintendent, resumes documenting 7 years of professional experience for each individual in the construction industry as a full-time employee, along with 3 references for each individual from previous projects completed within the past 5 years. Bidders shall also submit the attached form, “Section 5 – References,” which identifies a minimum of three projects completed in the past five years at water or wastewater facilities with a treatment capacity of 10 million gallons per day or larger, including construction cost, Contractor and subcontractor information, that demonstrate similar work experience and complexity to that included within these contract documents.

References provided by the General Contractor in Section 5, page BF-6 shall be for projects greater than \$2 million construction cost.

All key staff and subcontractors are subject to the approval by the City.

Official Documents

The City of Ann Arbor shall accept no alternates to the bid documents made by the Bidder unless those alternatives are set forth in the “Alternate” section of Bid form.

The City of Ann Arbor officially distributes bid documents from the Procurement Unit or through the Michigan Intergovernmental Trade Network (MITN). Copies of the bid documents obtained from any other source are not Official copies. Addenda and other bid information will only be posted to these official distribution sites. If you obtained City of

Ann Arbor Bid documents from other sources, it is recommended that you register on www.MITN.info and obtain an official Bid.

Complete Bid Documents, detailed specifications and plans may also be obtained at the office of the ENGINEER, Stantec Consulting Michigan Inc., 3754 Ranchero Drive, Ann Arbor, Michigan 48108, for a non-refundable fee of \$20.00 for Electronic Copies (CD). Hard copies are not available. When requesting the documents, prospective bidders shall provide the following:

1. Company Name, Contact Name and Address
2. Document Fee
3. Signed Non-Disclosure Agreement for Bidders

Non-Disclosure Agreement for Bidders

Beginning at page NDAB-1, prospective bidders must comply with the requirements of the Non-Disclosure Agreement for Bidders. All those obtaining Bid Documents for any purpose must sign and submit the Non-Disclosure Agreement for Bidders, along with their document fee, in order to receive the Bid Documents.

State of Michigan Drinking Water Revolving Fund Requirements

All prospective Bidders must meet the requirements for the State of Michigan Drinking Water Revolving Fund Requirements as provided on pages beginning with DS-1. All Bidders must complete and return with their bid completed Disadvantaged Business Enterprises (DBE), Good Faith Worksheets and the Debarment Certification.

Bid Security

Each bid must be accompanied by a certified check, or Bid Bond by a surety licensed and authorized to do business within the State of Michigan, in the amount of 5% of the total of the bid price.

Withdrawal of Bids

After the time of opening, no Bid may be withdrawn for the period of 120 days specified in the Advertisement.

Contract Time

Time is of the essence in the performance of the work under this Contract. The available time for work under this Contract is indicated on page C-2, Article III of the Contract. If these time requirements can not be met, the Bidder must stipulate on Bid Form Section 3 - Time Alternate its schedule for performance of the work. Consideration will be given to time in evaluating bids.

Liquidated Damages

A liquidated damages clause, as given on page C-2, Article III of the Contract, provides that the Contractor shall pay the City as liquidated damages, and not as a penalty, a sum certain per day for each and every day that the Contractor may be in default of completion of the specified work, within the time(s) stated in the Contract, or written extensions.

Liquidated damages clauses, as given in the General Conditions, provide further that the City shall be entitled to impose and recover liquidated damages for breach of the obligations under Chapter 112 of the City Code.

The liquidated damages are for the non-quantifiable aspects of any of the previously identified events and do not cover actual damages that can be shown or quantified nor are they intended to preclude recovery of actual damages in addition to the recovery of liquidated damages.

Human Rights Information

Section 5, beginning at page GC-3, outlines the requirements for fair employment practices under City of Ann Arbor Contracts. To establish compliance with this Ordinance, the Bidder should complete and return with its bid completed copies of the Human Rights Division Contract Compliance Forms or an acceptable equivalent. In the event Human Rights forms are not submitted with the bid, the bidder will have 24 hours to provide once requested by the City.

Wage Requirements

Section 4, beginning at page GC-2, outlines the requirements for payment of prevailing wages or of a "living wage" to employees providing service to the City under this contract. The successful bidder must comply with all applicable requirements and provide documentary proof of compliance when requested.

Major Subcontractors

The Bidder shall identify on Bid Form Section 4 each major subcontractor it expects to engage for this Contract if the work to be subcontracted is 15% or more of the bid sum or over \$50,000, whichever is less. The Bidder also shall identify the work to be subcontracted to each major subcontractor. The Bidder shall not change or replace a subcontractor without approval by the City.

Debarment

Submission of a Bid in response to this ITB is certification that the Bidder is not currently debarred, suspended, proposed for debarment, and declared ineligible or voluntarily excluded from participation in this transaction by any State or Federal departments or agency. Submission is also agreement that the City will be notified of any changes in this status.

Disclosures

After bids are opened, all information in a submitter's bid is subjected to disclosure under the provisions of Michigan Public Act No. 442 of 1976, as amended (MCL 15.231 et seq.) known as the "Freedom of Information Act". The Freedom of Information Act also provides for the complete disclosure of contracts and attachments thereto except where specifically exempted.

Bid Protest

All Bid protests must be in writing and filed with the Purchasing Agent within five (5) business days of the award action. The bidder must clearly state the reasons for the protest. If a bidder contacts a City Service Area/Unit and indicates a desire to protest an award, the Service Area/Unit shall refer the bidder to the Purchasing Agent. The Purchasing Agent will provide the bidder with the appropriate instructions for filing the protest. The protest shall be reviewed by the City Administrator or designee whose decision shall be final.

Reservation of Rights

The City of Ann Arbor reserves the right to accept any bid or alternative bid proposed in whole or in part, to reject any or all bids or alternatives bids in whole or in part and to waive irregularity and/or informalities in any bid and to make the award in any manner deemed in the best interest of the City.

NON-DISCLOSURE AGREEMENT FOR BIDDERS
BETWEEN _____
AND THE CITY OF ANN ARBOR

Whereas, the City of Ann Arbor, with municipal offices at 100 N. Fifth Avenue, Ann Arbor 48107 ("City") is the owner of certain confidential information relating to its water system and components thereof, which is or may be classified as exempt or restricted information under the Michigan Freedom of Information Act and federal bioterrorism and homeland security laws (collectively referred to as "Confidential Information").

Whereas, _____ (referred to as "Receiver") is interested in responding to an invitation-to-bid (ITB) on a water system construction project, and the bid documents for this project may contain Confidential Information related to the water system and components thereof.

It is hereby agreed:

That, the City shall, in its sole discretion, disclose to Receiver the Confidential Information that may be in the bid documents.

That, Receiver shall hold and use Confidential Information only for the above-stated purpose of this Agreement and shall restrict disclosure of such Confidential Information to its employees and sub-contractors on a need-to-know basis. The City shall be provided with a master list of the employees and subcontractors and the reason for their classification as "need to know."

That, Receiver will hold the Confidential Information or any part thereof in strict confidence and will not permit any disclosure thereof to any person or persons outside its organization or sub-contractors and not use or derive any direct or indirect benefit from the Confidential Information or any part thereof without the prior written consent of the City. Receiver agrees that it will not disseminate in any manner any part of the Confidential Information.

That, Receiver will not make or authorize to be made any copies of bid documents supplied by the City or showing or describing or embodying the Confidential Information unless authorized by the City in writing.

That, Upon submittal of the bid, the Receiver agrees it will return the bid plan set to the City.

That, Receiver, if bid is accepted, will agree to sign a non-disclosure agreement for any additional Confidential Information necessary to complete the project

That, nothing in this Agreement shall be construed as conferring to Receiver any right of ownership in the Confidential Information or license to use any, patents, industrial designs, copyrights or other intellectual property rights owned or licensed by the City.

That, nothing in this Agreement shall be construed as restricting the City's right to restrain use or dissemination of the Confidential Information in accordance with applicable federal, state or local law and regulation or at common law.

Receiver acknowledges that a breach by him/her of the provisions of this Agreement will cause the City irreparable damage for which the City cannot be reasonably or adequately compensated in damages. The City shall therefore be entitled, in addition to all other remedies available to it including, but not limited to, attorney fees and costs, to injunctive and/or other equitable relief to prevent a breach of this Agreement, or any part of it, and to secure its enforcement.

This Agreement shall be construed in accordance with the laws of the State of Michigan.

This Agreement and any amendments hereto may be executed by facsimile signature by the Receiver or its designated representative.

RECEIVER

By: _____
On Behalf of _____ (Company)

Print Name: _____ Date

Its:

CONTRACT COMPLIANCE FORMS

City of Ann Arbor Procurement Office INSTRUCTIONS FOR CONTRACTORS

For Completing CONTRACT COMPLIANCE FORM

City Policy

The “non discrimination in contracts” provision of the City Code, (Chapter 112, Section 9:161) requires contractors/bidders/grantees doing business with the City not to discriminate on the basis of actual or perceived race, color, religion, national origin, sex, age, condition of pregnancy, marital status, physical or mental limitations, source of income, family responsibilities, educational association, sexual orientation, gender identity or HIV status against any of their employees, any City employee working with them, or any applicant for employment. It also requires that the contractors/bidders/grantees include a similar provision in all subcontracts that they execute for City work or programs.

This Ordinance further requires that each prospective contractor/bidder submit employment data to the City showing current total employee breakdown by occupation, race and gender. This allows the Human Rights Office to determine whether or not the contractor/bidder has a workforce that is reflective of the availability of women and under-represented minorities within the contractor’s labor recruitment area (the area where they can reasonably be expected to recruit employees). *This data is provided to the City on the Human Rights Contract Compliance Forms (attached).*

To complete the form:

1) **If a company has more than one location, then that company must complete 2 versions of the form.**

- **Form #1** should contain the employment data for the **entire corporation.**
- **Form #2** should contain the employment data for those employees:
 - who will be working on-site;
 - in the office responsible for completing the contract; or,
 - in the case of non-profit grantees, those employees working on the project funded by the City grant(s).

2) If the company has only one location, fill out Form #1 only.

3) Complete all data in the upper section of the form including the name of the person who completes the form and the name of the company/organization’s president.

4) Complete the Employment Data in the remainder of the form. Please be sure to complete all columns including the Total Columns on the far right side of the form, and the Total row and Previous Year Total row at the bottom of the form.

5) Return the completed form(s) to your contact in the City Department for whom you will be conducting the work.

For assistance in completing the form, contact:
Procurement Office of the City of Ann Arbor
(734) 794-6500

If a contractor is determined to be out of compliance, the Procurement Office will work with them to assist them in coming into compliance.

CITY OF ANN ARBOR HUMAN RIGHTS OFFICE
CONTRACT COMPLIANCE FORM
Entire Organization (Totals for All Locations where applicable)

Form #1

Name of Company/Organization _____ Date Form Completed _____

Name and Title of Person Completing this Form _____ Name of President _____

Address _____ County _____ Phone # _____
 (Street address) (City) (State) (Zip) (Area Code)

Fax# _____ Email Address _____
 (Area Code)

EMPLOYMENT DATA

Job Categories	Number of Employees (Report employees in only one category)												TOTAL COLUMNS A-L
	Male						Female						
	White	Black or African American	Asian	Hispanic or Latino	Native Hawaiian or Other Pacific Islander	American Indian or Alaska Native	White	Black or African American	Asian	Hispanic Latino	or Native Hawaiian or Other Pacific Islander	American Indian or Alaskan Native	
	A	B	C	D	E	F	G	H	I	J	K	L	
Exec/Sr. Level Officials													
Supervisors													
Professionals													
Technicians													
Sales													
Admin. Support													
Craftspeople													
Operatives													
Service Workers													
Laborers/Helper													
Apprentices													
Other													
TOTAL													
PREVIOUS YEAR TOTAL													

**CITY OF ANN ARBOR HUMAN RIGHTS OFFICE
CONTRACT COMPLIANCE FORM**

Form #2

Local Office (Only those employees that will do local or on-site work, if applicable)

Name of Company/Organization _____ Date Form Completed _____

Name and Title of Person Completing this Form _____ Name of President _____

Address _____ County _____ Phone # _____
 (Street address) (City) (State) (Zip) (Area Code)

Fax# _____ Email Address _____
 (Area Code)

EMPLOYMENT DATA

Job Categories	Number of Employees (Report employees in only one category)												TOTAL COLUMNS A-L
	Male						Female						
	White	Black or African American	Asian	Hispanic or Latino	Native Hawaiian or Other Pacific Islander	American Indian or Alaska Native	White	Black or African American	Asian	Hispanic or Latino	Native Hawaiian or Other Pacific Islander	American Indian or Alaskan Native	
	A	B	C	D	E	F	G	H	I	J	K	L	
Exec/Sr. Level Officials													
Supervisors													
Professionals													
Technicians													
Sales													
Admin. Support													
Craftspeople													
Operatives													
Service Workers													
Laborers/Helper													
Apprentices													
Other													
TOTAL													
PREVIOUS YEAR TOTAL													

**ATTACHMENT C
CITY OF ANN ARBOR
LIVING WAGE ORDINANCE
DECLARATION OF COMPLIANCE**

The Ann Arbor Living Wage Ordinance (Section 1:811-1:821 of Chapter 23 of Title I of the Code) requires that employers providing services to the City or recipients of grants for financial assistance (in amounts greater than \$10,000 in a twelve-month period of time) pay their employees who are working on the City project or grant, a minimum level of compensation known as the **Living Wage**. This wage must be paid to the employees for the length of the contract/project.

Companies employing fewer than 5 persons and non-profits employing fewer than 10 persons are exempt from the Ordinance. If this exemption applies to your firm, please check below:

- _____ This **company** is exempt due to the fact that we employ or contract with fewer than 5 individuals.
- _____ This **non-profit agency** is exempt due to the fact that we employ or contract with fewer than 10 employees.

The Ordinance requires that all contractors/vendors and/or grantees agree to the following terms:

- a) To pay each of its employees performing work on any covered contract or grant with the City, no less than the living wage, which is defined as \$12.52/hour when health care is provided, or no less than \$13.96/hour for those employers that do *not* provide health care. It is understood that the Living Wage will be adjusted each year on April 30, and covered employers will be required to pay the adjusted amount thereafter. The rates stated above include any adjustment for 2013.
- b) Please check the boxes below which apply to your workforce:
- Employees who are assigned to *any covered* City project or grant will be paid at or above the applicable living wage without health benefits Yes_____ No_____
- OR**
- Employees who are assigned to *any covered* City project or grant will be paid at or above the applicable living wage with health benefits Yes_____ No_____
- c) To post a notice approved by the City regarding the Living Wage Ordinance in every work place or other location in which employees or other persons contracting for employment are working.
- d) To provide the City payroll records or other documentation as requested; and,
- e) To permit access to work sites to City representatives for the purposes of monitoring compliance, investigating complaints or non-compliance.

The undersigned authorized representative hereby obligates the contractor/vendor or grantee to the above stated conditions under penalty of perjury and violation of the Ordinance.

Company Name

Address, City, State, Zip

Signature of Authorized Representative

Phone (area code)

Type or Print Name and Title

Email address

Date signed

Questions about this form? Please contact:
Procurement Office City of Ann Arbor
Phone: 734/794-6500

**CITY OF ANN ARBOR
LIVING WAGE ORDINANCE**

RATE EFFECTIVE APRIL 30, 2013 - ENDING APRIL 29, 2014

\$12.52 per hour

If the employer provides health
care benefits*

\$13.96 per hour

If the employer does **NOT**
provide health care benefits*

Employers providing services to or for the City of Ann Arbor or recipients of grants or financial assistance from the City of Ann Arbor for a value of more than \$10,000 in a twelve-month period of time must pay those employees performing work on a City of Ann Arbor contract or grant, the above living wage.

ENFORCEMENT

The City of Ann Arbor may recover back wages either administratively or through court action for the employees that have been underpaid in violation of the law. Persons denied payment of the living wage have the right to bring a civil action for damages in addition to any action taken by the City.

Violation of this Ordinance is punishable by fines of not more than \$500/violation plus costs, with each day being considered a separate violation. Additionally, the City of Ann Arbor has the right to modify, terminate, cancel or suspend a contract in the event of a violation of the Ordinance.

* Health Care benefits include those paid for by the employer or making an employer contribution toward the purchase of health care. The employee contribution must not exceed \$.50 an hour for an average work week; and the employer cost or contribution must equal no less than \$1/hr for the average work week.

The Law Requires Employers to Display This Poster Where Employees Can Readily See It.

**For Additional Information or to File a Complaint Contact
Karen Lancaster at 734/794-6500 or Klancaster@a2gov.org**

INVITATION TO BID

City of Ann Arbor
Guy C. Larcom Municipal Building
Ann Arbor, Michigan 48107

Ladies and Gentlemen:

The undersigned, as Bidder, declares that this Bid is made in good faith, without fraud or collusion with any person or persons bidding on the same Contract; that this Bidder has carefully read and examined the bid documents, including Advertisement, Human Rights Division Contract Compliance Forms, Notice of Pre-Bid Conference, Instructions to Bidders, Bid, Bid Forms, Contract, Bond Forms, General Conditions, Standard Specifications, Detailed Specifications, all Addenda, and the Plans and understands them. The Bidder declares that it conducted a full investigation at the site and of the work proposed and is fully informed as to the nature of the work and the conditions relating to the work's performance. The Bidder also declares that it has extensive experience in successfully completing projects similar to this one.

The Bidder acknowledges that it has not received or relied upon any representations or warrants of any nature whatsoever from the City of Ann Arbor, its agents or employees, and that this Bid is based solely upon the Bidder's own independent business judgment.

The undersigned proposes to perform all work shown on the plans or described in the bid documents, including any addenda issued, and to furnish all necessary machinery, tools, apparatus, and other means of construction to do all the work, furnish all the materials, and complete the work in strict accordance with all terms of the Contract of which this Bid is one part.

In accordance with these bid documents, and Addenda numbered _____, the undersigned, as Bidder, proposes to perform at the sites in and/or around Ann Arbor, Michigan, all the work included herein for the amounts set forth in the Bid Forms.

The Bidder declares that it has become fully familiar with the liquidated damage clauses for completion times and for compliance with City Code Chapter 112, understands and agrees that the liquidated damages are for the non-quantifiable aspects of non-compliance and do not cover actual damages that may be shown and agrees that if awarded the Contract, all liquidated damage clauses form part of the Contract.

The Bidder declares that it has become fully familiar with the provisions of Chapter 14, Section 1:319 (Prevailing wages) and Chapter 23 (Living Wage) of the Code of the City of Ann Arbor and that it understands and agrees to comply, to the extent applicable to employees providing services to the City under this Contract, with the wage and reporting

requirements stated in the City Code provisions cited. Bidder further agrees that the cited provisions of Chapter 14 and Chapter 23 form a part of this Contract.

The Bidder encloses a certified check or Bid Bond in the amount of 5% of the total of the Bid Price. The Bidder agrees both to contract for the work and to furnish the necessary Bonds and insurance documentation within 10 days after being notified of the acceptance of the Bid.

If this Bid is accepted by the City and the Bidder fails to contract and furnish the required Bonds and insurance documentation within 10 days after being notified of the acceptance of this Bid, then the Bidder shall be considered to have abandoned the Contract and the certified check or Bid Bond accompanying this Bid shall become due and payable to the City.

If the Bidder enters into the Contract in accordance with this Bid, or if this Bid is rejected, then the accompanying check or Bid Bond shall be returned to the Bidder.

In submitting this Bid, it is understood that the right is reserved by the City to accept any Bid, to reject any or all Bids, to waive irregularities and/or informalities in any Bid, and to make the award in any manner the City believes to be in its best interest.

SIGNED THIS _____ DAY OF _____, 201__.

Bidder's Name

Authorized Signature of Bidder

Official Address

(Print Name of Signer Above)

Telephone Number

Email Address for Award Notice

LEGAL STATUS OF BIDDER

(The Bidder shall fill out the appropriate form and strike out the other two.)

Bidder declares that it is:

* A corporation organized and doing business under the laws of the state of _____, for whom _____, bearing the office title of _____, whose signature is affixed to this Bid, is authorized to execute contracts.

* A partnership, list all members and the street and mailing address of each:

Also identify the County and State where partnership papers are filed:

County of _____, State of _____

* An individual, whose signature with address, is affixed to this Bid: _____
(initial here)

BID FORM

Section 1 – Schedule of Prices

Project: Barton and South Industrial Pump Stations Electrical Improvements

Bid No.: ITB-4279

Bidder's Name: _____

Base Bid

Item No. 1 – Barton Pump Station Improvements

The Bidder agrees to complete the Project with complete and fully functional electrical improvements, civil, architectural, structural and mechanical work and all related work, as specified and shown on the drawings, for the following lump sum (the Base Bid does not include the amounts associated with Alternate No.1. The Base Bid includes switchboards manufactured by GE.)

_____ Dollars (\$_____)

(Amount shall be shown in both words and figures. In case of a discrepancy, the amount shown in words shall govern.)

Item No. 2 – South Industrial Pump Station Improvements

The Bidder agrees to complete the Project with complete and fully functional electrical improvements, civil, architectural, structural and mechanical work and all related work, as specified and shown on the drawings, for the following lump sum (the Base Bid does not include the amounts associated with Alternate No.1. The Base Bid includes Motor Control Centers manufactured by GE.).

_____ Dollars (\$_____)

(Amount shall be shown in both words and figures. In case of a discrepancy, the amount shown in words shall govern.)

Total Base Bid (Item No. 1 plus Item No. 2)

_____ Dollars (\$_____)

(Amount shall be shown in both words and figures. In case of a discrepancy, the amount shown in words shall govern.)

Base Bid Deduct

The Bidder agrees to provide the switchboards/MCC manufactured by _____ (Bidder to fill in the blank) as specified for the following deduct to the Base Bid.

a. Deduct Barton Pump Station: \$_____

b. Deduct South Industrial Pump Station: \$_____

Alternate #1

The Bidder agrees to complete the Barton Pump Station Storage Building with a complete and fully functional pre-engineered building including the demolition of the existing storage building, site improvements, concrete and foundation work, supply and erection of a pre-engineered building, associated architectural, mechanical and electrical improvements and all other related work, as specified and shown on the drawings for the following unit prices.

ALTERNATE #1 – PRE-ENGINEERED STORAGE BUILDING					
Item No.	Item Description	Qty	Unit	Unit Price	Total Price
1.	General Conditions, Insurance, Bonds, Mobilization, Testing and Related Work		LS	\$	\$
2.	Building Package, Installed, Materials and Labor. (Does Not Include Insulation and Interior Wall Panels.)		LS	\$	\$
3.	Concrete, Foundation Work		LS	\$	\$
4.	Site Work, Grading		LS	\$	\$
5.	Monorail, Hoist and Trolley		LS	\$	\$
6.	Insulation Package		LS	\$	\$
7.	Interior Wall Panels		LS	\$	\$
8.	Electrical Service, Panels, Lighting, Receptacles and Related Work		LS	\$	\$
9.	Mechanical Equipment, Exhaust Fans, Louvers, Dampers, T-Stat and Controls		LS	\$	\$

Notes:

1. All bidders shall provide a Unit Price and Total Price for all alternate bid items specified.
2. Quantities included in the bid table represent estimated quantities for different work. The CONTRACTOR shall be compensated for the actual number of items completed using the unit priced provided.
3. The City, at its sole discretion, may elect to delete any portion of the work delineated below, with no change to the unit prices provided. Work shall be determined based upon the availability of funds.
4. Any item not provided in the following list shall be considered incidental.
5. Contract shall be awarded based on the base bid or any combination of the base bid and alternate bid areas in any manner the City believes to be in its best interest.
6. In each item, it is prefaced by the following statement, "Each item will be payment in full for all labor, materials, equipment and related work for a fully functional, complete and tested item according to the plans and specifications."

_____ Dollars (\$_____)

(Amount shall be shown in both words and figures. In case of a discrepancy, the amount shown in words shall govern.)

BID FORM

Section 2 - Material and Equipment Alternates

The Base Bid proposal price shall include materials and equipment selected from the designated items and manufacturers listed in the bidding documents. This is done to establish uniformity in bidding and to establish standards of quality for the items named.

If the Contractor wishes to quote alternate items for consideration by the City, it may do so under this Section. A complete description of the item and the proposed price differential must be provided. Unless approved at the time of award, substitutions where items are specifically named will be considered only as a negotiated change in Contract Sum.

<u>Item Number</u>	<u>Description</u>	<u>Add/Deduct Amount</u>
--------------------	--------------------	--------------------------

If the Bidder does not suggest any material or equipment alternate, the Bidder **MUST** complete the following statement:

For the work outlined in this request for bid, the bidder does NOT propose any material or equipment alternate under the Contract.

Signature of Authorized Representative of Bidder _____

BID FORM

Section 3 - Time Alternate

If the Bidder takes exception to the time stipulated in Article III of the Contract, Time of Completion, page C-2, it is requested to stipulate below its proposed time for performance of the work. Consideration will be given to time in evaluating bids.

If the Bidder does not suggest any time alternate, the Bidder **MUST** complete the following statement:

For the work outlined in this request for bid, the bidder does NOT propose any time alternate under the Contract.

Signature of Authorized Representative of Bidder _____

BID FORM

Section 4 - Major Subcontractors

For purposes of this Contract, a Subcontractor is anyone (other than the Contractor) who performs work (other than or in addition to the furnishing of materials, plans or equipment) at or about the construction site, directly or indirectly for or on behalf of the Contractor (and whether or not in privity of Contract with the Contractor), but shall not include any individual who furnishes merely the individual's own personal labor or services.

For the work outlined in these documents the Bidder expects to engage the following major subcontractors to perform the work identified:

<u>Subcontractor (Name and Address)</u>	<u>Work</u>	<u>Amount</u>
	Concrete	
	Masonry	
	Pre-Engineered Building Supplier	
	Painting	
	Check Valve Manufacturer	
	Mechanical	
	Electrical	
	Instrumentation & Control	

Subcontractor (Name and Address)

Work

Amount

G.E.

Switchboard/MCC
Manufacturer
(Base Bid)

Switchboard/MCC
Manufacturer
(Alternate)

Other

If the Bidder does not expect to engage any major subcontractor, the Bidder **MUST** complete the following statement:

For the work outlined in this request for bid, the bidder does NOT expect to engage any major subcontractor to perform work under the Contract.

Signature of Authorized Representative of Bidder _____

BID FORM

Section 5 – References

GENERAL CONTRACTOR (Name: _____)

Include a minimum of three references from projects completed within the past ten years for major electrical improvements at water or wastewater facilities with a treatment capacity of 10 million gallons per day or larger.

Refer also to Instructions to Bidders for additional requirements.

1) _____
Project Name Cost Date Constructed

_____ Phone Number
Contact Name

2) _____
Project Name Cost Date Constructed

_____ Phone Number
Contact Name

3) _____
Project Name Cost Date Constructed

_____ Phone Number
Contact Name

BID FORM

Section 5 – References

SUBCONTRACTOR – INSTRUMENTATION AND CONTROLS (Name: _____)

Include a minimum of three references from projects completed within the past ten years at water or wastewater facilities with a treatment capacity of 10 million gallons per day or larger.

Refer also to Instructions to Bidders and Specification Section 17015 for additional requirements.

1) _____
Project Name Cost Date Constructed

Contact Name Phone Number

Description

2) _____
Project Name Cost Date Constructed

Contact Name Phone Number

Description

3) _____
Project Name Cost Date Constructed

Contact Name Phone Number

Description

BID FORM

Section 6 – Certification for Self-Performed Work

In submitting this Bid and by signing below, the Bidder certifies that, as General Contractor, they shall self-perform 50% or greater of the Work (based upon the Lump Sum Base Bid fee). For the purposes of this Contract, self-performed work shall not include administrative costs, overhead, profit, management, on-site supervision and all other construction management.

At the City's request, the Bidder shall provide supporting documentation during the Bid phase and construction phase demonstrating compliance.

Signature of Authorized Representative of Bidder _____

REQUIRED STANDARD CONTRACT LANGUAGE: CLEAN WATER STATE REVOLVING FUND AND DRINKING WATER REVOLVING FUND

- **Davis-Bacon/Prevailing Federal Wages, Including Labor Standards Provisions**
- **Disadvantaged Business Enterprise (DBE) Requirements***
- **Debarment/Suspension Certification***

*** Bidders should note these sections contain instructions regarding forms/information that must be completed/included with any submitted bid.**

Davis-Bacon/Prevailing Federal Wage Rates

P.L. 111-88 requires compliance with the Davis Bacon Act and adherence to the current U.S. Department of Labor Wage Decision. Attention is called to the fact that not less than the minimum salaries and wages as set forth in the Contract Documents (see Wage Decision included herein) must be paid on this project. The Wage Decision, including modifications, must be posted by the Contractor on the job site. A copy of the Federal Labor Standards Provisions is included and is hereby a part of this contract.

General Decision Number: MI 130074 01/04/2013 MI 74

Superseded General Decision Number: MI 20120074

State: Michigan

Construction Type: Heavy

County: Washtenaw County in Michigan.

HEAVY CONSTRUCTION PROJECTS

Modification Number 0 Publication Date 01/04/2013

CARPO687-006 06/01/2012

	Rates	Fringes
CARPENTER, Includes Form Work.	\$ 29.19	22.77

ELEC0252-009 06/04/2012

	Rates	Fringes
ELECTRICIAN.	\$ 38.98	20.18

ENGI 0326-008 06/01/2012

	Rates	Fringes
OPERATOR: Power Equipment		
GROUP 1.	\$ 38.59	20.30
GROUP 2.	\$ 37.09	20.30
GROUP 3.	\$ 35.59	20.30
GROUP 4.	\$ 35.29	20.30
GROUP 5.	\$ 34.47	20.30
GROUP 6.	\$ 33.61	20.30
GROUP 7.	\$ 32.64	20.30
GROUP 8.	\$ 30.93	20.30
GROUP 9.	\$ 22.59	20.30

FOOTNOTES: Tower cranes: to be paid the crane operator rate determined by the combined length of the mast and the boom.

POWER EQUIPMENT OPERATOR CLASSIFICATIONS

- GROUP 1: Crane with boom & jib or leads 400' or longer
- GROUP 2: Crane with boom & jib or leads 300' or longer
- GROUP 3: Crane with boom & jib or leads 220' or longer
- GROUP 4: Crane with boom & jib or leads 140' or longer
- GROUP 5: Crane with boom & jib or leads 120' or longer
- GROUP 6: Regular crane operator
- GROUP 7: Backhoe/Excavator, Bobcat/Skid Loader, Boring Machine, Broom/Sweeper, Bulldozer, Grader/Blade, Loader, Roller, Scraper, Tractor, Trencher
- GROUP 8: Forklift

GROUP 9: Oil er

IRON0025-006 06/04/2012

	Rates	Fri nges
IRONWORKER		
Rei nforci ng.	\$ 28. 74	23. 35
Structural.	\$ 33. 29	25. 34

LAB00334-009 07/01/2012

	Rates	Fri nges
Landscape Laborer		
GROUP 1.	\$ 20. 96	6. 50
GROUP 2.	\$ 16. 74	6. 50

LANDSCAPE LABORER CLASSI FICATI ONS

GROUP 1: Landscape speci alist, i ncl udi ng ai r, gas and di esel
equi pment operator, l awn sprinkl er i nstall er and ski dsteer
(or equi val ent)

GROUP 2: Landscape laborer: sm all power tool operator,
materi al mover, truck dri ver and l awn sprinkl er i nstall er
tender

* LAB00499-020 08/01/2012

	Rates	Fri nges
LABORER		
GROUP 1.	\$ 27. 19	13. 13
GROUP 2.	\$ 27. 39	13. 13
GROUP 3.	\$ 27. 51	13. 13

LABORER CLASSI FICATI ONS

GROUP 1: Common or General ; Grade Checker

GROUP 2: Mason Tender - Cement/Concrete

GROUP 3: Pi pel ayer

PAI N0022-005 07/01/2008

	Rates	Fri nges
PAI NTER		
Brush & Rol l er.	\$ 25. 06	14. 75
Spray.	\$ 25. 86	14. 75

PLAS0514-002 11/01/2011

	Rates	Fri nges
CEMENT MASON/CONCRETE FI NI SHER. . .	\$ 31. 91	14. 34

PLUM0190-010 06/01/2012

	Rates	Fri nges
PLUMBER.	\$ 37. 44	19. 92

SUMI 2010-072 11/09/2010

	Rates	Fri nges
TRUCK DRIVER: Off the Road Truck.....	\$ 20.82	3.69

TEAM0007-006 06/01/2012

	Rates	Fri nges
TRUCK DRIVER		
Dump Truck under 8 cu. yds.; Tractor Haul Truck....	\$ 24.895	.50 + a+b
Dump Truck, 8 cu. yds. and over.....	\$ 24.995	.50 + a+b
Lowboy/Semi -Trailer Truck...	\$ 25.145	.50 + a+b

FOOTNOTE:

- a. \$351.00 per week.
- b. \$49.90 dai ly.

WELDERS - Receive rate prescribed for craft performing
operati on to whi ch wel di ng is inci dental .

=====

Unl isted classi fi cations needed for work not i ncl uded wi thi n
the scope of the classi fi cations l isted may be added after
award only as provided i n the labor standards contract clauses
(29CFR 5.5 (a) (1) (ii)).

The body of each wage determi nation l ists the classi fi cation
and wage rates that have been found to be prevailing for the
cited type(s) of construction i n the area covered by the wage
determi nation. The classi fi cations are l isted i n al phabetical
order of "i denti fi ers" that i ndicate whether the parti cul ar
rate is uni on or non-uni on.

Uni on I denti fi ers

An i denti fi er enclosed i n dotted l ines begi nni ng wi th
characters other than "SU" denotes that the uni on
classi fi cation and rate have found to be prevailing for that
classi fi cation. Example: PLUM0198-005 07/01/2011. The first
four letters , PLUM, i ndicate the i nternational uni on and the
four-digit number, 0198, that follows i ndicates the local uni on
number or district council number where applicabl e , i .e. ,
Plumbers Local 0198. The next number, 005 i n the exampl e, i s
an i nternal number used i n processi ng the wage determi nation.
The date, 07/01/2011, fol l owi ng these characters i s the
effecti ve date of the most current negoti ated rate/collecti ve
bargai ni ng agreement whi ch woul d be July 1, 2011 i n the above
exampl e.

Uni on prevailing wage rates wi ll be updated to reflect any
changes i n the collecti ve bargai ni ng agreements governi ng the
rates.

0000/9999: weighted union wage rates will be published annually each January.

Non-Union Identifiers

Classifications listed under an "SU" identifier were derived from survey data by computing average rates and are not union rates; however, the data used in computing these rates may include both union and non-union data. Example: SULA2004-007 5/13/2010. SU indicates the rates are not union majority rates, LA indicates the State of Louisiana; 2004 is the year of the survey; and 007 is an internal number used in producing the wage determination. A 1993 or later date, 5/13/2010, indicates the classifications and rates under that identifier were issued as a General Wage Determination on that date.

Survey wage rates will remain in effect and will not change until a new survey is conducted.

WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

- * an existing published wage determination
- * a survey underlying a wage determination
- * a Wage and Hour Division letter setting forth a position on a wage determination matter
- * a conformance (additional classification and rate) ruling

On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

Branch of Construction Wage Determinations
Wage and Hour Division
U. S. Department of Labor
200 Constitution Avenue, N. W.
Washington, DC 20210

2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

Wage and Hour Administrator
U. S. Department of Labor
200 Constitution Avenue, N. W.
Washington, DC 20210

The request should be accompanied by a full statement of the

interested party's position and by any information (wage payment data, project description, area practice material, etc.) that the requestor considers relevant to the issue.

3.) If the decision of the Administrator is not favorable, an interested party may appeal directly to the Administrative Review Board (formerly the Wage Appeals Board). Write to:

Administrative Review Board
U.S. Department of Labor
200 Constitution Avenue, N.W.
Washington, DC 20210

4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION

General Decision Number: MI 130100 01/18/2013 MI 100

Superseded General Decision Number: MI 20120100

State: Michigan

Construction Type: Building

County: Washtenaw County in Michigan.

BUILDING CONSTRUCTION PROJECTS (does not include single family homes or apartments up to and including 4 stories).

Modification Number	Publication Date
0	01/04/2013
1	01/18/2013

ASBE0025-003 06/01/2012

Townships of Ann Arbor, Augusta, Lodi, Northfield, Pittsfield, Salem, Saline, Scio, Superior, Webster, Ypsilanti & York

	Rates	Fringes
ASBESTOS WORKER/HEAT & FROST INSULATOR.....	\$ 31.49	27.56

ASBE0047-001 07/02/2011

Townships of Bridgewater, Dexter, Freedom, Lims, Lyndon, Manchester, Sharon & Sylvan

	Rates	Fringes
ASBESTOS WORKER/HEAT & FROST INSULATOR.....	\$ 28.47	15.63

BOIL0169-001 01/01/2012

	Rates	Fringes
BOILERMAKER.....	\$ 31.88	25.89

BRMI 0009-010 06/01/2012

	Rates	Fringes
BRI CKLAYER.....	\$ 31.71	17.40
TILE FINISHER.....	\$ 25.62	16.81
TILE SETTER.....	\$ 31.64	16.81

CARP0687-001 06/01/2012

	Rates	Fringes
CARPENTER, Includes Drywall Hanging, Form Work, and Metal Stud Installation.....	\$ 29.19	22.77

CARP1045-001 06/01/2012

	Rates	Fringes
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CARPENTER (Floor Layer - Carpet, Resilient, & Vinyl Flooring).....\$ 26.70 20.37

 CARP1102-002 06/01/2012

	Rates	Fri nges
MI LLWRI GHT.....	\$ 31.07	27.64

 ELEC0252-010 06/04/2012

	Rates	Fri nges
ELECTRI CI AN.....	\$ 38.98	20.18

 ENGI 0324-017 06/01/2012

	Rates	Fri nges
OPERATOR: Power Equipment		
GROUP 1.....	\$ 38.59	20.30
GROUP 2.....	\$ 37.09	20.30
GROUP 3.....	\$ 35.59	20.30
GROUP 4.....	\$ 35.29	20.30
GROUP 5.....	\$ 34.47	20.30
GROUP 6.....	\$ 33.61	20.30
GROUP 7.....	\$ 32.64	20.30
GROUP 8.....	\$ 30.93	20.30
GROUP 9.....	\$ 22.59	20.30

FOOTNOTES:
 Tower cranes: to be paid the crane operator rate determined by the combined length of the mast and the boom. If the worker must climb 50 ft. or more to the work station, \$.25 per hour additional.

Derrick and cranes where the operator must climb 50 ft. or more to the work station, \$.25 per hour additional to the applicable crane operator rate.

POWER EQUIPMENT OPERATOR CLASSIFICATIONS

- GROUP 1: Crane with boom and jib or leads 400' or longer
- GROUP 2: Crane with boom and jib or leads 300' or longer
- GROUP 3: Crane with boom and jib or leads 220' or longer
- GROUP 4: Crane with boom and jib or leads 140' or longer
- GROUP 5: Crane with boom and jib or leads 120' or longer
- GROUP 6: Regular crane operator, and concrete pump with boom operator
- GROUP 7: Backhoe/Excavator/Trackhoe, bobcat/skid Loader, broom/sweeper, bulldozer, grader/blade, high lift, hoist, loader, roller, scraper, tractor & trencher
- GROUP 8: Forklift & extend-a-boom forklift
- GROUP 9: Oiler

IRON0025-019 06/04/2012

	Rates	Fringes
IRONWORKER		
REINFORCING.....	\$ 28.74	23.35
STRUCTURAL.....	\$ 33.29	25.34

LAB00334-005 07/01/2012

	Rates	Fringes
LABORER: Landscape & Irrigation		
GROUP 1.....	\$ 20.96	6.50
GROUP 2.....	\$ 16.74	6.50

CLASSIFICATIONS

GROUP 1: Landscape specialist, including air, gas and diesel equipment operator, lawn sprinkler installer, skidsteer (or equivalent)

GROUP 2: Landscape laborer: small power tool operator, material mover, truck driver and lawn sprinkler installer tender

LAB00499-005 08/01/2012

	Rates	Fringes
LABORER		
Common or General; Grade Checker; Sandblaster.....	\$ 27.19	13.13
Mason Tender - Brick; Mason Tender - Cement/Concrete.....	\$ 27.39	13.13
Pipelayer.....	\$ 27.51	13.13

PAI N0022-003 07/01/2009

	Rates	Fringes
PAINTER: Brush and Roller.....	\$ 25.06	14.75
PAINTER: Drywall Finishing/Taping.....	\$ 25.75	15.90
PAINTER: Spray.....	\$ 25.86	14.75

PAI N0357-002 06/01/2012

	Rates	Fringes
GLAZIER.....	\$ 29.16	17.01

PAID HOLIDAYS: New Year's Day, Decoration Day, Fourth of July, Labor Day, Thanksgiving Day and Christmas Day; provided that the employee has worked the last full regular scheduled work day prior to the holiday, and the first full regular scheduled work day following the holiday, provided the employee is physically able to work.

PLAS0514-006 11/01/2011

Rates	Fringes
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CEMENT MASON/CONCRETE FINISHER... \$ 31.91 14.34

PLUM0190-004 06/01/2012

Rates Fringes

PIPEFITTER (Including HVAC
Pipe Installation; Excluding
HVAC System Installation)... \$ 37.44 19.92
PLUMBER, Excludes HVAC Pipe
and Unit Installation... \$ 37.44 19.92

ROOF0070-001 06/01/2011

Rates Fringes

ROOFER... \$ 29.87 14.47

* SFMI 0704-001 01/01/2013

Rates Fringes

SPRINKLER FITTER (Fire
Sprinklers)... \$ 40.91 21.01

SHEE0080-001 07/01/2011

Rates Fringes

SHEET METAL WORKER, Includes
HVAC Duct and Unit
Installation... \$ 33.96 24.33

SUMI 2011-025 02/01/2011

Rates Fringes

IRONWORKER, ORNAMENTAL... \$ 18.48 7.93

TRUCK DRIVER: Tractor Haul
Truck... \$ 13.57 1.18

TEAM0247-001 06/01/2012

Rates Fringes

TRUCK DRIVER
GROUP 1
Flatbed; Pickup; Dump &
Tandem... \$ 25.69 a
GROUP 2
Semi... \$ 25.84 a
GROUP 3
Lowboy... \$ 25.94 a

PAID HOLIDAYS: New Year's Day, Memorial Day, Independence
Day, Labor Day, Thanksgiving Day and Christmas Day. If any
of the above holidays fall on a Sunday, the following
Monday shall be considered the holiday and, if work is
performed, the rate shall be double time.

FOOTNOTE:

a. \$346.20 per week, plus \$53.00 per day.

WELDERS - Receive rate prescribed for craft performing operation to which welding is incidental.

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Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clauses (29CFR 5.5 (a) (1) (ii)).

The body of each wage determination lists the classification and wage rates that have been found to be prevailing for the cited type(s) of construction in the area covered by the wage determination. The classifications are listed in alphabetical order of "identifiers" that indicate whether the particular rate is union or non-union.

Union Identifiers

An identifier enclosed in dotted lines beginning with characters other than "SU" denotes that the union classification and rate have been found to be prevailing for that classification. Example: PLUM0198-005 07/01/2011. The first four letters, PLUM, indicate the international union and the four-digit number, 0198, that follows indicates the local union number or district council number where applicable, i.e., Plumbers Local 0198. The next number, 005 in the example, is an internal number used in processing the wage determination. The date, 07/01/2011, following these characters is the effective date of the most current negotiated rate/collective bargaining agreement which would be July 1, 2011 in the above example.

Union prevailing wage rates will be updated to reflect any changes in the collective bargaining agreements governing the rates.

0000/9999: weighted union wage rates will be published annually each January.

Non-Union Identifiers

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WAGE DETERMINATION APPEALS PROCESS

1.) Has there been an initial decision in the matter? This can be:

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On survey related matters, initial contact, including requests for summaries of surveys, should be with the Wage and Hour Regional Office for the area in which the survey was conducted because those Regional Offices have responsibility for the Davis-Bacon survey program. If the response from this initial contact is not satisfactory, then the process described in 2.) and 3.) should be followed.

With regard to any other matter not yet ripe for the formal process described here, initial contact should be with the Branch of Construction Wage Determinations. Write to:

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2.) If the answer to the question in 1.) is yes, then an interested party (those affected by the action) can request review and reconsideration from the Wage and Hour Administrator (See 29 CFR Part 1.8 and 29 CFR Part 7). Write to:

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4.) All decisions by the Administrative Review Board are final.

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END OF GENERAL DECISION

29 CFR Part 5 – Labor Standards Provisions for Federally Assisted Projects

§ 5.5 Contract provisions and related matters.

(a) The Agency head shall cause or require the contracting officer to insert in full in any contract in excess of \$2,000 which is entered into for the actual construction, alteration and/or repair, including painting and decorating, of a public building or public work, or building or work financed in whole or in part from Federal funds or in accordance with guarantees of a Federal agency or financed from funds obtained by pledge of any contract of a Federal agency to make a loan, grant or annual contribution (except where a different meaning is expressly indicated), and which is subject to the labor standards provisions of any of the acts listed in Sec. 5.1, the following clauses (or any modifications thereof to meet the particular needs of the agency, *Provided*, That such modifications are first approved by the Department of Labor):

(1) *Minimum wages.* (i) All laborers and mechanics employed or working upon the site of the work (or under the United States Housing Act of 1937 or under the Housing Act of 1949 in the construction or development of the project), will be paid unconditionally and not less often than once a week, and without subsequent deduction or rebate on any account (except such payroll deductions as are permitted by regulations issued by the Secretary of Labor under the Copeland Act (29 CFR part 3)), the full amount of wages and bona fide fringe benefits (or cash equivalents thereof) due at time of payment computed at rates not less than those contained in the wage determination of the Secretary of Labor which is attached hereto and made a part hereof, regardless of any contractual relationship which may be alleged to exist between the contractor and such laborers and mechanics.

Contributions made or costs reasonably anticipated for bona fide fringe benefits under section 1(b)(2) of the Davis-Bacon Act on behalf of laborers or mechanics are considered wages paid to such laborers or mechanics, subject to the provisions of paragraph (a)(1)(iv) of this section; also, regular contributions made or costs incurred for more than a weekly period (but not less often than quarterly) under plans, funds, or programs which cover the particular weekly period, are deemed to be constructively made or incurred during such weekly period. Such laborers and mechanics shall be paid the appropriate wage rate and fringe benefits on the wage determination for the classification of work actually performed, without regard to skill, except as provided in Sec. 5.5(a)(4). Laborers or mechanics performing work in more than one classification may be compensated at the rate specified for each classification for the time actually worked therein: *Provided*, That the employer's payroll records accurately set forth the time spent in each classification in which work is performed. The wage determination (including any additional classification and wage rates conformed under paragraph (a)(1)(ii) of this section) and the Davis-Bacon poster (WH-1321) shall be posted at all times by the contractor and its subcontractors at the site of the work in a prominent and accessible place where it can be easily seen by the workers.

(ii)(A) The contracting officer shall require that any class of laborers or mechanics, including helpers, which is not listed in the wage determination and which is to be employed under the contract shall be classified in conformance with the wage determination. The contracting officer shall approve an additional classification and wage rate and fringe benefits therefore only when the following criteria have been met:

(1) The work to be performed by the classification requested is not performed by a classification in the wage determination; and

(2) The classification is utilized in the area by the construction industry; and

(3) The proposed wage rate, including any bona fide fringe benefits, bears a reasonable relationship to the wage rates contained in the wage determination.

(B) If the contractor and the laborers and mechanics to be employed in the classification (if known), or their representatives, and the contracting officer agree on the classification and wage rate (including the amount designated for fringe benefits where appropriate), a report of the action taken shall be sent by the contracting officer to the Administrator of the Wage and Hour Division, Employment Standards Administration, U.S. Department of Labor, Washington, DC 20210. The Administrator, or an authorized representative, will approve, modify, or disapprove every additional classification action within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(C) In the event the contractor, the laborers or mechanics to be employed in the classification or their representatives, and the contracting officer do not agree on the proposed classification and wage rate (including the amount designated for fringe benefits, where appropriate), the contracting officer shall refer the questions, including the views of all interested parties and the recommendation of the contracting officer, to the Administrator for determination. The Administrator, or an authorized representative, will issue a determination within 30 days of receipt and so advise the contracting officer or will notify the contracting officer within the 30-day period that additional time is necessary.

(D) The wage rate (including fringe benefits where appropriate) determined pursuant to paragraphs (a)(1)(ii) (B) or (C) of this section, shall be paid to all workers performing work in the classification under this contract from the first day on which work is performed in the classification.

(iii) Whenever the minimum wage rate prescribed in the contract for a class of laborers or mechanics includes a fringe benefit which is not expressed as an hourly rate, the contractor shall either pay the benefit as stated in the wage determination or shall pay another bona fide fringe benefit or an hourly cash equivalent thereof.

(iv) If the contractor does not make payments to a trustee or other third person, the contractor may consider as part of the wages of any laborer or mechanic the amount of any costs reasonably anticipated in providing bona fide fringe benefits under a plan or program, Provided, That the Secretary of Labor has found, upon the written request of the contractor, that the applicable standards of the Davis-Bacon Act have been met. The Secretary of Labor may require the contractor to set aside in a separate account assets for the meeting of obligations under the plan or program.

(2) *Withholding.* The (write in name of Federal Agency or the loan or grant recipient) shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld from the contractor under this contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to Davis-Bacon prevailing wage requirements, which is held by the same prime contractor, so much of the accrued payments or advances as may be considered necessary to pay laborers and mechanics, including apprentices, trainees, and helpers, employed by the contractor or any subcontractor the full amount of wages required by the contract. In the event of failure to pay any laborer or mechanic, including any apprentice, trainee, or helper, employed or working on the site of the work (or under the United States Housing Act of 1937 or under the Housing Act of

1949 in the construction or development of the project), all or part of the wages required by the contract, the (Agency) may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds until such violations have ceased.

(3) *Payrolls and basic records.* (i) Payrolls and basic records relating thereto shall be maintained by the contractor during the course of the work and preserved for a period of three years thereafter for all laborers and mechanics working at the site of the work (or under the United States Housing Act of 1937, or under the Housing Act of 1949, in the construction or development of the project). Such records shall contain the name, address, and social security number of each such worker, his or her correct classification, hourly rates of wages paid (including rates of contributions or costs anticipated for bona fide fringe benefits or cash equivalents thereof of the types described in section 1(b)(2)(B) of the Davis-Bacon Act), daily and weekly number of hours worked, deductions made and actual wages paid. Whenever the Secretary of Labor has found under 29 CFR 5.5(a)(1)(iv) that the wages of any laborer or mechanic include the amount of any costs reasonably anticipated in providing benefits under a plan or program described in section 1(b)(2)(B) of the Davis-Bacon Act, the contractor shall maintain records which show that the commitment to provide such benefits is enforceable, that the plan or program is financially responsible, and that the plan or program has been communicated in writing to the laborers or mechanics affected, and records which show the costs anticipated or the actual cost incurred in providing such benefits. Contractors employing apprentices or trainees under approved programs shall maintain written evidence of the registration of apprenticeship programs and certification of trainee programs, the registration of the apprentices and trainees, and the ratios and wage rates prescribed in the applicable programs.

(ii)(A) The contractor shall submit weekly for each week in which any contract work is performed a copy of all payrolls to the (write in name of appropriate federal agency) if the agency is a party to the contract, but if the agency is not such a party, the contractor will submit the payrolls to the applicant, sponsor, or owner, as the case may be, for transmission to the (write in name of agency). The payrolls submitted shall set out accurately and completely all of the information required to be maintained under 29 CFR 5.5(a)(3)(i), except that full social security numbers and home addresses shall not be included on weekly transmittals. Instead the payrolls shall only need to include an individually identifying number for each employee (e.g., the last four digits of the employee's social security number). The required weekly payroll information may be submitted in any form desired. Optional Form WH-347 is available for this purpose from the Wage and Hour Division Web site at <http://www.dol.gov/esa/whd/forms/wh347instr.htm> or its successor site. The prime contractor is responsible for the submission of copies of payrolls by all subcontractors. Contractors and subcontractors shall maintain the full social security number and current address of each covered worker, and shall provide them upon request to the (write in name of appropriate federal agency) if the agency is a party to the contract, but if the agency is not such a party, the contractor will submit them to the applicant, sponsor, or owner, as the case may be, for transmission to the (write in name of agency), the contractor, or the Wage and Hour Division of the Department of Labor for purposes of an investigation or audit of compliance with prevailing wage requirements. It is not a violation of this section for a prime contractor to require a subcontractor to provide addresses and social security numbers to the prime contractor for its own records, without weekly submission to the sponsoring government agency (or the applicant, sponsor, or owner).

(B) Each payroll submitted shall be accompanied by a "Statement of Compliance," signed by the contractor or subcontractor or his or her agent who pays or supervises the payment of the persons employed under the contract and shall certify the following:

(1) That the payroll for the payroll period contains the information required to be provided under Sec. 5.5 (a)(3)(ii) of Regulations, 29 CFR part 5, the appropriate information is being maintained under Sec. 5.5 (a)(3)(i) of Regulations, 29 CFR part 5, and that such information is correct and complete;

(2) That each laborer or mechanic (including each helper, apprentice, and trainee) employed on the contract during the payroll period has been paid the full weekly wages earned, without rebate, either directly or indirectly, and that no deductions have been made either directly or indirectly from the full wages earned, other than permissible deductions as set forth in Regulations, 29 CFR part 3;

(3) That each laborer or mechanic has been paid not less than the applicable wage rates and fringe benefits or cash equivalents for the classification of work performed, as specified in the applicable wage determination incorporated into the contract.

(C) The weekly submission of a properly executed certification set forth on the reverse side of Optional Form WH-347 shall satisfy the requirement for submission of the "Statement of Compliance" required by paragraph (a)(3)(ii)(B) of this section.

(D) The falsification of any of the above certifications may subject the contractor or subcontractor to civil or criminal prosecution under section 1001 of title 18 and section 231 of title 31 of the United States Code.

(iii) The contractor or subcontractor shall make the records required under paragraph (a)(3)(i) of this section available for inspection, copying, or transcription by authorized representatives of the (write the name of the agency) or the Department of Labor, and shall permit such representatives to interview employees during working hours on the job. If the contractor or subcontractor fails to submit the required records or to make them available, the Federal agency may, after written notice to the contractor, sponsor, applicant, or owner, take such action as may be necessary to cause the suspension of any further payment, advance, or guarantee of funds. Furthermore, failure to submit the required records upon request or to make such records available may be grounds for debarment action pursuant to 29 CFR 5.12.

(4) *Apprentices and trainees--(i) Apprentices.* Apprentices will be permitted to work at less than the predetermined rate for the work they performed when they are employed pursuant to and individually registered in a bona fide apprenticeship program registered with the U.S. Department of Labor, Employment and Training Administration, Office of Apprenticeship Training, Employer and Labor Services, or with a State Apprenticeship Agency recognized by the Office, or if a person is employed in his or her first 90 days of probationary employment as an apprentice in such an apprenticeship program, who is not individually registered in the program, but who has been certified by the Office of Apprenticeship Training, Employer and Labor Services or a State Apprenticeship Agency (where appropriate) to be eligible for probationary employment as an apprentice. The allowable ratio of apprentices to journeymen on the job site in any craft classification shall not be greater than the ratio permitted to the contractor as to the entire work force under the registered program. Any worker listed on a payroll at an apprentice wage rate, who is not registered or otherwise employed as stated above, shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any apprentice performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. Where a contractor is performing construction on a project in a locality other than that in which its

program is registered, the ratios and wage rates (expressed in percentages of the journeyman's hourly rate) specified in the contractor's or subcontractor's registered program shall be observed. Every apprentice must be paid at not less than the rate specified in the registered program for the apprentice's level of progress, expressed as a percentage of the journeymen hourly rate specified in the applicable wage determination. Apprentices shall be paid fringe benefits in accordance with the provisions of the apprenticeship program. If the apprenticeship program does not specify fringe benefits, apprentices must be paid the full amount of fringe benefits listed on the wage determination for the applicable classification. If the Administrator determines that a different practice prevails for the applicable apprentice classification, fringes shall be paid in accordance with that determination. In the event the Office of Apprenticeship Training, Employer and Labor Services, or a State Apprenticeship Agency recognized by the Office, withdraws approval of an apprenticeship program, the contractor will no longer be permitted to utilize apprentices at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(ii) *Trainees.* Except as provided in 29 CFR 5.16, trainees will not be permitted to work at less than the predetermined rate for the work performed unless they are employed pursuant to and individually registered in a program which has received prior approval, evidenced by formal certification by the U.S. Department of Labor, Employment and Training Administration. The ratio of trainees to journeymen on the job site shall not be greater than permitted under the plan approved by the Employment and Training Administration. Every trainee must be paid at not less than the rate specified in the approved program for the trainee's level of progress, expressed as a percentage of the journeyman hourly rate specified in the applicable wage determination. Trainees shall be paid fringe benefits in accordance with the provisions of the trainee program. If the trainee program does not mention fringe benefits, trainees shall be paid the full amount of fringe benefits listed on the wage determination unless the Administrator of the Wage and Hour Division determines that there is an apprenticeship program associated with the corresponding journeyman wage rate on the wage determination which provides for less than full fringe benefits for apprentices. Any employee listed on the payroll at a trainee rate who is not registered and participating in a training plan approved by the Employment and Training Administration shall be paid not less than the applicable wage rate on the wage determination for the classification of work actually performed. In addition, any trainee performing work on the job site in excess of the ratio permitted under the registered program shall be paid not less than the applicable wage rate on the wage determination for the work actually performed. In the event the Employment and Training Administration withdraws approval of a training program, the contractor will no longer be permitted to utilize trainees at less than the applicable predetermined rate for the work performed until an acceptable program is approved.

(iii) *Equal employment opportunity.* The utilization of apprentices, trainees and journeymen under this part shall be in conformity with the equal employment opportunity requirements of Executive Order 11246, as amended, and 29 CFR part 30.

(5) *Compliance with Copeland Act requirements.* The contractor shall comply with the requirements of 29 CFR part 3, which are incorporated by reference in this contract.

(6) *Subcontracts.* The contractor or subcontractor shall insert in any subcontracts the clauses contained in 29 CFR 5.5(a)(1) through (10) and such other clauses as the (write in the name of the Federal agency) may by appropriate instructions require, and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for the compliance by any subcontractor or lower tier subcontractor with all the contract clauses in 29 CFR 5.5.

(7) *Contract termination: debarment.* A breach of the contract clauses in 29 CFR 5.5 may be grounds for termination of the contract, and for debarment as a contractor and a subcontractor as provided in 29 CFR 5.12.

(8) *Compliance with Davis-Bacon and Related Act requirements.* All rulings and interpretations of the Davis-Bacon and Related Acts contained in 29 CFR parts 1, 3, and 5 are herein incorporated by reference in this contract.

(9) *Disputes concerning labor standards.* Disputes arising out of the labor standards provisions of this contract shall not be subject to the general disputes clause of this contract. Such disputes shall be resolved in accordance with the procedures of the Department of Labor set forth in 29 CFR parts 5, 6, and 7. Disputes within the meaning of this clause include disputes between the contractor (or any of its subcontractors) and the contracting agency, the U.S. Department of Labor, or the employees or their representatives.

(10) *Certification of eligibility.* (i) By entering into this contract, the contractor certifies that neither it (nor he or she) nor any person or firm who has an interest in the contractor's firm is a person or firm ineligible to be awarded Government contracts by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(ii) No part of this contract shall be subcontracted to any person or firm ineligible for award of a Government contract by virtue of section 3(a) of the Davis-Bacon Act or 29 CFR 5.12(a)(1).

(iii) The penalty for making false statements is prescribed in the U.S. Criminal Code, 18 U.S.C. 1001.

(b) *Contract Work Hours and Safety Standards Act.* The Agency Head shall cause or require the contracting officer to insert the following clauses set forth in paragraphs (b)(1), (2), (3), and (4) of this section in full in any contract in an amount in excess of \$100,000 and subject to the overtime provisions of the Contract Work Hours and Safety Standards Act. These clauses shall be inserted in addition to the clauses required by Sec. 5.5(a) or 4.6 of part 4 of this title. As used in this paragraph, the terms laborers and mechanics include watchmen and guards.

(1) *Overtime requirements.* No contractor or subcontractor contracting for any part of the contract work which may require or involve the employment of laborers or mechanics shall require or permit any such laborer or mechanic in any workweek in which he or she is employed on such work to work in excess of forty hours in such workweek unless such laborer or mechanic receives compensation at a rate not less than one and one-half times the basic rate of pay for all hours worked in excess of forty hours in such workweek.

(2) *Violation; liability for unpaid wages; liquidated damages.* In the event of any violation of the clause set forth in paragraph (b)(1) of this section the contractor and any subcontractor responsible there for shall be liable for the unpaid wages. In addition, such contractor and subcontractor shall be liable to the United States (in the case of work done under contract for the District of Columbia or a territory, to such District or to such territory), for liquidated damages. Such liquidated damages shall be computed with respect to each individual laborer or mechanic, including watchmen and guards, employed in violation of the clause set forth in paragraph (b)(1) of this section, in the sum of \$10 for each calendar day on which such individual was required or permitted to work in excess of the standard workweek of forty hours without payment of the overtime wages required by the clause set forth in paragraph (b)(1) of this section.

(3) *Withholding for unpaid wages and liquidated damages.* The (write in the name of the Federal agency or the loan or grant recipient) shall upon its own action or upon written request of an authorized representative of the Department of Labor withhold or cause to be withheld, from any moneys payable on account of work performed by the contractor or subcontractor under any such contract or any other Federal contract with the same prime contractor, or any other federally-assisted contract subject to the Contract Work Hours and Safety Standards Act, which is held by the same prime contractor, such sums as may be determined to be necessary to satisfy any liabilities of such contractor or subcontractor for unpaid wages and liquidated damages as provided in the clause set forth in paragraph (b)(2) of this section.

(4) *Subcontracts.* The contractor or subcontractor shall insert in any subcontracts the clauses set forth in paragraph (b)(1) through (4) of this section and also a clause requiring the subcontractors to include these clauses in any lower tier subcontracts. The prime contractor shall be responsible for compliance by any subcontractor or lower tier subcontractor with the clauses set forth in paragraphs (b)(1) through (4) of this section.

(c) In addition to the clauses contained in paragraph (b), in any contract subject only to the Contract Work Hours and Safety Standards Act and not to any of the other statutes cited in Sec. 5.1, the Agency Head shall cause or require the contracting officer to insert a clause requiring that the contractor or subcontractor shall maintain payrolls and basic payroll records during the course of the work and shall preserve them for a period of three years from the completion of the contract for all laborers and mechanics, including guards and watchmen, working on the contract. Such records shall contain the name and address of each such employee, social security number, correct classifications, hourly rates of wages paid, daily and weekly number of hours worked, deductions made, and actual wages paid. Further, the Agency Head shall cause or require the contracting officer to insert in any such contract a clause providing that the records to be maintained under this paragraph shall be made available by the contractor or subcontractor for inspection, copying, or transcription by authorized representatives of the (write the name of agency) and the Department of Labor, and the contractor or subcontractor will permit such representatives to interview employees during working hours on the job.

Disadvantaged Business Enterprises (DBE)

Prime contractors bidding on this project must follow, document, and maintain documentation of their Good Faith Efforts, as listed below, to ensure that Disadvantaged Business Enterprises (DBEs) have the opportunity to participate in the project by increasing DBE awareness of procurement efforts and outreach. Bidders must make the following Good Faith Efforts for any work that will be subcontracted.

1. Ensure DBEs are made aware of contracting opportunities to the fullest extent practicable through outreach and recruitment activities; including placing DBEs on solicitation lists and soliciting DBEs whenever they are potential sources.
2. Make information on forthcoming opportunities available to DBEs and arrange time frames for contracts and establish delivery schedules, where the requirements permit, in a way that encourages and facilitates participation by DBEs in the competitive process. This includes, whenever possible, posting solicitation for bids or proposals for a minimum of 30 calendar days before the bid or proposal closing date.
3. Consider in the contracting process whether firms competing for large contracts could be subcontracted with DBEs. This will include dividing total requirements when economically feasible into smaller tasks or quantities to permit maximum participation by DBEs in the competitive process.
4. Encourage contracting with a consortium of DBEs when a contract is too large for one DBE firm to handle individually.
5. Use the services and assistance of the Small Business Administration and the Minority Business Development Agency of the U.S. Department of Commerce.

Subsequent to compliance with the Good Faith Efforts, the following conditions also apply under the DBE requirements. Completed Good Faith Efforts Worksheets (Attachment 1), along with the required supporting documentation outlined in the instructions, must be submitted with your bid proposal.

1. The prime contractor must pay its subcontractor for work that has been satisfactorily completed no more than 30 days from the prime contractor's receipt of payment from the owner.
2. The prime contractor must notify the owner in writing prior to the termination of any DBE subcontractor for convenience by the prime contractor.
3. If a DBE contractor fails to complete work under the subcontract for any reason, the prime contractor must employ the Good Faith Efforts if soliciting a replacement contractor.
4. The prime contractor must employ the Good Faith Efforts.

Debarment Certification

The prime contractor must provide a completed **Certification Regarding Debarment, Suspension, and Other Responsibility Matters Form** with its bid or proposal package to the owner (Attachment 2).

Attachment 1

**Disadvantaged Business Enterprise (DBE) Utilization
GOOD FAITH EFFORTS WORKSHEET**

**Michigan Department of Environmental Quality
Resource Management Division – Revolving Loan Section
Disadvantaged Business Enterprise (DBE) Utilization
State Revolving Fund/Drinking Water Revolving Fund
GOOD FAITH EFFORTS WORKSHEET**

Bidder: _____

Subcontract Area of Work: _____

Contract Goal: Solicit a minimum of three (3) DBEs via email/letters/fax.

List the DBEs contacted for the above area of work and complete the following information for each DBE.

Company Name	Type of Contact	Date of Contact	Price Quote Received	Accepted/ Rejected	Please Explain if Rejected
				<input type="checkbox"/> A <input type="checkbox"/> R	
				<input type="checkbox"/> A <input type="checkbox"/> R	
				<input type="checkbox"/> A <input type="checkbox"/> R	
				<input type="checkbox"/> A <input type="checkbox"/> R	
				<input type="checkbox"/> A <input type="checkbox"/> R	
				<input type="checkbox"/> A <input type="checkbox"/> R	

Explanation for Not Achieving Minimum Contacts (attach extra sheets if necessary):

MITA DBE Posting Date (if applicable): _____
(attach a copy of the DBE advertisement)

Other Efforts (attach extra sheets if necessary):

Please include the completed worksheet and supporting documentation with the bid proposal.

Rev.7-2012

Rick Snyder, Governor



Dan Wyant, Director

Authorized under Parts 53 & 54 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

www.michigan.gov/deq

DS-25

**Michigan Department of Environmental Quality
Resource Management Division – Revolving Loan Section
Disadvantaged Business Enterprise (DBE) Utilization
State Revolving Fund/Drinking Water Revolving Fund
GOOD FAITH EFFORTS WORKSHEET**

Instructions to Bidders for the Completion of the Good Faith Efforts Worksheet

1. Separate worksheets must be provided for each area of work to be subcontracted out. This includes both major and minor subcontracts.
2. A minimum of three (3) DBEs must be contacted by a verifiable means of communication such as e-mail, letter, or fax for each area of work to be subcontracted out. Copies of the solicitation letters/e-mails and fax confirmation sheets must be provided with the worksheet.
3. If this minimum number cannot be achieved with local DBEs, then the solicitations must be sent to DBEs outside of the local area (i.e. statewide).
4. Posting solicitations for quotes/proposals from DBEs on the MITA website (www.mitadbe.com) is highly recommended to facilitate participation in the competitive process whenever possible. The solicitation needs to identify the project and the areas of work to be subcontracted out. A copy of the MITA DBE advertisement must be submitted with the worksheet, if used, or a printout of the resulting quotes posted to the MITA website can be submitted with this form as supporting documentation.
5. If the area of work is so specialized that no DBEs exist, then an explanation is required to support that conclusion.
6. The date of the DBE contact must be identified, as it is important to document that the DBE solicitation was made during the bidding period and that sufficient time was given for the DBE to return a quote.
7. Each DBE firm's price quote must be identified if one was received or N/A entered on the worksheet if a quote was not received. Copies of all quotes must be submitted with the worksheet.
8. If a quote was received, indicate if it was accepted or rejected. Justification for not accepting a quote and not using the DBE subcontractor must be provided.
9. Under Other Efforts, please indicate additional steps you have taken to obtain DBE contractors and provide the appropriate supporting documentation such as:
 - Follow-up e-mails, faxes, or letters.
 - Copies of announcements/postings in newspapers, trade publications, or minority media that target DBE firms.

Rev. 7-2012

Rick Snyder, Governor



Dan Wyant, Director

Authorized under Parts 53 & 54 of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended.

www.michigan.gov/deq

DS-26

Attachment 2

***Certification Regarding
Debarment, Suspension, and Other Responsibility Matters***

**Certification Regarding
Debarment, Suspension, and Other Responsibility Matters**

The prospective participant certifies, to the best of its knowledge and belief, that it and its principals:

- (1) Are not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from participation in transactions under federal nonprocurement programs by any federal department or agency;
- (2) Have not, within the three year period preceding the proposal, had one or more public transactions (federal, state, or local) terminated for cause or default; and
- (3) Are not presently indicted or otherwise criminally or civilly charged by a government entity (federal, state, or local) and have not, within the three year period preceding the proposal, been convicted of or had a civil judgment rendered against it:
 - (a) For the commission of fraud or a criminal offense in connection with obtaining, attempting to obtain, or performing a public transaction (federal, state, or local) or a procurement contract under such a public transaction;
 - (b) For the violation of federal or state antitrust statutes, including those proscribing price fixing between competitors, the allocation of customers between competitors, or bid rigging; or
 - (c) For the commission of embezzlement, theft, forgery, bribery, falsification or destruction of records, making false statements, or receiving stolen property.

I understand that a false statement on this certification may be grounds for the rejection of this proposal or the termination of the award. In addition, under 18 U.S.C. §1001, a false statement may result in a fine of up to \$10,000 or imprisonment for up to five years, or both.

Name and Title of Authorized Representative

Name of Participant Agency or Firm

Signature of Authorized Representative

Date

I am unable to certify to the above statement. Attached is my explanation.

Attachment 3

***Frequently Asked Questions About
Disadvantaged Business Enterprise (DBE) Solicitation***

Disadvantaged Business Enterprise (DBE) Requirements Frequently Asked Questions Regarding Contractor Compliance

Q: What is the Good Faith Efforts Worksheet form and how is it to be completed?

A: This form captures efforts by the prime contractor to solicit DBEs for each area of work type that will be subcontracted out. A separate Good Faith Efforts Worksheet must be provided by the prime contractor for each area of work type to be subcontracted out. There are specific instructions that accompany this form that prescribe minimum efforts which bidders must make in order to be in compliance with the DBE requirements.

Q: Can non-certified DBEs be used?

A: While non-certified DBEs can be used, only DBEs, MBEs, and WBEs that are certified by EPA, SBA, or MDOT (or by tribal, state and local governments, as long as their standards for certification meet or exceed the standards in EPA policy) can be counted toward the fair share goal. Proof of certification by one of these recognized and approved agencies should be sought from each DBE.

Q: How does a DBE get certified?

A: Applications for certification under MDOT can be found at <http://mdot270.state.mi.us:8080/UCP/FormsServlet>.

Applications for certification under EPA can be found on EPA's Small Business Programs website at <http://www.epa.gov/osbp/grants.htm> under Certification Forms.

Q: If a bidder follows the MDOT DBE requirements, will the bidder be in compliance with the SRF/DWRF DBE requirements?

A: No. Federally funded highway projects utilize DBE goals, which require that a certain percentage of work be performed by DBE subcontractors. For SRF/DWRF projects, there is no financial goal. However, there is a solicitation effort goal. Bidders must use Good Faith Efforts for each and every area of work to be subcontracted out to obtain DBEs. The bidders are not required to use DBEs if the quotes are higher than non-DBE subcontractors. **There is no required DBE participation percentage contract goal for the SRF/DWRF.**

Q: Must the Good Faith Efforts Worksheet and supporting documentation be turned in with the bid proposals?

A: Yes. This is a requirement to document that the contractor has complied with the DBE requirements and the five Good Faith Efforts. These compliance efforts must be done during the bidding phase and not after-the-fact. It is highly recommended that the need for these efforts and the submittal of the forms with the bid proposals be emphasized at the pre-bid meetings. Failure to show that the five Good Faith Efforts were complied with during the bidding process can lead to a prime contractor being found non-responsive.

- Q:** What kinds of documentation should a contractor provide to document solicitation efforts?
- A:** Documentation can include fax confirmation sheets, copies of solicitation letters/e-mails, printouts of online solicitations, printouts of online search results, affidavits of publication in newspapers, etc.
- Q:** How much time will compliance with the Good Faith Efforts require in terms of structuring an adequate bidding period?
- A:** Due to the extent of the efforts required, a minimum of 30 calendar days is recommended between bid posting and bid opening to ensure adequate time for contractors to locate certified DBEs and solicit quotes.
- Q:** How does a contractor locate certified DBEs?
- A:** The Michigan Department of Transportation has a directory of all Michigan certified entities located at <http://mdot270.state.mi.us:8080/UCP/HomePageServlet>. Additionally, the Central Contractor Registration (CCR) database is another place to search and can be found at www.ccr.gov
- Q:** If the bidder does not intend to subcontract any work, what forms, if any, must be provided with the bid proposal?
- A:** The bidder should complete the Good Faith Efforts Worksheet with a notation that no subcontracting will be done. However, if the bidder is awarded the contract and then decides to subcontract work at any point, then the Good Faith Efforts must be made to solicit DBEs.
- Q:** In the perfect world, the Good Faith Efforts Worksheet is required to be turned in with the proposal. What if no forms are turned in with the bid proposal or forms are blank or incomplete? Should this be cause to determine that the bidder is non-responsive?
- A:** While the Good Faith Efforts Worksheet is important, it is more critical to confirm that the contractor complied with the DBE requirements prior to bid opening. The owner should contact the bidder as soon as deficiencies are noted for a determination/documentation of efforts taken to comply with the DBE requirements. Immediate submittal of the completed forms will be acceptable provided the Good Faith Efforts were made and it is just a matter of transferring information to the forms.
- Q:** If the prime contractor is a DBE, does he have to solicit DBE subcontractors?
- A:** Yes, the DBE requirements still apply if the prime intends to subcontract work out. Good Faith Efforts must be used to solicit DBEs.
- Q:** If the area of work is one where there are less than three DBE contractors, how is the contractor to document this?
- A:** Copies of printouts from MDOT and CCR showing no DBEs and advertisements soliciting quotes for all subcontract areas, including the questionable areas, will be adequate.

NON-DISCLOSURE AGREEMENT FOR CONTRACT AWARD
BETWEEN _____
AND THE CITY OF ANN ARBOR

Whereas, the City of Ann Arbor, with municipal offices at 100 N. Fifth Avenue, Ann Arbor, MI 48107 (“City”) is the owner of certain confidential information relating to its water system and components thereof, which is or may be classified as exempt or restricted information under the Michigan Freedom of Information Act and federal bioterrorism and homeland security laws (collectively referred to as “Confidential Information”).

Whereas, _____ (referred to as “Receiver”) is desirous of receiving, reviewing, and/or evaluating the Confidential Information for the sole and exclusive purpose of performing technical engineering services for the Water Treatment Plant.

It is hereby agreed:

That, the City shall, in its sole discretion, disclose to Receiver some or all of the Confidential Information, based on Receiver’s request for:

- Water Treatment Plant/Pump Station operational data
- As-built drawings of water treatment plant/pump station infrastructure
- Water Distribution System infrastructure maps

It is understood that Receiver will secure at its sole cost any and all licenses, authorizations or other intellectual property rights necessary for the transfer of Confidential Information in the format requested by Receiver. Receiver will be required to provide documentation of it has all necessary licenses, authorizations or rights prior to transfer of the Confidential Information in the requested format.

That, Receiver shall hold and use Confidential Information only for the above-stated purpose of this Agreement and shall restrict disclosure of such Confidential Information to its employees with a need to know. Each employee of Receiver identified as “need to know” in connection with the receipt, review or evaluation of the Confidential Information shall be required to execute a Non-disclosure Agreement under the same terms as stated herein. The City shall be provided with a copy of the executed employee Non-Disclosure Agreements and a master list of the employees, their respective jobs, and the reason for their classification as “need to know”.

That, Receiver will hold the Confidential Information or any part thereof in strict confidence and will not permit any disclosure thereof to any person or persons outside its organization and not use or derive any direct or indirect benefit from the Confidential Information or any part thereof without the prior written consent of the City. Receiver agrees that it will not disseminate in any manner any part of the Confidential Information.

That, Receiver will not make or authorize to be made any copies of any reports, plans, drawings or electronic data files supplied by the City and showing or describing or embodying the Confidential Information unless authorized by the City in writing. At any time and for any reason, prior to the completion of the work performed by the Receiver, the

City may request and Receiver agrees it will return all of the said reports, plans, drawings or electronic data files together with any reports, drawings or electronic data files, including any independent notations of the Confidential Information, made by Receiver showing or describing or embodying the Confidential Information or any part thereof to the City immediately. After completion of the work, the Receiver shall return to the City any drawings, extracts, reproductions, or other documentation comprising the Confidential Information, in whatever format or media, including any independent notations of the Confidential Information made by Receiver showing or describing or embodying the Confidential Information or any part thereof. In addition, access shall be controlled by the Receiver to all Confidential Information generated as part of the work performed by the Receiver. Although the Receiver is permitted to maintain copies of their work, dissemination of this Confidential Information is not permitted without written authorization from the City.

That, the restrictions on the use or disclosure of Confidential Information by Receiver shall not include any information which:

1. at the time of disclosure to Receiver was known to Receiver free of restriction and such previous knowledge is evidenced by documentation in the possession of Receiver. A copy of which documentation will be provided to the City if requested by the City; or
2. is publicly known or later made publicly known by the City; or
3. is evidenced by documentation in the possession of Receiver as being received from a third party to this Agreement who: (a) has the legal right to so furnish such information to Receiver, and (b) is not obligated to the City to keep such information confidential; or
4. is approved for release in writing by the City.

That, nothing in this Agreement shall be construed as conferring to Receiver any right of ownership in the Confidential Information or license to use any, patents, industrial designs, copyrights or other intellectual property rights owned or licensed by the City.

That, nothing in this Agreement shall be construed as restricting the City's right to restrain use or dissemination of the Confidential Information in accordance with applicable federal, state or local law and regulation or at common law.

Receiver acknowledges that a breach by him/her of the provisions of this Agreement will cause the City irreparable damage for which the City cannot be reasonably or adequately compensated in damages. The City shall therefore be entitled, in addition to all other remedies available to it including, but not limited to, attorney fees and costs, to injunctive and/or other equitable relief to prevent a breach of this Agreement, or any part of it, and to secure its enforcement.

This Agreement shall be construed in accordance with the laws of the State of Michigan.

This Agreement and any amendments hereto may be executed by facsimile signature and in any number of counterparts, all of which taken together shall constitute one and the same instrument.

CITY OF ANN ARBOR

By: _____
Steven D. Powers Date
Its: City Administrator

By: _____
Date
Print Name: _____

Its:

Approved as to substance:

Craig Hupy
Public Services Area
Administrator

Approved as to form and content:

Stephen K. Postema
City Attorney

CONTRACT

THIS AGREEMENT is made on the _____ day of _____, 2013, between the CITY OF ANN ARBOR, a Michigan Municipal Corporation, 301 East Huron Street, Ann Arbor, Michigan 48104 (“City”) and _____ (“Contractor”)

(An individual/partnership/corporation, include state of incorporation)

(Address)

Based upon the mutual promises below, the Contractor and the City agree as follows:

ARTICLE I - Scope of Work

The Contractor agrees to furnish all of the materials, equipment and labor necessary; and to abide by all the duties and responsibilities applicable to it for the project titled “Barton and South Industrial Pump Stations Electrical Improvements” in accordance with the requirements and provisions of the following documents, including all written modifications incorporated into any of the documents, which are incorporated as part of this Contract:

Human Rights Division Contract
Living Wage Declaration of
Compliance Forms
(if applicable)
Bid Forms
Contract and Exhibits
Bonds

General Conditions
Standard Specifications
Detailed Specifications
Plans
Addenda
State of Michigan - Drinking Water
Revolving Fund Requirements
Davis Bacon/Prevailing Federal
Wages, Including Standard
Provisions
Disadvantaged Business Enterprise
Requirements
Debarment/Suspension Certification

ARTICLE II - Definitions

Administering Service Area/Unit means Public Services Area.

Supervising Professional or Owner means Senior Utilities Engineer or other persons acting under the authorization of the Administrator/Manager of the Administering Service Area/Unit.

Engineer or Owner’s Representative means Consulting Professional acting under the authorization of the Supervising Professional/Owner.

Project means, Barton and South Industrial Pump Stations Electrical Improvements, Bid No. ITB-4279

ARTICLE III - Time of Completion

- (A) The work to be completed under this Contract shall begin immediately on the date specified in the Notice to Proceed issued by the City.
- (B) The entire work for this Contract shall be completed within twenty-two (22) consecutive months. Shorter completion times for certain portions of the work are specified in the Detailed Specifications. Liquidated damages shall also apply to these intermediate milestones based on the amounts listed in the Detailed Specifications.
- (C) Failure to complete all the work within the time specified above, including any extension granted in writing by the Supervising Professional, shall obligate the Contractor to pay the City, as liquidated damages and not as a penalty, an amount equal to \$500.00 for each calendar day of delay in the completion of all the work. If any liquidated damages are unpaid by the Contractor, the City shall be entitled to deduct these unpaid liquidated damages from the monies due the Contractor.

As an independent requirement, where the Detailed Specifications or Plans identify certain portions of the work to be completed within a shorter period of time and the Contractor fails to complete each portion within the shorter period specified for each portion, including any extension granted in writing by the Project Supervisor, the City is entitled to deduct from the monies due the Contractor, as liquidated damages and not as a penalty, the amount equal to that identified in Specification Section 01140, Table 1 and Table 2 for each portion or Phase of the work not timely completed for each calendar day of delay in completion of each portion of the work.

The liquidated damages are for the non-quantifiable aspects of any of the previously identified events and do not cover actual damages that can be shown or quantified nor are they intended to preclude recovery of actual damages in addition to the recovery of liquidated damages.

Liquidated damages under this section are in addition to any liquidated damages due under Section 5 of the General Conditions.

ARTICLE IV - The Contract Sum

- (A) The City shall pay to the Contractor for the performance of the Contract, the unit prices as given in the Bid Forms for the estimated bid total of:

_____ Dollars (\$_____)
- (B) The amount paid shall be equitably adjusted to cover changes in the work ordered by the Supervising Professional but not required by the Contract Documents. Increases or decreases shall be determined only by written agreement between the City and Contractor.

ARTICLE V - Assignment

This Contract may not be assigned or subcontracted without the written consent of the City.

ARTICLE VI - Choice of Law

This Contract shall be construed, governed, and enforced in accordance with the laws of the State of Michigan. By executing this agreement, the Contractor and the City agree to venue in a court of appropriate jurisdiction sitting within Washtenaw County for purposes of any action arising under this Contract. The parties stipulate that the venue referenced in this Contract is for convenience and waive any claim of non-convenience.

Whenever possible, each provision of the Contract will be interpreted in a manner as to be effective and valid under applicable law. The prohibition or invalidity, under applicable law, of any provision will not invalidate the remainder of the Contract.

ARTICLE VII - Relationship of the Parties

The parties of the Contract agree that it is not a Contract of employment but is a Contract to accomplish a specific result. Contractor is an independent Contractor performing services for the City. Nothing contained in this Contract shall be deemed to constitute any other relationship between the City and the Contractor.

Contractor certifies that it has no personal or financial interest in the project other than the compensation it is to receive under the Contract. Contractor certifies that it is not, and shall not become, overdue or in default to the City for any Contract, debt, or any other obligation to the City including real or personal property taxes. City shall have the right to set off any such debt against compensation awarded for services under this agreement.

ARTICLE VIII - Notice

All notices given under this Contract shall be in writing, and shall be by personal delivery or by certified mail with return receipt requested to the parties at their respective addresses as specified in the Contract Documents or other address the Contractor may specify in writing.

ARTICLE IX - Indemnification

To the fullest extent permitted by law, Contractor shall indemnify, defend and hold harmless the City, its officers, employees and agents harmless from all suits, claims, judgments and expenses including attorney's fees resulting or alleged to result, in whole or in part, from any act or omission, which is in any way connected or associated with this Contract, by the Contractor or anyone acting on the Contractor's behalf under this Contract. Contractor shall not be responsible to indemnify the City for losses or damages caused by or resulting from the City's sole negligence.

ARTICLE X - Entire Agreement

This Contract represents the entire understanding between the City and the Contractor and it supersedes all prior representations or agreements whether written or oral. Neither party has relied on

any prior representations in entering into this Contract. This Contract may be altered, amended or modified only by written amendment signed by the City and the Contractor.

FOR CONTRACTOR

By _____
Its: _____

FOR THE CITY OF ANN ARBOR

By _____
John Hieftje, Mayor

By _____
Jacqueline Beaudry, City Clerk

Approved as to substance

By _____
Steven D. Powers, City Administrator

By _____
Craig Hupy, Public Services
Area Administrator

Approved as to form and content

Stephen K. Postema, City Attorney

PERFORMANCE BOND

(1) _____ of _____ (referred to as "Principal"), and _____, a corporation duly authorized to do business in the State of Michigan (referred to as "Surety"), are bound to the City of Ann Arbor, Michigan (referred to as "City"), for

\$ _____, the payment of which Principal and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, by this bond.

(2) The Principal has entered a written Contract with the City dated _____, 2013, for: _____ and this bond is given for that Contract in compliance with Act No. 213 of the Michigan Public Acts of 1963, as amended, being MCL 129.201 et seq.

(3) Whenever the Principal is declared by the City to be in default under the Contract, the Surety may promptly remedy the default or shall promptly:

(a) complete the Contract in accordance with its terms and conditions; or

(b) obtain a bid or bids for submission to the City for completing the Contract in accordance with its terms and conditions, and upon determination by Surety of the lowest responsible bidder, arrange for a Contract between such bidder and the City, and make available, as work progresses, sufficient funds to pay the cost of completion less the balance of the Contract price; but not exceeding, including other costs and damages for which Surety may be liable hereunder, the amount set forth in paragraph 1.

(4) Surety shall have no obligation to the City if the Principal fully and promptly performs under the Contract.

(5) Surety agrees that no change, extension of time, alteration or addition to the terms of the Contract or to the work to be performed thereunder, or the specifications accompanying it shall in any way affect its obligations on this bond, and waives notice of any such change, extension of time, alteration or addition to the terms of the Contract or to the work, or to the specifications.

SIGNED AND SEALED this _____ day of _____, 20__.

(Name of Surety Company)

By _____
(Signature)

Its _____
(Title of Office)

(Name of Principal)

By _____
(Signature)

Its _____
(Title of Office)

Approved as to form:

Stephen K. Postema, City Attorney

Name and address of agent:

LABOR AND MATERIAL BOND

- (1) _____
of _____ (referred to as "Principal"), and _____, a corporation duly authorized to do business in the State of Michigan, (referred to as "Surety"), are bound to the City of Ann Arbor, Michigan (referred to as "City"), for the use and benefit of claimants as defined in Act 213 of Michigan Public Acts of 1963, as amended, being MCL 129.201 et seq., in the amount of \$ _____, for the payment of which Principal and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, by this bond.
- (2) The Principal has entered a written Contract with the City, dated _____, 2013, for _____
_____; and this bond is given for that Contract in compliance with Act No. 213 of the Michigan Public Acts of 1963 as amended;
- (3) If the Principal fails to promptly and fully repay claimants for labor and material reasonably required under the Contract, the Surety shall pay those claimants.
- (4) Surety's obligations shall not exceed the amount stated in paragraph 1, and Surety shall have no obligation if the Principal promptly and fully pays the claimants.

SIGNED AND SEALED this _____ day of _____, 2013.

(Name of Surety Company)
By _____
(Signature)
Its _____
(Title of Office)

(Name of Principal)
By _____
(Signature)
Its _____
(Title of Office)

Approved as to form:

Name and address of agent:

Stephen K. Postema, City Attorney

GENERAL CONDITIONS

Section 1 - Execution, Correlation and Intent of Documents

The contract documents shall be signed in 2 copies by the City and the Contractor.

The contract documents are complementary and what is called for by any one shall be binding. The intention of the documents is to include all labor and materials, equipment and transportation necessary for the proper execution of the work. Materials or work described in words which so applied have a well-known technical or trade meaning have the meaning of those recognized standards.

In case of a conflict among the contract documents listed below in any requirement(s), the requirement(s) of the document listed first shall prevail over any conflicting requirement(s) of a document listed later.

(1) Addenda in reverse chronological order; (2) Detailed Specifications; (3) Standard Specifications; (4) Plans; (5) General Conditions; (6) Contract; (7) Bid Forms; (8) Bond Forms; (9) Bid.

Section 2 - Order of Completion

The Contractor shall submit with each invoice, and at other times reasonably requested by the Supervising Professional, schedules showing the order in which the Contractor proposes to carry on the work. They shall include the dates at which the Contractor will start the several parts of the work, the estimated dates of completion of the several parts, and important milestones within the several parts.

Section 3 - Familiarity with Work

The Bidder or its representative shall make personal investigations of the site of the work and of existing structures and shall determine to its own satisfaction the conditions to be encountered, the nature of the ground, the difficulties involved, and all other factors affecting the work proposed under this Contract. The Bidder to whom this Contract is awarded will not be entitled to any additional compensation unless conditions are clearly different from those which could reasonably have been anticipated by a person making diligent and thorough investigation of the site.

The Bidder shall immediately notify the City upon discovery, and in every case prior to submitting its Bid, of every error or omission in the bidding documents that would be identified by a reasonably competent, diligent Bidder. In no case will a Bidder be allowed the benefit of extra compensation or time to complete the work under this Contract for extra expenses or time spent as a result of the error or omission.

Section 4 - Wage Requirements

Under this Contract, the Contractor shall conform to Chapter 14 of Title I of the Code of the City of Ann Arbor as amended; which in part states "...that all craftsmen, mechanics and laborers employed directly on the site in connection with said improvements, including said employees of subcontractors, shall receive the prevailing wage for the corresponding classes of craftsmen, mechanics and laborers, as determined by statistics for the Ann Arbor area compiled by the United States Department of Labor. At the request of the City, any contractor or subcontractor shall provide satisfactory proof of compliance with the contract provisions required by the Section."

Where the Contract and the Ann Arbor City Ordinance are silent as to definitions of terms required in determining contract compliance with regard to prevailing wages, the definitions provided in the Davis-Bacon Act as amended (40 U.S.C. 278-a to 276-a-7) for the terms shall be used.

Further, to the extent that any employees of the Contractor providing services under this contract are not part of the class of craftsmen, mechanics and laborers who receive a prevailing wage in conformance with Section 1:319 of Chapter 14 of Title I of the Code of the City of Ann Arbor, the Contractor agrees to conform to Chapter 23 of Title I of the Code of the City of Ann Arbor, as amended, which in part states:

1:814. Applicability.

f1: H\g'7\Udhf'g\U`Udd'mhc'Ubm'dYfgcb'hUh'g'UWbhfUMcf#V\XXY'cf'[fUbhYYUg'XYZ]bYX]bGYM]cb%, %hUhYa d'cng'cf'WbhfUMgk]h'Zj'Yf]Ecf'a'cfY]bXj]Xi'Ug'dfcj]XXZ' \ck'Yj'Yz' hUh' h\g' 7\Udhf' g\U` bch'Udd'm'hc' U' bcb!dfcZ]h'WbhfUMcf#V\XXY'cf' bcb!dfcZ]h' fUbhYYi' b'Ygg]hYa d'cng'cf'WbhfUMgk]h' h'b'fSL'cf'a'cfY]bXj]Xi'Ug"

f2: H\g'7\Udhf'g\U`Udd'mhc'Ubm]fUblz'WbhfUMz'cf'g'WbhfUMcf'ch'Yf'Z'fa'cZ'Z]bU]U'Ugg]g'U]bWUk'UFYX]hc'cf'YbhfYX]bhc'k]h'UWbhfUMcf#V\XXY'cf'[fUbhYY'UZM'h'Y'YZM]j'YXUH'cZ]h'g'7\Udhf'U'X'hc'h'Y'Y]h'bg]cb'cf'fYbYk'U'UZM'h'Y'YZM]j'YXUH'cZ]h'g'7\Udhf'cZ]bn]fUblz'WbhfUMz'cf'g'WbhfUMcf'ch'Yf'Z'fa'cZ'Z]bU]U'Ugg]g'U]bWUk]h'UWbhfUMcf#V\XXY'cf'[fUbhYY"

1:815. Living Wages Required.

f3: 9j'Yfm'WbhfUMcf#V\XXY'cf'[fUbhYYZ]Ug'XYZ]bYX]bGYM]cb%, %zg\U`dU]h]gWj'YfYX'Ya d'cnYg'U'lj]b[kU'YUg'Yg]U]g'YX]b'h]g'GYM]cb"

f4: :cf'UWj'YfYX'Ya d'cnYf'h'U]dfcj]XYg'Ya d'cnY'\YU'h'WfY'hc']lg'Ya d'cnYg'z'h'Y'lj]b[kU'Yg\U`V~%&) &Ub\ci'fzcf'h'YUX'i'g]XU'a'ci'bh'\YfYU]M'Yg]U]g'YX'ibXYf'GYM]cb%, %fl'E"

f5: :cf'UWj'YfYX'Ya d'cnYf'h'U]X'c'Yg'bch]dfcj]XY'\YU'h'WfY'hc']lg'Ya d'cnYg'z'h'Y'lj]b[kU'Yg\U`V~%"- *Ub\ci'fzcf'h'YUX'i'g]XU'a'ci'bh'\YfYU]M'Yg]U]g'YX'ibXYf'GYM]cb%, %fl'E"

f&L: =b'cfXYf'hc'ei U]Znhc'dUhh Y`lj]b['k U Y fUHY'Zcf'Wj FYX Ya d'cnmf'g dfcj]X]b[' Ya d'cnmY\YUH WfYi bXf'g VgW]cb%, % f&fLZUWj FYX Ya d'cnmf'g U`Z fb]g\ dfccZcZgU]X\YUH WfYWj YfU YUbXdUa Ybh YfZcf'hc'h Y7]m5Xa]b]gfUcf'cf' \]g# Yf'Xy]b]bY"

fl E: H YUa ci bhczh Y`lj]b['k U Y YgUV]g\ YX]b'h]gGWM]cb'g\ U`VYUX'i ghX'i dk UFX bc`UHf'h Ub'5df]'` Sz&SS&zUbXY YfmYUf'h YfYUZF VnUdYfWbhU YYei U'hc'h Y dYfWbhU Y]bWYUgZ]ZUbrz]b'h Y ZXYFU'dcj Yfm[i]XY]bYg'Ug'di V]g\ YX Vnh Y I b]hXGHUg'8YdUfa Ybhcz< YUH`UbX< i a Ub'GYf]Wg'Zcf'h YmUf'g&SS%UbX &SS&'G VgYei YbhUbi U'UX'i ga Yblg'g U`VYUgXi dcb'h YdYfWbhU Y]bWYUgZ]ZUbrz]b'h YI b]hXGHUg'8YdUfa Ybhcz< YUH`UbX< i a Ub'GYf]Wg'dcj Yfm [i]XY]bYg'k\Yb'Wa dUf]b['h Y df]cf'WYbXUf' mUf'g'cj Yfm[i]XY]bYg'hc'h Y dfYgYbh WYbXUf' mUf'g' [i]XY]bYg'" H Y Ud']WVY dYfWbhU Y Ua ci bhk]`VY Wbj YhX'hc' Ub'Ua ci bh]b'Wblg'Vma i 'hd'n]b['h Y Y]g]b['k U Y i bXY'GWM]cb' % % f&fLVngU]XdYfWbhU Yzcfi bX]b[i dk UFX'hc'h YbY hWblzUbXUX]b['h]g' Ua ci bhczWblg'hc'h Y Y]g]b['lj]b['k U Y `y Yg' YgUV]g\ YX i bXY' GWM]cbg' % % f&fL UbX% % f&fM`Df]cf'hc'5df]'%cZUW WYbXUf' mUf'zh Y7]mk]`bchZn UbmWj FYX Ya d'cnmf'czh]gUX'i ga YbhVndcg]b[Uk f]hYb bch]W]b Udfca]bYbhi d'UW]b'7]mk U`zUbXz]b'h Y WgY cZUWj FYX Ya d'cnmf'hc'h U\ Ug'dfcj]XX'Ub' UXXYg'cZfWfX'hc'h Y7]hazVnUk f]hYb`Yhf'hc'YUW'g W Wj FYX Ya d'cnmf"

Contractor agrees that all subcontracts entered into by the Contractor shall contain similar wage provision covering subcontractor's employees who perform work on this contract.

Section 5 - Non-Discrimination

The Contractor agrees to comply, and to require its subcontractor(s) to comply, with the nondiscrimination provisions of Section 209 of the Elliot-Larsen Civil Rights Act (MCL 37.2209). The Contractor further agrees to comply with the nondiscrimination provisions of Chapter 112 of the Ann Arbor City Code and to assure that applicants are employed and that employees are treated during employment in a manner which provides equal employment opportunity. The Contractor further agrees to comply with the provisions of Section 9:161 of Chapter 112 of the Ann Arbor City Code and in particular the following excerpts:

9:161 NONDISCRIMINATION BY CITY CONTRACTORS

- (1) All Contractors proposing to do business with the City of Ann Arbor shall satisfy the nondiscrimination administrative policy adopted by the City Administrator in accordance with the guidelines of this section. All Contractors shall receive approval from the Director prior to entering into a Contract with the City, unless specifically exempted by administrative policy. All City contractors shall take affirmative action to insure that applicants are employed and that employees are treated during employment in a manner which provides equal employment opportunity and tends to eliminate inequality based upon race, national origin or sex.
- (2) Each prospective Contractor shall submit to the City data showing current total employment by occupational category, sex and minority group. If, after verifying this data, the Director concludes that it indicates total minority and female employment commensurate with their availability within the Contractor's labor recruitment area, i.e., the area from which the Contractor can reasonably be expected to recruit, said contractor shall be accepted by the

Director as having fulfilled affirmative action requirements for a period of one year at which time the Director shall conduct another review. Other Contractors shall develop an affirmative action program in conjunction with the Director. Said program shall include specific goals and timetables for the hiring and promotion of minorities and females. Said goals shall reflect the availability of minorities and females within the contractor's labor recruitment area. In the case of construction contractors, the Director shall use for employment verification the labor recruitment area of the Ann Arbor-Ypsilanti standard metropolitan statistical area. Construction contractors determined to be in compliance shall be accepted by the Director as having fulfilled affirmative action requirements for a period of six (6) months at which time the Director shall conduct another review.

- (3) In hiring for construction projects, contractors shall make good faith efforts to employ local persons, so as to enhance the local economy.
- (4) All contracts shall include provisions through which the contractor agrees, in addition to any other applicable Federal or State labor laws:
 - (a) To set goals, in conference with the Human Resources Director, for each job category or division of the work force used in the completion of the City work;
 - (b) To provide periodic reports concerning the progress the Contractor has made in meeting the affirmative action goals it has agreed to;
 - (c) To permit the Director access to all books, records and accounts pertaining to its employment practices for the purpose of determining compliance with the affirmative action requirements.
- (5) The Director shall monitor the compliance of each contractor with the nondiscrimination provisions of each Contract. The Director shall develop procedures and regulations consistent with the administrative policy adopted by the City Administrator for notice and enforcement of non-compliance. Such procedures and regulations shall include a provision for the posting of Contractors not in compliance.
- (6) All City Contracts shall provide further that breach of the obligation not to discriminate shall be a material breach of the Contract for which the City shall be entitled, at its option, to do any or all of the following:
 - (a) To cancel, terminate, or suspend the Contract in whole or part and/or refuse to make any required periodic payments under the Contract;
 - (b) Declare the Contractor ineligible for the award of any future Contracts with the City for a specified length of time;
 - (c) To recover liquidated damages of a specified sum, said sum to be that percentage of the labor expenditure for the time period involved which would have accrued to minority group members had the affirmative action not been breached;

(d) Impose for each day of non-compliance, liquidated damages of a specified sum, based upon the following schedule:

<u>Contract Amount</u>	<u>Assessed Damages Per Day of Non-Compliance</u>
\$ 10,000 - 24,999	\$ 25.00
25,000 - 99,999	50.00
100,000 - 199,999	100.00
200,000 - 499,999	150.00
500,000 - 1,499,999	200.00
1,500,000 - 2,999,999	250.00
3,000,000 - 4,999,999	300.00
5,000,000 - and above	500.00

(e) In addition the Contractor shall be liable for any costs or expenses incurred by the City of Ann Arbor in obtaining from other sources the work and services to be rendered or performed or the goods or properties to be furnished or delivered to the City under this contract.

Section 6 - Materials, Appliances, Employees

Unless otherwise stipulated, the Contractor shall provide and pay for all materials, labor, water, tools, equipment, light, power, transportation, and other facilities necessary or used for the execution and completion of the work. Unless otherwise specified, all materials incorporated in the permanent work shall be new, and both workmanship and materials shall be of the highest quality. The Contractor shall, if required, furnish satisfactory evidence as to the kind and quality of materials.

The Contractor shall at all times enforce strict discipline and good order among its employees, and shall seek to avoid employing on the work any unfit person or anyone not skilled in the work assigned.

Adequate sanitary facilities shall be provided by the Contractor.

Section 7 - Qualifications for Employment

The Contractor shall employ competent laborers and mechanics for the work under this Contract. For work performed under this Contract, employment preference shall be given to qualified local residents.

Section 8 - Royalties and Patents

The Contractor shall pay all royalties and license fees. It shall defend all suits or claims for infringements of any patent rights and shall hold the City harmless from loss on account of infringement except that the City shall be responsible for all infringement loss when a particular process or the product of a particular manufacturer or manufacturers is specified, unless the City has notified the Contractor prior to the signing of the Contract that the particular process or product is patented or is believed to be patented.

Section 9 - Permits and Regulations

The Contractor must secure and pay for all permits, permit or plan review fees and licenses necessary for the prosecution of the work. These include but are not limited to City building permits, right-of-way permits, lane closure permits, right-of-way occupancy permits, and the like. The City shall secure and pay for easements shown on the plans unless otherwise specified.

The Contractor shall give all notices and comply with all laws, ordinances, rules and regulations bearing on the conduct of the work as drawn and specified. If the Contractor observes that the contract documents are at variance with those requirements, it shall promptly notify the Supervising Professional in writing, and any necessary changes shall be adjusted as provided in the Contract for changes in the work.

Section 10 - Protection of the Public and of Work and Property

The Contractor is responsible for the means, methods, sequences, techniques and procedures of construction and safety programs associated with the work contemplated by this contract. The Contractor, its agents or sub-contractors, shall comply with the "General Rules and Regulations for the Construction Industry" as published by the Construction Safety Commission of the State of Michigan and to all other local, State and National laws, ordinances, rules and regulations pertaining to safety of persons and property.

The Contractor shall take all necessary and reasonable precautions to protect the safety of the public. It shall continuously maintain adequate protection of all work from damage, and shall take all necessary and reasonable precautions to adequately protect all public and private property from injury or loss arising in connection with this Contract. It shall make good any damage, injury or loss to its work and to public and private property resulting from lack of reasonable protective precautions, except as may be due to errors in the contract documents, or caused by agents or employees of the City. The Contractor shall obtain and maintain sufficient insurance to cover damage to any City property at the site by any cause.

In an emergency affecting the safety of life, or the work, or of adjoining property, the Contractor is, without special instructions or authorization from the Supervising Professional, permitted to act at its discretion to prevent the threatened loss or injury. It shall also so act, without appeal, if authorized or instructed by the Supervising Professional.

Any compensation claimed by the Contractor for emergency work shall be determined by agreement or in accordance with the terms of Claims for Extra Cost - Section 15.

Section 11 - Inspection of Work

The City shall provide sufficient competent personnel for the inspection of the work.

The Supervising Professional shall at all times have access to the work whenever it is in preparation or progress, and the Contractor shall provide proper facilities for access and for inspection.

If the specifications, the Supervising Professional's instructions, laws, ordinances, or any public authority require any work to be specially tested or approved, the Contractor shall give the Supervising Professional timely notice of its readiness for inspection, and if the inspection is by an

authority other than the Supervising Professional, of the date fixed for the inspection. Inspections by the Supervising Professional shall be made promptly, and where practicable at the source of supply. If any work should be covered up without approval or consent of the Supervising Professional, it must, if required by the Supervising Professional, be uncovered for examination and properly restored at the Contractor's expense.

Re-examination of any work may be ordered by the Supervising Professional, and, if so ordered, the work must be uncovered by the Contractor. If the work is found to be in accordance with the contract documents, the City shall pay the cost of re-examination and replacement. If the work is not in accordance with the contract documents, the Contractor shall pay the cost.

Section 12 - Superintendence

The Contractor shall keep on the work site, during its progress, a competent superintendent and any necessary assistants, all satisfactory to the Supervising Professional. The superintendent will be responsible to perform all on-site project management for the Contractor. The superintendent shall be experienced in the work required for this Contract. The superintendent shall represent the Contractor and all direction given to the superintendent shall be binding as if given to the Contractor. Important directions shall immediately be confirmed in writing to the Contractor. Other directions will be confirmed on written request. The Contractor shall give efficient superintendence to the work, using its best skill and attention.

Section 13 - Changes in the Work

The City may make changes to the quantities of work within the general scope of the Contract at any time by a written order and without notice to the sureties. If the changes add to or deduct from the extent of the work, the Contract Sum shall be adjusted accordingly. All the changes shall be executed under the conditions of the original Contract except that any claim for extension of time caused by the change shall be adjusted at the time of ordering the change.

In giving instructions, the Supervising Professional shall have authority to make minor changes in the work not involving extra cost and not inconsistent with the purposes of the work, but otherwise, except in an emergency endangering life or property, no extra work or change shall be made unless in pursuance of a written order by the Supervising Professional, and no claim for an addition to the Contract Sum shall be valid unless the additional work was ordered in writing.

The Contractor shall proceed with the work as changed and the value of the work shall be determined as provided in Claims for Extra Cost - Section 15.

Section 14 - Extension of Time

Extension of time stipulated in the Contract for completion of the work will be made if and as the Supervising Professional may deem proper under any of the following circumstances:

- (1) When work under an extra work order is added to the work under this Contract;
- (2) When the work is suspended as provided in Section 20;
- (3) When the work of the Contractor is delayed on account of conditions which could not have been foreseen, or which were beyond the control of the Contractor, and which were not the

result of its fault or negligence;

- (4) Delays in the progress of the work caused by any act or neglect of the City or of its employees or by other Contractors employed by the City;
- (5) Delay due to an act of Government;
- (6) Delay by the Supervising Professional in the furnishing of plans and necessary information;
- (7) Other cause which in the opinion of the Supervising Professional entitles the Contractor to an extension of time.

The Contractor shall notify the Supervising Professional within 7 days of an occurrence or conditions which, in the Contractor's opinion, entitle it to an extension of time. The notice shall be in writing and submitted in ample time to permit full investigation and evaluation of the Contractor's claim. The Supervising Professional shall acknowledge receipt of the Contractor's notice within 7 days of its receipt. Failure to timely provide the written notice shall constitute a waiver by the Contractor of any claim.

In situations where an extension of time in contract completion is appropriate under this or any other section of the contract, the Contractor understands and agrees that the only available adjustment for events that cause any delays in contract completion shall be extension of the required time for contract completion and that there shall be no adjustments in the money due the Contractor on account of the delay.

Section 15 - Claims for Extra Cost

If the Contractor claims that any instructions by drawings or other media issued after the date of the Contract involved extra cost under this Contract, it shall give the Supervising Professional written notice within 7 days after the receipt of the instructions, and in any event before proceeding to execute the work, except in emergency endangering life or property. The procedure shall then be as provided for Changes in the Work-Section 13. No claim shall be valid unless so made.

If the Supervising Professional orders, in writing, the performance of any work not covered by the contract documents, and for which no item of work is provided in the Contract, and for which no unit price or lump sum basis can be agreed upon, then the extra work shall be done on a Cost-Plus-Percentage basis of payment as follows:

- (1) The Contractor shall be reimbursed for all reasonable costs incurred in doing the work, and shall receive an additional payment of 15% of all the reasonable costs to cover both its indirect overhead costs and profit;
- (2) The term "Cost" shall cover all payroll charges for employees and supervision required under the specific order, together with all worker's compensation, Social Security, pension and retirement allowances and social insurance, or other regular payroll charges on same; the cost of all material and supplies required of either temporary or permanent character; rental of all power-driven equipment at agreed upon rates, together with cost of fuel and supply charges for the equipment; and any costs incurred by the Contractor as a direct result of executing the order, if approved by the Supervising Professional;

- (3) If the extra is performed under subcontract, the subcontractor shall be allowed to compute its charges as described above. The Contractor shall be permitted to add an additional charge of 5% percent to that of the subcontractor for the Contractor's supervision and contractual responsibility;
- (4) The quantities and items of work done each day shall be submitted to the Supervising Professional in a satisfactory form on the succeeding day, and shall be approved by the Supervising Professional and the Contractor or adjusted at once;
- (5) Payments of all charges for work under this Section in any one month shall be made along with normal progress payments. Retainage shall be in accordance with Progress Payments-Section 16.

No additional compensation will be provided for additional equipment, materials, personnel, overtime or special charges required to perform the work within the time requirements of the Contract.

When extra work is required and no suitable price for machinery and equipment can be determined in accordance with this Section, the hourly rate paid shall be 1/40 of the basic weekly rate listed in the Rental Rate Blue Book published by Dataquest Incorporated and applicable to the time period the equipment was first used for the extra work. The hourly rate will be deemed to include all costs of operation such as bucket or blade, fuel, maintenance, "regional factors", insurance, taxes, and the like, but not the costs of the operator.

Section 16 - Progress Payments

The Contractor shall submit each month, or at longer intervals, if it so desires, an invoice covering work performed for which it believes payment, under the Contract terms, is due. The submission shall be to the City's Finance Department - Accounting Division. The Supervising Professional will, within 10 days following submission of the invoice, prepare a certificate for payment for the work in an amount to be determined by the Supervising Professional as fairly representing the acceptable work performed during the period covered by the Contractor's invoice. To insure the proper performance of this Contract, the City will retain a percentage of the estimate in accordance with Act 524, Public Acts of 1980. The City will then, following the receipt of the Supervising Professional's Certificate, make payment to the Contractor as soon as feasible, which is anticipated will be within 15 days.

An allowance may be made in progress payments if substantial quantities of permanent material have been delivered to the site but not incorporated in the completed work if the Contractor, in the opinion of the Supervising Professional, is diligently pursuing the work under this Contract. Such materials shall be properly stored and adequately protected. Allowance in the estimate shall be at the invoice price value of the items. Notwithstanding any payment of any allowance, all risk of loss due to vandalism or any damages to the stored materials remains with the Contractor.

In the case of Contracts which include only the Furnishing and Delivering of Equipment, the payments shall be; 60% of the Contract Sum upon the delivery of all equipment to be furnished, or in the case of delivery of a usable portion of the equipment in advance of the total equipment delivery, 60% of the estimated value of the portion of the equipment may be paid upon its delivery in advance of the time of the remainder of the equipment to be furnished; 30% of the Contract Sum upon completion of erection of all equipment furnished, but not later than 60 days after the date of delivery

of all of the equipment to be furnished; and payment of the final 10% on final completion of erection, testing and acceptance of all the equipment to be furnished; but not later than 180 days after the date of delivery of all of the equipment to be furnished, unless testing has been completed and shows the equipment to be unacceptable.

With each invoice for periodic payment, the Contractor shall enclose a Contractor's Declaration - Section 43, and an updated project schedule per Order of Completion - Section 2.

Section 17 - Deductions for Uncorrected Work

If the Supervising Professional decides it is inexpedient to correct work that has been damaged or that was not done in accordance with the Contract, an equitable deduction from the Contract price shall be made.

Section 18 - Correction of Work Before Final Payment

The Contractor shall promptly remove from the premises all materials condemned by the Supervising Professional as failing to meet Contract requirements, whether incorporated in the work or not, and the Contractor shall promptly replace and re-execute the work in accordance with the Contract and without expense to the City and shall bear the expense of making good all work of other contractors destroyed or damaged by the removal or replacement.

If the Contractor does not remove the condemned work and materials within 10 days after written notice, the City may remove them and, if the removed material has value, may store the material at the expense of the Contractor. If the Contractor does not pay the expense of the removal within 10 days thereafter, the City may, upon 10 days written notice, sell the removed materials at auction or private sale and shall pay to the Contractor the net proceeds, after deducting all costs and expenses that should have been borne by the Contractor. If the removed material has no value, the Contractor must pay the City the expenses for disposal within 10 days of invoice for the disposal costs.

The inspection or lack of inspection of any material or work pertaining to this Contract shall not relieve the Contractor of its obligation to fulfill this Contract and defective work shall be made good. Unsuitable materials may be rejected by the Supervising Professional notwithstanding that the work and materials have been previously overlooked by the Supervising Professional and accepted or estimated for payment or paid for. If the work or any part shall be found defective at any time before the final acceptance of the whole work, the Contractor shall forthwith make good the defect in a manner satisfactory to the Supervising Professional. The judgment and the decision of the Supervising Professional as to whether the materials supplied and the work done under this Contract comply with the requirements of the Contract shall be conclusive and final.

Section 19 - Acceptance and Final Payment

Upon receipt of written notice that the work is ready for final inspection and acceptance, the Supervising Professional will promptly make the inspection. When the Supervising Professional finds the work acceptable under the Contract and the Contract fully performed, the Supervising Professional will promptly sign and issue a final certificate stating that the work required by this Contract has been completed and is accepted by the City under the terms and conditions of the Contract. The entire balance found to be due the Contractor, including the retained percentage, shall be paid to the Contractor by the City within 30 days after the date of the final certificate.

Before issuance of final certificates, the Contractor shall file with the City:

- (1) The consent of the surety to payment of the final estimate;
- (2) The Contractor's Affidavit in the form required by Section 44.

In case the Affidavit or consent is not furnished, the City may retain out of any amount due the Contractor, sums sufficient to cover all lienable claims.

The making and acceptance of the final payment shall constitute a waiver of all claims by the City except those arising from:

- (1) unsettled liens;
- (2) faulty work appearing within 12 months after final payment;
- (3) hidden defects in meeting the requirements of the plans and specifications;
- (4) manufacturer's guarantees.

It shall also constitute a waiver of all claims by the Contractor, except those previously made and still unsettled.

Section 20 - Suspension of Work

The City may at any time suspend the work, or any part by giving 5 days notice to the Contractor in writing. The work shall be resumed by the Contractor within 10 days after the date fixed in the written notice from the City to the Contractor to do so. The City shall reimburse the Contractor for expense incurred by the Contractor in connection with the work under this Contract as a result of the suspension.

If the work, or any part, shall be stopped by the notice in writing, and if the City does not give notice in writing to the Contractor to resume work at a date within 90 days of the date fixed in the written notice to suspend, then the Contractor may abandon that portion of the work suspended and will be entitled to the estimates and payments for all work done on the portions abandoned, if any, plus 10% of the value of the work abandoned, to compensate for loss of overhead, plant expense, and anticipated profit.

Section 21 - Delays and the City's Right to Terminate Contract

If the Contractor refuses or fails to prosecute the work, or any separate part of it, with the diligence required to insure completion, ready for operation, within the allowable number of consecutive calendar days specified plus extensions, or fails to complete the work within the required time, the City may, by written notice to the Contractor, terminate its right to proceed with the work or any part of the work as to which there has been delay. After providing the notice the City may take over the work and prosecute it to completion, by contract or otherwise, and the Contractor and its sureties shall be liable to the City for any excess cost to the City. If the Contractor's right to proceed is terminated, the City may take possession of and utilize in completing the work, any materials, appliances and plant as may be on the site of the work and useful for completing the work. The right of the Contractor to proceed shall not be terminated or the Contractor charged with liquidated damages where an extension of time is granted under Extension of Time - Section 14.

If the Contractor is adjudged a bankrupt, or if it makes a general assignment for the benefit of creditors, or if a receiver is appointed on account of its insolvency, or if it persistently or repeatedly refuses or fails except in cases for which extension of time is provided, to supply enough properly skilled workers or proper materials, or if it fails to make prompt payments to subcontractors or for material or labor, or persistently disregards laws, ordinances or the instructions of the Supervising Professional, or otherwise is guilty of a substantial violation of any provision of the Contract, then the City, upon the certificate of the Supervising Professional that sufficient cause exists to justify such action, may, without prejudice to any other right or remedy and after giving the Contractor 3 days written notice, terminate this Contract. The City may then take possession of the premises and of all materials, tools and appliances thereon and without prejudice to any other remedy it may have, make good the deficiencies or finish the work by whatever method it may deem expedient, and deduct the cost from the payment due the Contractor. The Contractor shall not be entitled to receive any further payment until the work is finished. If the expense of finishing the work, including compensation for additional managerial and administrative services exceeds the unpaid balance of the Contract Sum, the Contractor and its surety are liable to the City for any excess cost incurred. The expense incurred by the City, and the damage incurred through the Contractor's default, shall be certified by the Supervising Professional.

Section 22 - Contractor's Right to Terminate Contract

If the work should be stopped under an order of any court, or other public authority, for a period of 3 months, through no act or fault of the Contractor or of anyone employed by it, then the Contractor may, upon 7 days written notice to the City, terminate this Contract and recover from the City payment for all acceptable work executed plus reasonable profit.

Section 23 - City's Right To Do Work

If the Contractor should neglect to prosecute the work properly or fail to perform any provision of this Contract, the City, 3 days after giving written notice to the Contractor and its surety may, without prejudice to any other remedy the City may have, make good the deficiencies and may deduct the cost from the payment due to the Contractor.

Section 24 - Removal of Equipment and Supplies

In case of termination of this Contract before completion, from any or no cause, the Contractor, if notified to do so by the City, shall promptly remove any part or all of its equipment and supplies from the property of the City, failing which the City shall have the right to remove the equipment and supplies at the expense of the Contractor.

The removed equipment and supplies may be stored by the City and, if all costs of removal and storage are not paid by the Contractor within 10 days of invoicing, the City upon 10 days written notice may sell the equipment and supplies at auction or private sale, and shall pay the Contractor the net proceeds after deducting all costs and expenses that should have been borne by the Contractor and after deducting all amounts claimed due by any lien holder of the equipment or supplies.

Section 25 - Responsibility for Work and Warranties

The Contractor assumes full responsibility for any and all materials and equipment used in the construction of the work and may not make claims against the City for damages to materials and equipment from any cause except negligence or willful act of the City. Until its final acceptance, the

Contractor shall be responsible for damage to or destruction of the project (except for any part covered by Partial Completion and Acceptance - Section 26). The Contractor shall make good all work damaged or destroyed before acceptance. All risk of loss remains with the Contractor until final acceptance of the work (Section 19) or partial acceptance (Section 26). The Contractor is advised to investigate obtaining its own builders risk insurance.

The Contractor shall guarantee the quality of the work for a period of one year. The Contractor shall also unconditionally guarantee the quality of all equipment and materials that are furnished and installed under the contract for a period of one year. At the end of one year after the Contractor's receipt of final payment, the complete work, including equipment and materials furnished and installed under the contract, shall be inspected by the Contractor and the Supervising Professional. Any defects shall be corrected by the Contractor at its expense as soon as practicable but in all cases within 60 days. Any defects that are identified prior to the end of one year shall also be inspected by the Contractor and the Supervising Professional and shall be corrected by the Contractor at its expense as soon as practicable but in all cases within 60 days.

The Contractor shall assign all manufacturer or material supplier warranties to the City prior to final payment. The assignment shall not relieve the Contractor of its obligations under this paragraph to correct defects.

Section 26 - Partial Completion and Acceptance

If at any time prior to the issuance of the final certificate referred to in Acceptance and Final Payment - Section 19, any portion of the permanent construction has been satisfactorily completed, and if the Supervising Professional determines that portion of the permanent construction is not required for the operations of the Contractor but is needed by the City, the Supervising Professional shall issue to the Contractor a certificate of partial completion, and immediately the City may take over and use the portion of the permanent construction described in the certificate, and exclude the Contractor from that portion.

The issuance of a certificate of partial completion shall not constitute an extension of the Contractor's time to complete the portion of the permanent construction to which it relates if the Contractor has failed to complete it in accordance with the terms of this Contract. The issuance of the certificate shall not release the Contractor or its sureties from any obligations under this Contract including bonds.

If prior use increases the cost of, or delays the work, the Contractor shall be entitled to extra compensation, or extension of time, or both, as the Supervising Professional may determine.

Section 27 - Payments Withheld Prior to Final Acceptance of Work

The City may withhold or, on account of subsequently discovered evidence, nullify the whole or part of any certificate to the extent reasonably appropriate to protect the City from loss on account of:

- (1) Defective work not remedied;
- (2) Claims filed or reasonable evidence indicating probable filing of claims by other parties against the Contractor;

- (3) Failure of the Contractor to make payments properly to subcontractors or for material or labor;
- (4) Damage to another Contractor.

When the above grounds are removed or the Contractor provides a Surety Bond satisfactory to the City which will protect the City in the amount withheld, payment shall be made for amounts withheld under this section.

Section 28 - Contractor's Insurance

A. The Contractor shall procure and maintain during the life of this Contract, including the guarantee period and during any warranty work, such insurance policies, including those set forth below, as will protect itself from all claims for bodily injuries, death or property damage which may arise under this Contract; whether the acts were made by the Contractor or by any subcontractor or anyone employed by them directly or indirectly. The following insurance policies are required:

1. Worker's Compensation Insurance in accordance with all applicable state and federal statutes. Further, Employers Liability Coverage shall be obtained in the following minimum amounts:

Bodily Injury by Accident - \$500,000 each accident
Bodily Injury by Disease - \$500,000 each employee
Bodily Injury by Disease - \$500,000 each policy limit

2. Commercial General Liability Insurance equivalent to, as a minimum, Insurance Services Office form CG 00 01 07 98. The City of Ann Arbor shall be named as an additional insured. There shall be no added exclusions or limiting endorsements including, but not limited to: Products and Completed Operations, Explosion, Collapse and Underground coverage or Pollution. Further, the following minimum limits of liability are required:

\$1,000,000 Each occurrence as respect Bodily Injury Liability or Property Damage Liability, or both combined.

\$2,000,000 Per Job General Aggregate

\$1,000,000 Personal and Advertising Injury

\$2,000,000 Products and Completed Operations Aggregate

3. Motor Vehicle Liability Insurance, including Michigan No-Fault Coverages, equivalent to, as a minimum, Insurance Services Office form CA 00 01 07 97. The City of Ann Arbor shall be named as an additional insured. There shall be no added exclusions or limiting endorsements. Coverage shall include all owned vehicles, all non-owned vehicles and all hired vehicles. Further, the limits of liability shall be \$1,000,000 for each occurrence as respects Bodily Injury Liability or Property Damage Liability, or both combined.

4. Umbrella/Excess Liability Insurance shall be provided to apply excess of the Commercial General Liability, Employers Liability and the Motor Vehicle coverage enumerated above, for each occurrence and for aggregate in the amount of \$3,000,000.
- B. Insurance required under Section A.2 and A.3 of this Contract shall be considered primary as respects any other valid or collectible insurance that the City may possess, including any self-insured retentions the City may have; and any other insurance the City does possess shall be considered excess insurance only and shall not be required to contribute with this insurance. Further, the Contractor agrees to waive any right of recovery by its insurer against the City.
 - C. In the case of all Contracts involving on-site work, the Contractor shall provide to the City before the commencement of any work under this Contract documentation demonstrating it has obtained the above mentioned policies. Documentation must provide and demonstrate an unconditional 30 day written notice of cancellation in favor of the City of Ann Arbor. Further, the documentation must explicitly state the following: (a) the policy number; name of insurance company; name and address of the agent or authorized representative; name and address of insured; project name; policy expiration date; and specific coverage amounts; (b) any deductibles or self-insured retentions which shall be approved by the City, in its sole discretion; (c) that the policy conforms to the requirements specified. An original certificate of insurance may be provided as an initial indication of the required insurance, provided that no later than 21 calendar days after commencement of any work the Contractor supplies a copy of the endorsements required on the policies. Upon request, the Contractor shall provide within 30 days a copy of the policy(ies) to the City. If any of the above coverages expire by their terms during the term of this Contract, the Contractor shall deliver proof of renewal and/or new policies to the Administering Service Area/Unit at least ten days prior to the expiration date.
 - D. Any Insurance provider of Contractor shall be admitted and authorized to do business in the State of Michigan and shall carry and maintain a minimum rating assigned by A.M. Best & Company's Key Rating Guide of "A-" Overall and a minimum Financial Size Category of "V". Insurance policies and certificates issued by non-admitted insurance companies are not acceptable unless approved in writing by the City.

Section 29 - Surety Bonds

Bonds will be required from the successful bidder as follows:

- (1) A Performance Bond to the City of Ann Arbor for the amount of the bid(s) accepted;
- (2) A Labor and Material Bond to the City of Ann Arbor for the amount of the bid(s) accepted.

Bonds shall be executed on forms supplied by the City in a manner and by a Surety Company satisfactory to the City Attorney.

Section 30 - Damage Claims

The Contractor shall be held responsible for all damages to property of the City or others, caused by or resulting from the negligence of the Contractor, its employees, or agents during the progress of or connected with the prosecution of the work, whether within the limits of the work or elsewhere. The Contractor must restore all property injured including sidewalks, curbing, sodding, pipes, conduit, sewers or other public or private property to not less than its original condition with new work.

Section 31 - Refusal to Obey Instructions

If the Contractor refuses to obey the instructions of the Supervising Professional, the Supervising Professional shall withdraw inspection from the work, and no payments will be made for work performed thereafter nor may work be performed thereafter until the Supervising Professional shall have again authorized the work to proceed.

Section 32 - Assignment

Neither party to the Contract shall assign the Contract without the written consent of the other. The Contractor may assign any monies due to it to a third party acceptable to the City.

Section 33 - Rights of Various Interests

Whenever work being done by the City's forces or by other contractors is contiguous to work covered by this Contract, the respective rights of the various interests involved shall be established by the Supervising Professional, to secure the completion of the various portions of the work in general harmony.

The Contractor is responsible to coordinate all aspects of the work, including coordination of, and with, utility companies and other contractors whose work impacts this project.

Section 34 - Subcontracts

The Contractor shall not award any work to any subcontractor without prior written approval of the City. The approval will not be given until the Contractor submits to the City a written statement concerning the proposed award to the subcontractor. The statement shall contain all information the City may require.

The Contractor shall be as fully responsible to the City for the acts and omissions of its subcontractors, and of persons either directly or indirectly employed by them, as it is for the acts and omissions of persons directly employed by it.

The Contractor shall cause appropriate provisions to be inserted in all subcontracts relative to the work to bind subcontractors to the Contractor by the terms of the General Conditions and all other contract documents applicable to the work of the subcontractors and to give the Contractor the same power to terminate any subcontract that the City may exercise over the Contractor under any provision of the contract documents.

Nothing contained in the contract documents shall create any contractual relation between any subcontractor and the City.

Section 35 - Supervising Professional's Status

The Supervising Professional has the right to inspect any or all work. The Supervising Professional has authority to stop the work whenever stoppage may be appropriate to insure the proper execution of the Contract. The Supervising Professional has the authority to reject all work and materials which do not conform to the Contract and to decide questions which arise in the execution of the work.

The Supervising Professional shall make all measurements and determinations of quantities. Those measurements and determinations are final and conclusive between the parties.

Section 36 - Supervising Professional's Decisions

The Supervising Professional shall, within a reasonable time after their presentation to the Supervising Professional, make decisions in writing on all claims of the City or the Contractor and on all other matters relating to the execution and progress of the work or the interpretation of the contract documents.

Section 37 - Storing Materials and Supplies

Materials and supplies may be stored at the site of the work at locations agreeable to the City unless specific exception is listed elsewhere in these documents. Ample way for foot traffic and drainage must be provided, and gutters must, at all times, be kept free from obstruction. Traffic on streets shall be interfered with as little as possible. The Contractor may not enter or occupy with agents, employees, tools, or material any private property without first obtaining written permission from its owner. A copy of the permission shall be furnished to the Supervising Professional.

Section 38 - Lands for Work

The Contractor shall provide, at its own expense and without liability to the City, any additional land and access that may be required for temporary construction facilities or for storage of materials.

Section 39 - Cleaning Up

The Contractor shall, as directed by the Supervising Professional, remove at its own expense from the City's property and from all public and private property all temporary structures, rubbish and waste materials resulting from its operations unless otherwise specifically approved, in writing, by the Supervising Professional.

Section 40 - Salvage

The Supervising Professional may designate for salvage any materials from existing structures or underground services. Materials so designated remain City property and shall be transported or stored at a location as the Supervising Professional may direct.

Section 41 - Night, Saturday or Sunday Work

No night or Sunday work (without prior written City approval) will be permitted except in the case of an emergency and then only to the extent absolutely necessary. The City may allow night work which, in the opinion of the Supervising Professional, can be satisfactorily performed at night. Night

work is any work between 8:00 p.m. and 7:00 a.m. No Saturday work will be permitted unless the Contractor gives the Supervising Professional at least 48 hours but not more than 5 days notice of the Contractor's intention to work the upcoming Saturday.

Section 42 - Sales Taxes

Under State law the City is exempt from the assessment of State Sales Tax on its direct purchases. Contractors who acquire materials, equipment, supplies, etc. for incorporation in City projects are not likewise exempt. State Law shall prevail. The Bidder shall familiarize itself with the State Law and prepare its Bid accordingly. No extra payment will be allowed under this Contract for failure of the Contractor to make proper allowance in this bid for taxes it must pay.

Section 43

CONTRACTOR'S DECLARATION

I hereby declare that I have not, during the period _____, 20___, to _____, 20___, performed any work, furnished any materials, sustained any loss, damage or delay, or otherwise done anything in addition to the regular items (or executed change orders) set forth in the Contract titled Barton and South Industrial Pump Stations Electrical Improvements, for which I shall ask, demand, sue for, or claim compensation or extension of time from the City, except as I hereby make claim for additional compensation or extension of time as set forth on the attached itemized statement. I further declare that I have paid all payroll obligations related to this Contract that have become due during the above period and that all invoices related to this Contract received more than 30 days prior to this declaration have been paid in full except as listed below.

There is/is not (Contractor please circle one and strike one as appropriate) an itemized statement attached regarding a request for additional compensation or extension of time.

Contractor

Date

By _____
(Signature)

Its _____
(Title of Office)

Past due invoices, if any, are listed below.

Section 44

CONTRACTOR'S AFFIDAVIT

The undersigned Contractor, _____, represents that on _____, 20___, it was awarded a contract by the City of Ann Arbor, Michigan to _____ under the terms and conditions of a Contract titled Barton and South Industrial Pump Stations Electrical Improvements. The Contractor represents that all work has now been accomplished and the Contract is complete.

The Contractor warrants and certifies that all of its indebtedness arising by reason of the Contract has been fully paid or satisfactorily secured; and that all claims from subcontractors and others for labor and material used in accomplishing the project, as well as all other claims arising from the performance of the Contract, have been fully paid or satisfactorily settled. The Contractor agrees that, if any claim should hereafter arise, it shall assume responsibility for it immediately upon request to do so by the City of Ann Arbor.

The Contractor, for valuable consideration received, does further waive, release and relinquish any and all claims or right of lien which the Contractor now has or may acquire upon the subject premises for labor and material used in the project owned by the City of Ann Arbor.

This affidavit is freely and voluntarily given with full knowledge of the facts.

Contractor

Date

By _____
(Signature)

Its _____
(Title of Office)

Subscribed and sworn to before me, on this ____ day of _____, 20__
_____, _____ County, Michigan

Notary Public

County, MI
My commission expires on:

STANDARD SPECIFICATIONS

All work under this contract shall be performed in accordance with the Public Services Department Standard Specifications in effect at the date of availability of the contract documents stipulated in the Advertisement. All work under this Contract which is not included in these Standard Specifications, or which is performed using modifications to these Standard Specifications, shall be performed in accordance with the Detailed Specifications included in these contract documents.

A copy of the Public Services Department Standard Specifications may be purchased from the Engineering Division, (Fourth Floor, City Hall, Ann Arbor, Michigan), for \$35.00 per copy. In addition, a copy of these Standard Specifications is available for public viewing at the Engineering Division office, for review Monday through Friday between the hours of 8:30 a.m. and 4:00 p.m. Copies of the Standard Specifications can also be downloaded from the web link:

http://www.a2gov.org/government/publicservices/project_management/privatedev/pages/standardspecificationsbook.aspx.

SUPPLEMENTAL CONDITIONS

1. In addition to the requirements of the General Conditions, Section 28 – Contractor's Insurance, include the following requirements:
 - a. The CONTRACTOR shall purchase for the OWNER an OWNER's Protective Liability policy to protect the OWNER, the ENGINEER, their consultants, agents, employees, and such public corporations in whose jurisdiction the work is located for their contingent liability for work performed by the CONTRACTOR, the Subcontractor(s), and the Sub-subcontractor(s) under this Contract.
 - b. The CONTRACTOR shall purchase a Builder's Risk-Installation Floater in a form acceptable to the OWNER covering property of the Project for the full cost of replacement as of the time of any loss which shall include as named insureds:
 - i. The CONTRACTOR;
 - ii. All Subcontractors;
 - iii. All Sub-subcontractors;
 - iv. The OWNER, the ENGINEER, and their consultant(s), agents and employees.

DETAILED SPECIFICATIONS

SECTION 01010

SUMMARY OF WORK

PART 1 – GENERAL

1.1 SUMMARY OF WORK

- A. Work to be done includes the demolition, construction, startup, and testing of electrical improvements at the Barton Pump Station and the South Industrial Booster Station. The project will include new transformers, switchboards, soft starts, motors, instrumentation, controls and related work. Other improvements include masonry improvements, doors and windows installation, painting, concrete work, construction of a pre-engineered storage building, mechanical improvements, and all other related work
- B. The principal features of the Work to be performed under this Contract are:

SINGLE PRIME CONTRACT: Includes furnishing and installing facilities as described in the Contract Documents including the electrical improvements to the Barton Pump Station and South Industrial Pump Station, miscellaneous architectural, structural, civil, process and mechanical improvements, and a new pre-engineered storage building, and all related work.
- C. The foregoing description(s) shall not be construed as a complete description of all work required.

1.2 CONTRACT DOCUMENTS

- A. The Work to be done is shown on the set of Drawings entitled Barton and South Industrial Pump Stations electrical Improvements and dated April 2013. The numbers and titles of all Drawings appear on the cover sheet of the Drawings. All drawings so enumerated shall be considered an integral part of the Contract Documents as defined herein.
- B. Certain Document Sections refer to Divisions of the Contract Specifications. Sections are each individually numbered portions of the Specifications (numerically) such as 08110, 13182, 15206, etc. The term Division is used as a convenience term meaning all Sections within a numerical grouping. Division 16 would thus include Sections 16000 through 16955.
- C. Where references in the Contract Documents are made to CONTRACTORS for specific disciplines of work (e.g. Electrical CONTRACTOR, etc.), these references shall be interpreted to be the single prime CONTRACTOR when the project is bid or awarded as a single prime Contract.
- D. The prime CONTRACTOR shall be responsible for all work in the Contract Documents regardless of the division of disciplines.
- E. ENGINEER shall provide the CONTRACTOR an electronic copy on CD of the Specifications and Contract Drawings. The CONTRACTOR shall be responsible for the production of his construction sets.

1.3 GENERAL ARRANGEMENT

- A. Drawings indicate the extent and general arrangement of the work. If any departures from the Drawings are deemed necessary by the CONTRACTOR to accommodate the

materials and equipment CONTRACTOR proposes to furnish, details of such departures and reasons therefore shall be submitted as soon as practicable to the ENGINEER for approval by OWNER and ENGINEER. No such departures shall be made without the prior written approval of the OWNER or ENGINEER. Approved changes shall be made without additional cost to the OWNER for this work or related work under other Contracts of the Project.

- B. The specific equipment proposed for use by the CONTRACTOR on the project may require changes in structures, auxiliary equipment, piping, electrical, mechanical, controls or other work to provide a complete satisfactory operating installation. The CONTRACTOR shall submit to the ENGINEER, for approval by OWNER and ENGINEER, all necessary Drawings and details showing such changes to verify conformance with the overall project structural and architectural requirements and overall project operating performance. The Bid Price shall include all costs in connection with the preparation of new drawings and details and all changes to construction work to accommodate the proposed equipment, including increases in the costs of other Contracts.

1.4 CONSTRUCTION PERMITS, EASEMENTS AND ENCROACHMENTS

- A. The OWNER shall obtain or cause to be obtained all permanent and temporary construction easements required. No easements are anticipated for this project.
- B. The CONTRACTOR shall obtain, keep current and pay all fees for any other necessary construction permits from those authorities, agencies, or municipalities having jurisdiction over land areas, utilities, or structures which are located within the Contract limits and which will be occupied, encountered, used, or temporarily interrupted by the CONTRACTOR's operations unless otherwise stated. CONTRACTOR shall pay plan review fees and any other fees for required permits. Record copies of all permits shall be furnished to the ENGINEER and OWNER.
- C. When construction permits are accompanied by regulations or requirements issued by a particular authority, agency or municipality, it shall be the CONTRACTOR's responsibility to become familiar with and comply with such regulations or requirements as they apply to CONTRACTOR's operations on this Project.
- D. The CONTRACTOR will be required to follow the requirements established by all permits necessary for the construction of this project. The following is a list of all permits that must be obtained prior to the beginning of construction.
 - 1. MDEQ Permit for Water System Construction (Part 399)
 - 2. Applicable City Building Permits (all trades)
 - 3. Soil Erosion Control
- E. The permit for water system construction will be applied for and obtained by the OWNER through the Michigan Department of Environmental Quality. The CONTRACTOR shall obtain a copy of this permit from the ENGINEER prior to construction.
- F. The permits for the various trades shall be applied for, paid for and procured by the CONTRACTOR. A cash allowance of \$50,000 has been included in the Contract price for the payment of the permit fees. The CONTRACTOR must submit a copy of these permits to the ENGINEER prior to construction.

- G. The Soil Erosion and Sedimentation Control permit shall be applied for and paid for by the CONTRACTOR and issued by the City of Ann Arbor. The CONTRACTOR will be required to adhere to all requirements of the permit. The CONTRACTOR shall have an SESC-certified inspector assigned to the project to complete all required inspections and reports. An electronic copy of all inspections shall be provided to the OWNER

1.5 ADDITIONAL ENGINEERING SERVICES

- A. In the event that the ENGINEER is required to provide additional engineering services as a result of substitution of materials or equipment which are not "or equal" by the CONTRACTOR, or changes by the CONTRACTOR in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the ENGINEER is required to examine and evaluate any changes proposed by the CONTRACTOR for the convenience of the CONTRACTOR, then the ENGINEER's charges in connection with such additional services shall be charged to the CONTRACTOR by the OWNER.
- B. Structural design shown on the Contract Drawings is based upon typical weights for major items of equipment as indicated on the Contract Drawings and specified. If the equipment furnished exceeds the weights of said equipment, the CONTRACTOR shall assume the responsibility for all costs of redesign and for any construction changes required to accommodate the equipment furnished, including the ENGINEER's expenses in connection therewith.
- C. In the event that the ENGINEER is required to provide additional engineering services as a result of CONTRACTOR's errors, omissions, or failure to conform to the requirements of the Contract Documents, or if the ENGINEER is required to examine and evaluate any changes proposed by the CONTRACTOR solely for the convenience of the CONTRACTOR, then the ENGINEER's charges in connection with such additional services shall be charged to the CONTRACTOR by the OWNER.

1.6 ADDITIONAL OWNER'S EXPENSES

- A. In the event the Work of this Contract is not completed within the time set forth in the Contract or within the time to which such completion may have been extended in accordance with the Contract Documents, the additional engineering or inspection charges incurred by the OWNER may be charged to the CONTRACTOR and deducted from the monies due the CONTRACTOR. Extra work or supplemental Contract work added to the original Contract, as well as extenuating circumstances beyond the control of the CONTRACTOR, will be given due consideration by the OWNER before assessing engineering and inspection charges against the CONTRACTOR.
- B. Charges assessed to the CONTRACTOR for additional engineering and inspection costs will be determined based on actual hours charged to the job by the ENGINEER. Daily rates will depend on the number and classifications of employees involved, but in no case shall such charges exceed \$900 per day for field personnel and \$1,100 per day for engineering personnel, based on an eight hour workday.
- C. Charges for additional OWNER's expenses shall be in addition to any liquidated damages assessed in accordance with the Contract.

1.7 PROTECTION OF WORK

- A. Unless otherwise specifically permitted, all work that would be subject to damage shall be stopped during inclement, stormy or freezing weather. Only such work as will not suffer injury to workmanship or materials will be permitted. CONTRACTOR shall carefully

protect the work against damage or injury from the weather, and when work is permitted during freezing weather, CONTRACTOR shall provide and maintain approved facilities for heating the materials and for protecting the finished work.

1.8 SUBSURFACE DATA

- A. Subsurface data is offered in good faith solely for placing the Bidder in receipt of all information available to the OWNER and ENGINEER.
- B. The Bidder must interpret such subsurface data according to Bidder's own judgment and shall acknowledge that Bidder is not relying upon the same as accurately describing the subsurface conditions, which may be found to exist.
 - 1. The test boring logs present factual information of the subsurface conditions at the specific test boring location only. The Bidder should not consider, or conclude, that the subsurface conditions will be consistent between test boring locations.
- C. The Bidder further acknowledges that Bidder assumes all risks contingent upon the nature of the sub-surface conditions to be actually encountered in performing the work covered by the Contract, even though such actual conditions may result in the Bidder performing more or less work than Bidder originally anticipated.
- D. The Bidder is further advised that the OWNER has made sub-surface investigations and a report has been prepared, in connection with this project for the ENGINEER, a copy of which is appended to the rear of these specifications.
- E. In making this data available, the OWNER makes no guarantee, either expressed or implied, as to their accuracy or to the accuracy of any interpretation thereof.

1.9 SURVEYS AND LAYOUT

- A. All work under this Contract shall be constructed in accordance with the lines and grades shown on the Drawings or as directed by the ENGINEER or OWNER. Elevation of existing ground and appurtenances are believed to be reasonably correct but are not guaranteed to be absolute and therefore are presented only as an approximation. Any error or apparent discrepancy in the data shown or omissions of data required for accurately accomplishing the stake out survey shall be referred immediately to the ENGINEER for interpretation or correction.
- B. All survey work for construction control purposes shall be performed by the OWNER/ENGINEER.
- C. CONTRACTOR shall have the responsibility to carefully preserve the bench marks, reference points and stakes, and in the case of destruction thereof by the CONTRACTOR or resulting from CONTRACTOR's negligence, the CONTRACTOR shall be charged with the expense and damage resulting therefrom and shall be responsible for any mistakes that may be caused by the unnecessary loss or disturbance of such bench marks, reference points and stakes.
- D. Existing or new control points, property markers and monuments that will be or are destroyed during the normal causes of construction shall be reestablished by the CONTRACTOR and all reference ties recorded therefore shall be furnished to the OWNER and ENGINEER. All computations necessary to establish the exact position of the work shall be made and preserved by the CONTRACTOR.

- E. The OWNER or ENGINEER may check all or any portion of the work and the CONTRACTOR shall afford all necessary assistance to the OWNER and ENGINEER in carrying out such checks. Any necessary corrections to the work shall be immediately made by the CONTRACTOR. Such checking by the OWNER or ENGINEER shall not relieve the CONTRACTOR of any responsibilities for the accuracy or completeness of CONTRACTOR's work.

1.10 FIRE PROTECTION

- A. CONTRACTOR shall take all necessary precautions to prevent fires at or adjacent to the work, buildings, etc., and shall provide adequate facilities for extinguishing fires which do occur. Burning of debris is not permitted on the project site.
- B. When fire or explosion hazards are created in the vicinity of the work as a result of the locations of fuel tanks, or similar hazardous utilities or devices, the CONTRACTOR shall immediately alert the local Fire Marshal, the ENGINEER, and the OWNER of such tank or device. The CONTRACTOR shall exercise all safety precautions and shall comply with all instructions issued by the Fire Marshal and shall cooperate with the OWNER of the tank or device to prevent the occurrence of fire or explosion.
- C. Fire protection alarm and detection systems shall comply with the Michigan International Building Code 2009 and NFPA standards.
- D. Hydrants must be maintained in service and approved during all phases of work.
- E. Storage area for construction materials must not interfere with fire/emergency site access.
- F. All material demolished from site should not be stored on location.

1.11 CHEMICALS

- A. All chemicals used during project construction or furnished for project operation, whether herbicide, pesticide, disinfectant, polymer, or reactant of other classification, must show approval of either the EPA or USDA. Use of all such chemicals and disposal of residues shall be in strict conformance with all applicable rules and regulations.
- B. Provide MSDS sheets for all chemicals to OWNER.

1.12 FIRST AID FACILITIES AND ACCIDENTS

- A. First Aid Facilities
 - 1. The CONTRACTOR shall provide at the site such equipment and facilities as are necessary to supply first aid to any of CONTRACTOR's personnel who may be injured in connection with the work.
- B. Accidents
 - 1. The CONTRACTOR shall promptly report, in writing, to the ENGINEER and OWNER all accidents whatsoever out of, or in connection with, the performance of the work, whether on or adjacent to the site, which cause death, personal injury or property damage, giving full details and statements of witnesses.

2. If death, serious injuries, or serious damages are caused, the accident shall be reported immediately by telephone or messenger to both the OWNER and the ENGINEER.
3. If any claim is made by anyone against the CONTRACTOR or a Subcontractor on account of any accidents, the CONTRACTOR shall promptly report the facts, in writing, to the ENGINEER and OWNER, giving full details of the claim.

1.13 ULTIMATE DISPOSITION OF CLAIMS BY ONE CONTRACTOR ARISING FROM ALLEGED DAMAGE BY ANOTHER CONTRACTOR

- A. During the progress of the work, other CONTRACTORS may be engaged in performing other work or may be awarded other Contracts for additional work on this project and/or on this site. In that event, the CONTRACTOR shall coordinate the work to be done hereunder with the work of such other CONTRACTORS and the CONTRACTOR shall fully cooperate with such other CONTRACTORS and carefully fit its own work to that provided under other Contracts as may be directed by the OWNER. The CONTRACTOR shall not commit or permit any act which will interfere with the performance of work by any other CONTRACTOR.
- B. If the OWNER shall determine that the CONTRACTOR is failing to coordinate this work with the work of the other CONTRACTORS as the OWNER directed, then the OWNER shall have the right to withhold any payments otherwise due hereunder until the CONTRACTOR completely complies with the OWNER's directions.
- C. If the CONTRACTOR notifies the OWNER in writing that another CONTRACTOR is failing to coordinate his work with the work of this Contract as directed, the OWNER will promptly investigate the charge. If the OWNER finds it to be true, he will promptly issue such directions to the other CONTRACTOR with respect thereto as the situation may require. The OWNER, the ENGINEER, nor any of their agents shall not, however, be liable for any damages suffered by the CONTRACTOR by reason of the other CONTRACTOR's failure to promptly comply with the directions so issued by the OWNER, or by reason of another CONTRACTOR's default in performance, it being understood that the OWNER does not guarantee the responsibility or continued efficiency of any CONTRACTOR.
- D. The CONTRACTOR shall indemnify and hold the OWNER and the ENGINEER harmless from any and all claims of judgments for damages and from costs and expenses to which the OWNER may be subjected or which it may suffer or incur by reason of the CONTRACTOR's failure to comply with the OWNER's directions promptly.
- E. Should the CONTRACTOR sustain any damage through any act or omission of any other CONTRACTOR having a Contract with the OWNER for the performance of work upon the site or of work which may be necessary to be performed for the proper execution of the work to be performed hereunder, or through any act or omission of a Subcontractor of such Contract, the CONTRACTOR shall have no claim against the OWNER or the ENGINEER for such damage, but shall have a right to recover such damage from the other CONTRACTOR.
- F. Should any other CONTRACTOR having or who shall hereafter have a Contract with the OWNER for the performance of work upon the site sustain any damage through any act or omission of the CONTRACTOR hereunder or through any act or omission of any Subcontractor of the CONTRACTOR, the CONTRACTOR agrees to reimburse such other CONTRACTOR for all such damages and to defend at his own expense any suit based upon such claim and if any judgment or claims against the OWNER shall be allowed, the CONTRACTOR shall pay or satisfy such judgment or claim and pay all costs

and expenses in connection therewith and shall indemnify and hold the OWNER harmless from all such claims.

- G. The OWNER's right to indemnification hereunder shall in no way be diminished, waived or discharged, by its recourse to assessment of liquidated damages as provided in the Contract, or by the exercise of any other remedy provided for by Contract Documents or by law.

1.14 BLASTING AND EXPLOSIVES

- A. The use of blasting or explosives shall not be allowed under this project.

1.15 LIMITS OF WORK AREA

- A. The CONTRACTOR shall confine the construction operations within the Contract limits shown on the Drawings and/or property lines and/or fence lines. Storage of equipment and materials, or erection and use of sheds outside of the Contract limits, if such areas are the property of the OWNER, shall be used only with the OWNER's approval. Such storage or temporary structures, even within the Contract's limits, shall be confined to the OWNER's property and shall not be placed on properties designated as easements or rights-of-way unless specifically permitted elsewhere in the Contract Documents.

1.16 WEATHER CONDITIONS

- A. No work shall be done when the weather is unsuitable. The CONTRACTOR shall take necessary precautions (in the event of impending storms) to protect all work, materials, or equipment from damage or deterioration due to floods, driving rain, or wind, and snow storms. The OWNER reserves the right to order that additional protection measures over and beyond those proposed by the CONTRACTOR, be taken to safeguard all components of the Project. The CONTRACTOR shall not claim any compensation for such precautionary measures so ordered, nor claim any compensation from the OWNER for damage to the work from weather elements.
- B. The mixing and placing of concrete or pavement courses, the laying of masonry, and installation of sewers and water mains shall be stopped during rainstorms and when ordered by the OWNER; and all freshly placed work shall be protected by canvas or other suitable covering in such manner as to prevent running water from coming in contact with it. Sufficient coverings shall be provided and kept ready at hand for this purpose. The limitations and requirements for mixing and placing concrete, or laying of masonry, in cold weather shall be as described elsewhere in these Specifications.
- C. The ENGINEER shall have permissive authority over the work which is proposed to be done during the winter months. The CONTRACTOR shall provide adequate weather protection, temporary heating and take any other measures which are necessary to insure that the work performed during the winter months is properly installed and protected against damage from freezing.

1.17 USE OF FACILITIES BEFORE COMPLETION

- A. The OWNER reserves the right to enter and use any portion of the constructed facilities before final completion of the whole work to be done under this Contract. However, only those portions of the facilities which have been completed to the OWNER's satisfaction, as evidenced by issuing a Certificate of Partial Completion covering that part of the work, shall be placed in service.

- B. It shall be the OWNER's responsibility to prevent premature connections to or use of any portion of the installed facilities by private or public parties, persons or groups of persons, before the OWNER issues the Certificate of Partial Completion covering that portion of the work to be placed in service.
- C. Consistent with the approved progress schedule, the CONTRACTOR shall cooperate with the OWNER, his agents, and the ENGINEER to accelerate completion of those facilities, or portions thereof, which have been designated for early use by the OWNER.

1.18 PIPING, VALVES AND SUPPORTS

- A. Various pipelines and conduits are shown on the Plans in diagram form. Where such pipelines and conduits are shown only in diagram, they shall be arranged clear of other pipelines, equipment and walking areas, and be accessible for maintenance. Such pipelines shall be fitted and installed in a neat and workmanlike manner in accordance with approved shop drawings. An adequate number of unions shall be provided in main pipe and branch pipe runs to facilitate dismantling or removal of pipeline sections without disturbing adjacent branch or connecting lines. Pipe and conduit supports shall be designed by CONTRACTOR and approved by ENGINEER unless noted otherwise in the Contract Documents.

1.19 DELIVERY, STORAGE, AND HANDLING

- A. All materials, supplies and equipment, whether furnished by the CONTRACTOR or by the OWNER, shall be delivered, stored and handled as to prevent the inclusion of foreign materials and/or damage by water, freezing, breakage or other causes. The ENGINEER may require the CONTRACTOR to provide an enclosed storage shed for the storage of the above mentioned materials, supplies and equipment. Packaged materials shall be delivered in the original unopened containers and shall be stored until ready for use. All materials which have been stored shall meet the requirements of the Specifications at the time they are used in the project.

1.20 PROTECTION OF TREES

- A. All trees which are to be preserved and which, in the opinion of the ENGINEER, might be subject to damage by the CONTRACTOR's operations, shall be adequately protected against damage to the bark by 2-inch thick vertical planking securely wired or tied completely around the tree trunk. Such protection shall not be removed until authorized by the ENGINEER.
- B. Machine excavation shall not be made within a circular area of any tree, the diameter of the area in feet being equal to the radius of the tree in inches. Snow fencing shall be placed around this area for any tree in or facing the work area. If hand excavation within this area cuts across a large root of a tree, the butting of which, in the opinion of the ENGINEER, would be injurious to the tree, the CONTRACTOR shall tunnel under such root and protect it from injury throughout the work.
- C. Trees which interfere with the work, and the removal of which is permitted, shall be removed by the CONTRACTOR at his expense and in a safe manner. Such tree removal shall be considered incidental to the work. No trees are to be removed without the expressed approval of the governmental body having jurisdiction thereof, and of the ENGINEER.

PART 2 – PRODUCTS

(NOT USED)

PART 3 – EXECUTION

(NOT USED)

END OF SECTION

SECTION 01140

WORK RESTRICTIONS

PART 1 - GENERAL

1.1 SUMMARY

- 1.A. The proposed improvements shall be fully constructed, started, tested and put into operation while portions of the existing pump station remains in service.
- 1.B. The existing pump stations shall be maintained in continuous operation during the entire construction period of this Project. The intent of this section is to outline the minimum requirements necessary to provide continuous piping of the required capacity throughout the construction period.
- 1.C. Work under this Contract shall be scheduled and conducted by the CONTRACTOR so as not to impede any pumping process, discharge water, or cause odor or other nuisance except as explicitly permitted hereinafter. In performing the work shown and specified, the CONTRACTOR shall plan and schedule his work to meet the OWNER's operating requirements, and the constraints and construction requirements as outlined in this Section. The CONTRACTOR shall pay all civil penalties, costs, assessments, etc., associated with any failure or inability to supply water from the pump stations that do not meet water quality standards, adequate quantity requirements or maintain system pressure requirements; provided the inadequacy was associated with the CONTRACTOR's work.
- 1.D. The CONTRACTOR shall be responsible for coordinating the general construction and electrical, HVAC, plumbing, and instrumentation construction schedules and for ensuring that permanent or temporary power is available for all existing, proposed, and temporary facilities that are required to be on line at any given time.
- 1.E. The CONTRACTOR has the option of providing temporary facilities that can eliminate a constraint, provided it is done without cost to the OWNER and provided that all requirements of these Specifications are fulfilled. Work not specifically covered in the following paragraphs may, in general, be done at any time during the contract period, subject to the operating requirements and constraints and construction requirements outlined hereinafter. All references to days in this Section shall be consecutive calendar days.

1.2 GENERAL CONSTRAINTS

- 2.A. The CONTRACTOR shall schedule the Work so that the pump stations are maintained in continuous operation. Portions of the pumping processes shall be maintained in continuous operation during the construction period except during approved process interruptions. Shutdowns and diversions shall conform to the requirements hereinafter specified and shall be minimized by the CONTRACTOR as much as possible. If in the judgment of the ENGINEER, a requested shutdown is not required for the CONTRACTOR to perform the Work, the CONTRACTOR shall utilize approved alternative methods to accomplish the Work. All shutdowns shall be coordinated with and scheduled at times suitable to the OWNER. Shutdowns shall not begin until all required materials are on hand and ready for installation. Each shutdown period shall commence at a time approved by the OWNER. If the CONTRACTOR completes all required Work before the specified shutdown period has ended, the OWNER may immediately place the existing system back into service.

- 2.B. The CONTRACTOR shall give OWNER advance notice of proposed shutdowns of any pipe, process, equipment, tank, or power source, and shall present all desired shutdowns in the 30 and 60 day schedules at the progress meetings. Shutdowns shall be fully coordinated with the OWNER at least 72 hours before the scheduled shutdown. CONTRACTOR shall lockout/tagout equipment and power sources involved in the shutdowns and diversions. The OWNER's personnel shall operate OWNER's facilities during shutdowns.
- 2.C. The CONTRACTOR shall submit a proposed written plan of work, with a request to schedule shutdown work for OWNER and ENGINEER approval. Work plan shall include sequence of events, needs for coordination with plant staff, plans for lock-out/tag-out, contingency plans for how to return equipment and tanks to service early if needed for emergencies, and details of how the duration of the shut-down shall be minimized.
- 2.D. Short-term shutdowns (24 hours or less) shall require 7 days prior notice to schedule date and time with OWNER, unless otherwise noted herein. Once a short-term shutdown starts, CONTRACTOR shall work continuously until the work is complete and the disrupted process or system can be returned to service. Long-term shutdowns (longer than 24 hours) shall require 14 days prior notice to schedule date and time with OWNER, unless otherwise noted herein. The CONTRACTOR shall submit a plan of work showing sequence of events throughout shutdown period, and listing all items requiring coordination with OWNER's staff. The CONTRACTOR shall schedule a coordination meeting with the OWNER prior to the initiation of a long-term shutdown. Once a long-term shutdown starts, CONTRACTOR shall work on the shutdown area full days, every regular work day, until the work is complete and the disrupted process or system can be returned to service, unless otherwise required herein.
- 2.E. Any temporary work, facilities, roads, walks, protection of existing structures, piping, blind flanges, valves, equipment, etc. that may be required within the CONTRACTOR's work limits to maintain continuous and dependable operation shall be furnished by the CONTRACTOR at the direction of the OWNER or ENGINEER at no extra cost to the OWNER.
- 2.F. The OWNER shall have the authority to order work stopped or prohibited that would, in his opinion, unreasonably result in interrupting the necessary functions of the pump station operations. The OWNER reserves the right to cancel a scheduled shutdown, without additional compensation due the CONTRACTOR, and shall consider a contract extension if the cancellation affects the CONTRACTOR's critical path.
- 2.G. Unless specifically required by this specification, the CONTRACTOR shall not request more than one shutdown occur simultaneously.
- 2.H. If the CONTRACTOR impairs performance or operation of the pump station as a result of not complying with specified provisions for maintaining pump station operations, then the CONTRACTOR shall immediately make all repairs or replacements and do all work necessary to restore the pump stations to operation to the satisfaction of the OWNER and ENGINEER. Such work shall progress continuously to completion 24 hours per day and seven work days per week.
- 2.I. After any damage to the existing facilities by the CONTRACTOR's Work that, in the opinion of the OWNER, constitutes an emergency, the CONTRACTOR shall be immediately available and provide immediate services for the repair of damage and mitigation of the emergency.
- 2.J. Shutdowns shall be scheduled between Monday and Friday, unless there are extenuating circumstances approved by the ENGINEER.

1.3 GENERAL REQUIREMENTS

3.A. Access to Site, Roadways, and Parking Areas

- 3.A.1. An unobstructed traffic route through all gates shall be maintained at all times for the OWNER's operations personnel and maintenance equipment. The CONTRACTOR shall be responsible for providing access to the construction area and for preparing and maintaining temporary access road, fence, and gate.

Barton Pump Station: The CONTRACTOR shall park all equipment and vehicles within the boundaries of the fence area. No equipment or vehicles shall be permitted to occupy the adjacent recreational area parking.

South Industrial Pump Station: This site has one driveway with no provisions to turn around. Access in and out of the station must be maintained at all times. No more than one vehicle at a time can be parked in the driveway. The OWNER has made arrangements to park vehicles during normal business hours in the parking directly to the south at the Inspectors Office. No overnight parking is permitted in this parking lot. Please note: A botanical rain garden is located in the walking path between the Inspectors office and the pump station. The CONTRACTOR shall install a silt fence around the rain garden to minimize foot traffic damage. Any damage to the rain garden shall be repaired by CONTRACTOR to the OWNERS satisfaction.

- 3.A.2 An unobstructed traffic route around the site shall be maintained at all times for the OWNER's operations personnel, maintenance equipment, and delivery vehicles. Vehicular access to the buildings, and storage facilities for OWNER personnel and for delivery vehicles shall be maintained at all times by the CONTRACTOR except as explicitly permitted hereinafter.
- 3.A.3. The CONTRACTOR shall provide temporary measures to protect the existing pavement by filling over with temporary asphalt or supplying other measures acceptable to the ENGINEER, and he shall repair any damage to existing paved surfaces that occurs during the construction period. Any areas disturbed along the shoulders of the access road and interior roads and elsewhere inside and outside of the plant shall be repaired, graded, seeded, etc. as necessary to match pre construction conditions.
- 3.A.4. The CONTRACTOR shall not undertake the restoration/construction of roadway (paved, gravel, or asphalt overlay) shown on the Contract Drawings, until all other work has been completed.
- 3.A.5. It shall be the responsibility of the General CONTRACTOR to apply for and obtain any permits required from the State of Michigan and City of Ann Arbor and pay all associated fees.
- 3.A.6. The CONTRACTOR shall be responsible for removal of snow in areas of the CONTRACTOR's work.
- 3.A.7. The CONTRACTOR shall not disturb the maintenance of pump station operations without a written and approved plan.
- 3.A.8. The CONTRACTOR shall submit plans for approval for any needed outages or disturbances to operations. These plans shall include the area, process or

systems that shall be impacted and duration of the outage. No plans can be implemented without written authorization from OWNER or ENGINEER.

3.B. Personnel Access

3.B.1. OWNER's personnel shall have access to all areas which remain in operation throughout the construction period. The CONTRACTOR shall locate stored material, dispose of construction debris and trash, provide temporary walkways, provide temporary lighting, and other such work as directed by the ENGINEER to maintain personnel access to areas in operation. Access and adequate parking areas for OWNER's personnel must be maintained throughout construction.

3.C. Plumbing Facilities

3.C.1. Unless otherwise allowed by the ENGINEER, sanitary facilities in the existing structures shall be operational at all times for OWNER operating personnel. All other building plumbing systems such as roof and floor drains, pumping, etc., shall be maintained for all structures.

3.D. Building Heating and Ventilating

3.D.1. Building heating and ventilating for the existing structures shall be in service for the entire construction period. Additional temporary heating and ventilation shall be provided as required to maintain facilities under construction adequately heated and vented. The temperatures to be maintained in any areas occupied by OWNER operating personnel such as offices, bathrooms, etc., shall be at least 65°F. The temperatures to be maintained in all other interior areas, whether new, existing or temporary, shall be maintained at a minimum of 55°F.

3.E. Power, Light and Communications Systems (General)

3.E.1. Electric power, lighting service and communications systems shall be maintained in uninterrupted operation in all areas which remain in operation. Individual units may be disconnected as required for replacement, but service shall be available at all times including periods when pump station elements are out of service. Shutdown of electrical facilities, when allowed, shall be limited to not more than two (2) hours unless otherwise noted or approved by the OWNER. The CONTRACTOR shall coordinate shutdowns required to minimize the duration of shutdowns and the total number of shutdowns required to complete construction. OWNER's phone service to the pump station shall be maintained in continuous operation during construction.

3.F. Draining Process Pipes and Conduits (General)

3.F.1. The contents of all pipes and conduits to be removed, replaced or relocated (or dewatered for a specific purpose) shall be transferred to a suitable facility in a manner approved by the OWNER through hoses or piping, or by using pumps if hydraulic conditions so require them. The CONTRACTOR shall provide the pumps, piping, taps, valves and hoses at no additional cost to the OWNER. No uncontrolled spillage of a pipe or conduit shall be permitted. Any spillage, other than potable water, shall be immediately washed down and flushed to the appropriate

disposal location. The CONTRACTOR may use drains if available, appropriate and approved by the OWNER.

3.G. Sump Pumps and Sumps

3.G.1. All existing sumps shall be maintained in an operable condition with either existing pumps or temporary pumps until replaced with new. Interim piping, power and controls shall be provided as required by the staged construction sequence.

3.H. Seal Water and Service Water Piping

3.H.1. A supply of service and seal water and the necessary connections to existing equipment shall be maintained during construction.

1.4 SPECIFIC OPERATIONAL CONSTRAINTS

4.A. The General CONTRACTOR shall schedule the work for the following based on the constraints given in such a manner as to maintain the pump station operation. CONTRACTOR shall submit a proposed construction schedule including all planned system and shutdowns and tie-ins for the OWNER's and ENGINEER's review no later than 30 calendar days after issuance of the Notice to Proceed. At a minimum, Construction Schedule shall indicate a proposed start date and duration for each of the items listed in this section. No construction shall begin on any of the items listed in this section until the proposed schedule has been approved. Refer to Table 1 and Table 2 for further details on dates and expected durations.

4.B. CONTRACTOR shall install as much of the new equipment that is to replace the existing equipment as feasible prior to shut-down of any pipe, to minimize the duration of the shut-down.

4.C. OWNER shall be responsible to turn all valves necessary to isolate pipe sections for connection, and to place the new pipe section to service.

4.C.1. Medium Voltage Services – Barton Pump Station

4.C.1.a. The CONTRACTOR shall be responsible for priority coordination with DTE Energy. As part of the project both Medium Voltage Services shall be upgraded while keeping the facility pumps downtime to a minimum. No single pump shall be allowed to be down more than two (2) weeks.

4.C.1.b. Prior to removal/construction of any service, all existing underground/overhead services shall be physically verified and tested by the CONTRACTOR and documented with ENGINEER/OWNER.

4.C.1.c. All removal/construction steps shall be scheduled four (4) weeks in advance.

4.C.1.d. Each feeder shall be meggered before put into operation

4.C.1.e. New Medium Voltage connections shall be provided by DTE Energy and paid for by the allowance in the contract. The Phoenix service shall be provided first. The conduits, conductors, transformer and switchboard shall be installed and made operational before and motors are migrated to the new service.

4.C.1.f. After pumps #3 (12 MGD Summer) and #4 (12 MGD Winter) are migrated to the new Phoenix service, pumps #1 (9 MGD) and #2 (7 MGD) can be migrated to

Hobart switchboard. The Hobart switchboard shall be connected into Phoenix primary service by closing the tie breaker.

4.C.1.g. The Hobart service shall be upgrade at this point and pumps #1 (9 MGD) and #4 (7 MGD) shall remain on the Phoenix service until the Hobart system are fully operational.

4.C.2. South Industrial Booster Station

4.C.2.a. The complete Motor Control Center (MCC) at the South Industrial Booster Station shall be replaced. The new MCC shall be located in the same location.

4.C.2.b. Before the MCC is decommissioned, three temporary service disconnects shall be connected to the existing transformer. All disconnects shall be service rated and grouped/labeled together as main disconnects. The first disconnect shall be for a mini-power zone for 120 volt power for temporary controls. The other two (2) disconnects shall be for two (2) of the four (4) booster pumps.

4.C.2.c. The north louver (replaced with new) shall be removed to allow temporary wiring to pump motors. Temporary free standing motor starters shall be placed by the booster pumps. These temporary starters shall also serve as the local disconnects.

4.C.2.d. The CONTRACTOR shall work with the OWNER to make a fully operational temporary control system that shall operate the pumps. The Owner will provide the temporary control panel and related hardware and the CONTRACTOR will make this panel fully operational.

4.C.2.e. Once all the temporary systems are in place and functional (starters/controls), the station shall operate in this mode for one (1) week before the demolition of the MCC is performed.

4.C.2.f. Four (4) shutdowns shall be scheduled. The first shutdown shall be needed to connect the temporary systems. The second shutdown shall be needed to disconnect the existing MCC. The third shutdown shall be needed to connect the new MCC. The final shutdown shall disconnect the temporary services.

4.C.2.g. During each of the scheduled shutdown a manually started on-site generator is available to minimize outages. The OWNER shall be reimbursed all fuel used.

4.C.2.h. All shutdowns/power outages shall be less than two (2) hours.

4.C.2.i. After the new MCC is operational the two (2) pumps that were not temporarily wired in shall be transferred to the MCC. The Soft Start parameters shall be coordinated with OWNER/ENGINEER. Each of the pumps shall operate for 96 hours (break-in period) each individually. The temporary pumps shall be turned off but not disconnected.

4.C.2.j. The temporary wired pumps shall be transferred to the new MCC after 96 hours break-in period is complete. All temporary services at this point can be removed.

4.C.3. Instrumentation and Controls

4.C.3.a. Before any pump can be used on the permanent electrical systems, the instrumentation and controls systems (MCP) must be fully validated and commissioned.

4.C.3.b. The Barton Drive Pump Station shall connect back to the WTP via an existing spread spectrum wireless radio. The CONTRACTOR shall operate the new Barton MCP from the main WTP SCADA systems for two weeks. This includes 24/7/7 technical support on the control system during this period. Any failures or issues that arise during this period shall be immediately corrected. Only after the system has had two (2) weeks of operations without any failure or issues before the system is turned over to the OWNER.

4.C.3.c. The South Industrial Pump Station shall connect back to the WTP via a new OWNER provided fiber optic network. The CONTRACTOR shall operate the new South Industrial MCP from the main WTP SCADA systems for one week. This includes 24/7/7 technical support on the control system during this period. Any failures or issues that arise during this period shall be immediately corrected. Only after the system has had two (2) weeks of operations without any failure or issues before the system is turned over to the OWNER.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

Table 1
City of Ann Arbor
Barton and South Industrial Pump Stations
Spec Section 01140

Summary of Shutdown Notices, Durations, Dates, Deadlines, and Liquidated Damages

Part	Item	Notice to OWNER (days)	Maximum Duration	Dates and Deadlines	Liquidated Damages (See Note)
1.1	General short-term	7	< 24 hours	NA	\$250/day
	General long-term	14	> 24 hours	Submit schedule/sequence Requires coordination meeting	\$250/day
4.C.1	Medium Voltage Services	30	See Table 2	See Table 2	\$500/day
4.C.2	South Industrial Booster Station	30	6 weeks	Within January 1, 2014 - May 1, 2014	\$500/day
	South Industrial Generator Work	30	6 weeks	Within January 1, 2014 – May 1, 2014	\$500/day

Note: Liquidated damages shall apply for each shutdown that exceeds its assigned maximum duration. Liquidated damages shall also apply for each shutdown that is not completed by its assigned deadline or within its assigned dates. Liquidated damages for exceeding durations shall be in addition to damages for missing assigned deadlines or dates.

Table 2
City of Ann Arbor
Barton Pump Station
Spec Section 01140
Barton Pump Station Electrical Migration Plan

City of Ann Arbor- Barton Pump Station Electrical Migration Plan									
					*Note: Total capacity does not include the natural gas fired pump				
					**Note:Durations and windows subject to liquidated damages				
Task	Approximate Dates	Approximate End	Duration Days	Total Capacity*	Pump No. 1	Pump No. 2	Pump No. 3	Pump No. 4	Notes
Phase 1- Phoenix Migration	Start	Start	**	MGD	Out of Service	Out of Service	Out of Service	Out of Service	
Shop Drawings	10/1/2013	12/30/2013	90	40					
Equipment Production		4/21/2014	112	40					
Install new 480V transformer secondary conduits (crawl space)			14	40					
Run Phoenix primary conduits			10	40					
Place Hobart final primary pole			3	40					
Run Hobart primary conduits			10	40					
Install Hobart and Phoenix switchboards			28	40					Hobart switchboard can be installed at anytime at this point
Install Phoenix secondary conductors			5	40					
Install Phoenix primary conductors to pole top connections			5	40					
Install new secondary tap on Phoenix primary pole (DTE work)			2	40					
Place both Transformers			5	40					
Commission new Phoenix switchboard (dose fuses)	7/12/2014		1	16			X	X	Taking pumps No. 3 and No. 4 out of service as a precaution only
Install pump No. 3 feeders			3	40					
Migrate pump No. 3	10/1/2014	10/15/2014	14	28			X		Includes motor, disconnect, motor branch wiring, testing
Install pump No. 4 feeders			3	40					
Migrate pump No. 4	11/1/2014	11/6/2014	5	28				X	Includes disconnect, motor branch wiring, testing
Disconnect existing Phoenix primary tap (DTE work)	11/10/2014		1	16			X	X	Taking pumps No. 3 and No. 4 out of service as a precaution only
Remove Phoenix existing primary feeders/transformer	11/20/2014		5	40					
Remove remaining Phoenix equipment		12/5/2014	10	40					
Total Phase 1 Duration			430						
Task	Approximate Dates	Approximate End	Duration Days	Total Capacity*	Pump No. 1	Pump No. 2	Pump No. 3	Pump No. 4	Notes
Phase 2- Hobart Migration	Start	Start	**	MGD	Out of Service	Out of Service	Out of Service	Out of Service	
Finalize Hobart switchboard installation	11/1/2014		5	40					
Lock-out tie-breaker			0	40					
Run Hobart secondary conductors			5	40					
Install Hobart primary conductors to pole top connections			5	40					
Install new secondary tap on Hobart primary pole (DTE work)			2	40					
Commission new Hobart switchboard (dose fuses)	1/2/2015		1	24	X	X			Taking pumps No. 1 and No. 2 out of service as a precaution only
Install pump No. 2 feeders			3	40					
Migrate pump No. 2	1/15/2015	1/29/2015	14	33		X			Includes motor, disconnect, motor branch wiring, testing
Install pump No. 1 feeders			3	40					
Migrate pump No. 1	2/15/2015	3/1/2015	14	31	X				Includes motor, disconnect, motor branch wiring, testing
Disconnect existing Hobart primary tap (DTE work)	3/15/2015		1	24	X	X			Taking pumps No. 1 and No. 2 out of service as a precaution only
Remove Hobart existing primary feeders/transformer	3/25/2015		5	40					
Remove remaining Hobart equipment		4/9/2015	10	40					
Total Phase 2 Duration			159						

END OF SECTION

SECTION 01210

ALLOWANCES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cash Allowances

1.2 DEFINITIONS

- A. Cash Allowance: A monetary sum that includes, as part of the contract price, the associated costs and requirements to complete the specified allowance.

1.3 SUBMITTALS

- A. Submit detailed invoices to indicate the work performed or delivery slips to indicate actual quantities of materials delivered to the site for use in fulfillment of each allowance.

1.4 OWNER'S INSTRUCTIONS

- A. At the earliest feasible date after contract award the Contractor shall notify all utility companies and begin coordination efforts in order to avoid delay in performance of the work.
- B. Use allowances only as directed for Owner's purposes, and only by Change Orders which designate amounts to be charged to the allowance.
- C. If the actual price for the specified allowance is more or less than the stated allowance, the contract price shall be adjusted accordingly by Change Order. The adjustment in contract price shall be made in accordance with the General Conditions.
- D. At project closeout, any amounts remaining in allowances will be credited to Owner by Change Order.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate materials and their installation for each allowance with related materials and installations to ensure that each allowance item is completely integrated and interfaced with related construction activities.

3.2 CASH ALLOWANCE FOR PERMITS

- A. Contractor shall apply for and pay all fees for the City of Ann Arbor building trade and Soil Erosion Control permits. A cash allowance of \$50,000 shall be included in the contract price for the payment of the permit fees. This allowance shall only be used to pay for the documented permit fees. All paperwork and coordination between the Contractor and City shall be considered incidental to the Contract.
- B. Contractor shall pay all fees related to DTE Energy for the medium voltage upgrades at Barton Pump Station. DTE Energy will be performing the following work:
- Furnish and install new skip poles
 - Furnish and install new overhead equipment and conductors as required
 - Install and terminate all incoming service conductors including underground conductors
 - Install and terminate all conductors up to primary side of utility transformers including all related terminations to the primary side load break switch/utility metering
 - Furnish and install utility metering that is capable of remote reads. Commission remote reading system.
 - Commission primary utility services, load breaker switches and metering.
- The cash allowance of \$150,000 is to be included in the contract price to pay DTE Energy for their scope of work.
- C. Contractor shall pay fees related to DTE Energy for temporary services and upgrades at the South Industrial Booster Station. The cash allowance of \$10,000 is to be included in the contract price to pay DTE Energy for their work.
- D. Contractor shall furnish and install a new generator controller with breaker system, including field verification of breaker operation, interlocks, breaker size/function and shunt trip current transformers to be located in the generator. An allowance of \$25,000 is to be included in the contract price for this work.

END OF SECTION

SECTION 01290

PAYMENT PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Schedule of Values.
- B. Initial Application of Payment
- C. Application for Payment
- D. Application for Payment at Substantial Completion
- E. Final Payment Application

1.2 RELATED SECTIONS

- A. Section 01330 - Submittal Procedures

1.3 SCHEDULE OF VALUES

- A. Submit typed schedule for review and approval. The approved schedule of values will be used to prepare future Applications for Payment.
- B. Submit Schedule of Values in triplicate to the Engineer within 15 days after date of Owner-Contractor Agreement for approval.
- C. Format: Identify each line item with number and title of the major specification Section.
- D. Include within each line item, a direct proportional amount of Contractor's overhead and profit.
- E. Revise schedule to list approved Change Orders, with each Application for Payment.
- F. Include the following Project Identification on the Schedule of Values:
 - 1. Project Name and Location
 - 2. Name of Engineer
 - 3. Project Number
 - 4. Contractor's Name and Address
 - 5. Date of Submittal
- G. Arrange Schedule of Values in a tabular form with separate rows for each Specification Section and separate columns for each major structure of area of Work. Additionally, separate line items for the following shall be included:
 - 1. Mobilization (Maximum 5% of Contract Total)

2. Bonds & Insurance
 3. Allowances
 4. Start-Up and Commissioning
 5. Training and O&M Manuals (Minimum 1% of Contract Total)
 6. Project Close-Out
- H. Provide a breakdown of the Contract Price in sufficient detail to facilitate continued evaluation of Application for Payment and progress reports. Break principal subcontract amounts down into several line items.
- I. For each part of the Work where an Applicant for Payment may include materials for equipment, purchased or fabricated and stored, but not yet installed, provide separate line items on Schedule of Values for initial cost of the materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
- J. Update and resubmit schedule of values when change orders result in a change in the contract price.
- K. Schedule of Valves shall be submitted as a shop drawing for Owner approval.
- L. Schedule of Valves shall be divided into the major divisions.

1.4 INITIAL APPLICATION FOR PAYMENT

- A. Administrative actions and submittals that must precede submittal of the first Application for Payment include the following:
1. List of Subcontractors
 2. List of Principal Suppliers and Fabricators
 3. Schedule of Values
 4. Contractor's Construction Schedule (preliminary not final)
 5. Submittal Schedule (preliminary if not final)
 6. All State of Michigan Drinking Water Revolving Fund requirements, including but not limited to, weekly payrolls, payroll affidavits, and all related documents.

1.5 APPLICATIONS FOR PAYMENT

- A. Submit six (6) copies of each application.
- B. Content and Format: Utilize Schedule of Values and Change Orders for listing items in Application for Payment.
- C. Payment Period: Payments made according to the schedule described in the General Conditions and or in accordance with the Owner's requirements.
- D. With each copy of the applications submit Waiver of Lien from all subcontractors or suppliers for work included in Application for Payment, other than the first pay application.

- E. Submit a completed Contractor's Declaration with each Application for Payment.
- F. All State of Michigan Drinking Water Revolving Fund requirements, including but not limited to, weekly payrolls, payroll affidavits, and all related documents.

1.6 APPLICATION FOR PAYMENT AT SUBSTANTIAL COMPLETION

- A. Following issuance of Certificate of Substantial Completion, submit an Application for Payment.
- B. Administrative actions and submittals that shall proceed or coincide with this application include:
 - 1. Occupancy permits and similar approvals.
 - 2. Warranties (guarantees) and maintenance agreements.
 - 3. Test/adjust/balance records.
 - 4. Maintenance instructions; O&M manuals.
 - 5. Meter readings.
 - 6. Start-up performance reports and inspection reports.
 - 7. Changeover information related to Owner's occupancy, use, operation and maintenance.
 - 8. Final cleaning.
 - 9. Application for reduction of retainage, and consent of surety.
 - 10. Advice on shifting insurance coverage.
 - 11. List of incomplete work, recognized as exceptions to Engineer's Certificate of Substantial Completion.
 - 12. As-Built Drawings.
 - 13. Delivery of spare parts.

1.7 FINAL PAYMENT APPLICATION

- A. Administrative actions and submittals which must precede or coincide with submittal of the final payment Application for Payment include the following:
 - 1. Completion of Project Closeout requirements.
 - 2. Completion of items specified for completion after Substantial Completion.
 - 3. Assurance that unsettled claims will be settled.
 - 4. Assurance that work not complete and accepted will be completed without undue delay.

5. Proof that taxes, fees, and similar obligations have been paid.
6. Removal of temporary facilities and services.
7. Removal of surplus materials, rubbish, and similar elements.
8. Change of door locks to OWNER's access.
9. CONTRACTOR's waivers of liens for project.
10. Written description of how all punch list items were addressed.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01310

PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Project Superintendence
- B. Coordination and Project Conditions
- C. Field Engineering
- D. Pre-Construction Conference
- E. Site Mobilization Meeting
- F. Progress Meetings
- G. Preinstallation Meetings

1.2 PROJECT SUPERINTENDENCE

- A. CONTRACTOR's superintendent shall be on site full time for the duration of the project and shall meet the experience requirements identified in the Instructions to Bidders.

1.3 COORDINATION AND PROJECT CONDITIONS

- A. Coordinate with utility companies for construction of utilities to the construction site.
- B. Coordinate with other contractors to complete connections to other work.
- C. Coordinate construction operations included under different Section of the Specifications that are dependent upon each other for proper installation, connection, and operation. Where installation of one part of the work is dependent on installation of other components, either before or after its own installation, schedule construction activities in the sequence required to obtain the best results. Where availability of space is limited, coordinate installation of different components to assure maximum accessibility for required maintenance, service and repair. Make adequate provisions to accommodate items scheduled for later installation.
- D. CONTRACTOR shall be responsible for coordinating any exchange of material safety data sheets or other hazard communication information required to be made available to or exchanged between or among employers at Site in accordance with Laws or Regulations. CONTRACTOR shall train CONTRACTOR's employees on use of these sheets and shall keep a master copy on hand at site.
- . Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and ensure orderly progress of the work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Schedules
 2. Installation and removal of temporary facilities.
 3. Delivery and processing of submittals.
 4. Progress meetings.
 5. Request of information.
 6. Project closeout activities.
- E. Coordinate scheduling, submittals, and Work of the various sections of the Contract Documents to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- F. Verify utility requirements and characteristics of operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- G. Check motor voltages and control characteristics.
- H. Coordinate controls, interlocks, wiring of switches, and relays.
- I. Coordinate wiring and control diagrams.
- J. After OWNER occupancy of premises, coordinate access to site for correction of defective Work and Work not in accordance with Contract Documents, to minimize disruption of OWNER's activities.

1.4 FIELD ENGINEERING

- A. CONTRACTOR shall protect survey control and reference points. Promptly notify ENGINEER of any discrepancies discovered.
- B. Control datum for survey is shown on Drawings.
- C. Field verify all dimensions and measurements.
- D. Verify setbacks and easements; confirm drawing dimensions and elevations.
- E. Provide field-engineering services. Establish elevations, lines, and levels, utilizing recognized engineering survey practices.
- F. Protect survey control points prior to starting site work; preserve permanent reference points during construction.
- G. Promptly report to ENGINEER the loss or destruction of any reference point or relocation required because of changes in grades or other reasons.
- H. Replace dislocated survey control points based on original survey control. Make no changes without prior written Notice to ENGINEER.

1.5 PRE-CONSTRUCTION CONFERENCE

- A. OWNER will schedule a pre-construction conference and organizational meeting at the site or other convenient location prior to commencement of construction activities to review responsibilities and personnel assignments.
- B. Attendees: OWNER, ENGINEER and ENGINEER's consultants, CONTRACTOR and its superintendent, major subcontractors, manufacturers, suppliers, utility companies, and other concerned parties shall each be represented at the conference by persons familiar with and authorized to conclude matter relating to the work.
- C. Agenda: Discuss items of significance that could affect progress including such topics as:
 - 1. Site Access and Badging
 - 2. Tentative Construction Schedule.
 - 3. Critical Work sequencing.
 - 4. Designation of responsible personnel.
 - 5. Coordination with other construction work and other CONTRACTORS.
 - 6. Procedures for processing field decisions and Change Orders.
 - 7. Procedures for processing Applications for Payment.
 - 8. Distribution of Contract Documents.
 - 9. Submittal of Shop drawings, Product Data, Samples and Schedule.
 - 10. Preparation of record documents
 - 11. Use of the premises.
 - 12. Office, work, and storage areas.
 - 13. Equipment deliveries and priorities.
 - 14. CONTRACTOR's Quality Assurance Plan.
 - 15. Safety procedures.
 - 16. First Aid.
 - 17. Security.
 - 18. Housekeeping.
 - 19. Working hours.

- 20. Stormwater Management and Soil Erosion Control Provisions.
- 21. Utility Contacts.
- D. In addition to the Pre-Construction Conference, ENGINEER may also require a Pre-Excavation, Concrete Pre-Pour Conference, and/or other critical activity conference. CONTRACTOR and Subcontractors performing excavation work on site shall describe their plans for shoring, dewatering, disposal of spoils, and any other particulars of the excavation process, including the technical basis for their selection of the means and methods to be employed.

1.6 SITE MOBILIZATION MEETING

- A. OWNER will schedule a conference at the project site prior to the CONTRACTOR's occupancy.
- B. Attendance required by the OWNER, ENGINEER, CONTRACTOR's Superintendent, and the major subcontractors.
- C. CONTRACTOR shall submit a site plan identifying the CONTRACTOR's limits of work, trailer and storage area locations, for coordination with other work.
- D. Agenda:
 - 1. Use of premises by OWNER and CONTRACTOR.
 - 2. OWNER's requirements.
 - 3. Construction facilities and controls.
 - 4. Temporary utilities.
 - 5. Survey.
 - 6. Security and housekeeping procedures.
 - 7. Schedules.
 - 8. Procedures for maintaining record documents.
 - 9. Inspection and acceptance of equipment put into service during the construction period.

1.7 SITE SAFETY MEETING

- A. OWNER will schedule a conference at the project site prior to the CONTRACTOR's occupancy.
- B. Attendance required by the OWNER, ENGINEER, CONTRACTOR's Superintendent, CONTRACTOR's Safety Officers, and all subcontractors.

- C. Agenda:
 - 1. Safety procedures.
 - 2. First Aid
 - 3. Security

1.8 PROGRESS MEETINGS

- A. Schedule and administer meetings throughout progress of the Work at maximum monthly intervals.
- B. Make arrangements for meetings, prepare agenda with copies for participants, preside at meetings, record and distribute the minutes.
- C. Attendance Required: Job superintendent, major subcontractors and suppliers, OWNER, ENGINEER as appropriate to agenda topics for each meeting.
- D. Agenda:
 - 1. Review minutes of previous meetings.
 - 2. Review of Work progress.
 - 3. Field observations, problems, and decisions.
 - 4. Identification of problems that impede planned progress.
 - 5. Review of submittals schedule and status of submittals.
 - 6. Review of RFIs.
 - 7. Review of off-site fabrication and delivery schedules.
 - 8. Maintenance of progress schedule.
 - 9. Corrective measures to regain projected schedules.
 - 10. Planned progress during succeeding work period.
 - 11. Coordination of projected progress.
 - 12. Maintenance of quality and work standards.
 - 13. Effect of proposed changes on progress schedule and coordination.
 - 14. Other business relating to Work.
- E. Record minutes and distributes copies within two days after meeting to participants, with copies to ENGINEER, OWNER, participants, and those affected by decisions made.

- F. Submit updated construction schedule to the OWNER/ENGINEER for review two days before each progress meeting. Revise construction schedule as needed after each progress meeting and resubmit to the OWNER/ENGINEER with the meeting minutes.

1.9 PREINSTALLATION OR SHUTDOWN COORDINATION MEETING

- A. When required in individual specification sections, or as deemed necessary by the CONTRACTOR, ENGINEER or OWNER, convene a preinstallation or shutdown coordination meeting at the site prior to commencing work.
- B. Require attendance of parties directly affecting, or affected by, Work of the specific section.
- C. Notify OWNER/ENGINEER five working days in advance of meeting date.
- D. Prepare agenda and preside at meeting:
 - 1. Review conditions of shutdown, installation, preparation and installation procedures.
 - 2. Review coordination with related work.
- E. Record minutes and distributes copies within two days after meeting to participants, with copies to ENGINEER/OWNER participants, and those affected by decisions made.

1.10 FINAL INSPECTION MEETING

- A. When the CONTRACTOR has provided written notice that the project is complete, a final inspection meeting shall be scheduled with the CONTRACTOR, ENGINEER, and OWNER.
- B. ENGINEER will notify the CONTRACTOR in writing of all items which this inspection reveals are incomplete or defective.
- C. CONTRACTOR shall immediately take all necessary measures to remedy such deficiencies. A written description of how each item has been addressed shall be submitted to the ENGINEER and OWNER.

1.11 CLOSEOUT/WARRANTY MEETING

- A. Prior to final application for payment, a closeout/warranty meeting shall be scheduled with the CONTRACTOR, ENGINEER and OWNER.
- B. Agenda:
 - 1. Project record document review.
 - 2. Verify receipt of spare parts and maintenance products.
 - 3. Review preventative maintenance schedule.
 - 4. Review submitted warranties and bonds.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01320

CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pre-Construction Documentation
- B. Photographic Progress Documentation

1.2 ELECTRONIC STORAGE

- A. Maintain organized electronic storage of project pre-construction and progress photos and video until Final Payment.

1.3 PRE-CONSTRUCTION DOCUMENTATION

- A. Contractor shall take a sufficient number of digital pre-construction photographs, minimum 100, so as to resolve any disputes, which may arise regarding the considerations prior to and subsequent to construction.
- B. Contractor shall furnish one USB flash drive of the digital Pre-construction photographs to the Engineer, and shall make others available for review in settling any disputes.
- C. In addition to photographs, the Contractor shall produce a high quality pre-construction video of the entire site on USB Flash Drive and submit it to the Engineer.
- D. If a dispute arises where digital pre-construction photographs or video was not taken, the disputed area shall be restored to the extent directed by the Engineer and to the complete satisfaction of the Engineer.

1.4 PROGRESS PHOTOGRAPHS

- A. Contractor shall take enough digital photographs to sufficiently record the construction progress of the project. All critical construction events shall be thoroughly recorded with photographs.
- B. Contractor shall maintain one 3-ring binder in the construction trailer with photos printed on 8.5" x 11" pages. Each page of the binder shall have two 4" x 6" digital photos printed along with an identification caption below each photo. Photos shall be organized in tabbed sections by the type of work shown. Photo binder shall be delivered to the Owner with the final application for payment.
- C. With the each application for payment, the Contractor shall submit all photos taken during the previous month on one USB flash drive.
- D. Contractor shall organize the photos into files by work area, discipline and date.

PART 2 - PRODUCTS

2.1 PHOTOGRAPHS

- A. Digital
- B. Size: 10.0 Megapixel Minimum
- C. Format: JPEG

2.2 BINDER PAGES

- A. Paper Size: 8.5" x 11"
- B. Paper Weight: 240 g/m²
- C. Finish: Semi-Gloss

2.3 IDENTIFICATION

- A. Identify in caption below each print:
 - 1. Description and location of view.
 - 2. Time and date of exposure.

PART 3 - EXECUTION

3.1 TECHNIQUE

- A. Factual presentation.
- B. Correct exposure and focus.
 - 1. High resolution and sharp.
 - 2. Maximum depth-of-field.
 - 3. Minimum distortion.

3.2 VIEWS REQUIRED

- A. Consult with Engineer for instructions concerning views required.
- B. Photograph from locations to adequately illustrate state of project, or condition of construction.
- C. In addition, provide photographs prior to, at critical stages of, and at the end of construction, when they do not coincide with scheduled times.

3.3 DELIVERY OF PRINTS

- A. Deliver digital copies of photos monthly to accompany each request for progress payment. Photos shall be submitted on one USB flash drive.
- B. Deliver 3-ring photo binder with the final application for payment.

END OF SECTION

SECTION 01330

SUMITTAL PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Submittal Procedures
- B. Certifications
- C. Shop Drawings
- D. Product Data
- E. Samples
- F. Manufacturers' Instructions
- G. Manufacturers' Field Reports
- H. Construction Schedule
- I. Submittal Schedule

1.2 SUBMITTAL PROCEDURES

- A. Package each submittal appropriately for shipping and handling. This shall include an index either on the transmittal or within the submittal itself. Transmit each submittal from CONTRACTOR to ENGINEER using a transmittal form. Submittals received from sources other than CONTRACTOR will be returned without action. Use separate transmittals for items from different specification sections. Number each submittal consecutively. Resubmittals should have the same number as the original, plus a letter designation for each Resubmittal (i.e. 7-A, 7-B, etc.)
- B. Indicate on the transmittal relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include CONTRACTOR's certification that information complies with Contract Document requirements. On Resubmittal, all changes shall be clearly identified for ease of review. Resubmittals shall be reviewed for the clearly identified changes only. Any changes not clearly identified will not be reviewed and original submittal shall govern.
- C. Include the following information on the label for processing and recording action taken.
 - 1. Project name.
 - 2. Date.
 - 3. Name and address of ENGINEER.
 - 4. Name and address of CONTRACTOR.

5. Name and address of subcontractor.
 6. Name and address of supplier.
 7. Name of manufacturer.
 8. Number and title of appropriate specification sections.
 9. Drawing number and detail references, as appropriate.
- D. Schedule submittals to expedite the Project, and deliver to ENGINEER at business address. Coordinate submission of related items. Coordinate related activities that require sequential activity.
 - E. Submit a schedule of shop drawing submittals.
 - F. Review and approve shop drawings, project data, and samples before submitting them.
 - G. Verify field measurements, field construction criteria, catalog numbers, and similar data. Indicate on the submission exactly what was verified.
 - H. Any markings done by CONTRACTOR shall be done in a color other than red. Red is reserved for ENGINEER's marking.
 - I. The number of copies to be submitted will be determined at the pre-construction conference. Reproducible may be submitted and will be marked and returned to CONTRACTOR. Blue or black line prints shall be submitted in sufficient quantity for distribution to ENGINEER and OWNER recipients.
 - J. Coordinate each submittal with the requirements of the Contract Documents.
 - K. Provide space for CONTRACTOR and ENGINEER review stamps.
 - L. Apply CONTRACTOR's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information, is in accordance with the requirements of the Work and Contract Documents.
 - M. Submit the number of copies that the CONTRACTOR requires, plus four copies that will be retained by the OWNER and ENGINEER.
 - N. Identify variations from Contract Documents and Product or system limitations that may be detrimental to successful performance of the completed Work.
 - O. No claim will be allowed for damages or extension of time because of delays in the work resulting from rejection of material or from revision and resubmittal of shop drawings, project data, or samples.
 - P. No extension of contract time will be authorized because of failure to transmit submittals to ENGINEER sufficiently in advance of the work to permit processing.
 - Q. ENGINEER reserves the right to withhold action on a submittal required coordination with other submittals until related submittals are received.

- R. Do not install materials or equipment which requires submittals until the submittals are returned with ENGINEER's/OWNER's stamp and initials or signature indicating approval. The OWNER shall have final approval authority.
- S. CONTRACTOR's responsibility of errors, omissions, and deviations from requirements of Contract Documents in submittals is not relieved by the ENGINEER's review.
- T. Distribute copies of reviewed submittals to concerned parties. Instruct parties to promptly report any inability to comply with requirements.
- U. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.
- V. Submittals not requested in conformance with this Specification will not be recognized or processed.
- W. Revise and resubmit as required, identify all changes made since the previous submittal.
- X. In the event that more than two re-submittals of any submittal is necessary to achieve conformance to the contract requirements, CONTRACTOR shall be charged for excess engineering. The OWNER shall deduct these charges from the CONTRACTOR's final payment. Charges will be \$125.00/hr. minimum 4 hours, for each additional submittal of an item. A tabulated record of such charges will be provided for the CONTRACTOR's review prior to the processing of the final payment.
- Y. Submit new project data and samples when the initial submittal is returned disapproved.

1.3 CERTIFICATIONS

- A. When specified in individual specification sections, submit certification by the manufacturer, installation/application subcontractor, or the CONTRACTOR to ENGINEER, in quantities specified for Product Data.
- B. Indicate that the material or Product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
- C. Certifications may be recent or previous test results of the material or product, but must be acceptable to ENGINEER.

1.4 SHOP DRAWINGS

- A. Shop Drawings: Submit to ENGINEER for review for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. Produce copies and distribute in accordance with Paragraph 1.2 - Submittal Procedures.
- B. Submit newly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of shop drawings. Standard information prepared without specific reference to the project is not considered shop drawings.
- C. Shop drawings include fabrication and installation drawings, setting diagrams, schedules, patterns, templates, and similar drawings. Include the following information:

1. Dimension.
 2. Identification of products and materials included.
 3. Compliance with specified standards.
 4. Notation of coordination requirements.
 5. Notation of dimensions established by field measurements.
- D. Nameplate data for equipment including electric motors shall be included on shop drawings. Electric motor data shall state the manufacturer, horsepower, service factor, voltage, enclosure type, oversize wiring box, etc.
- E. Shop drawings shall indicate shop painting requirements to include type of paint and manufacturer.
- F. Standard manufactured items in the form of catalog work sheets showing illustrated cuts of the items to be furnished, scale details, sizes, dimensions, quantity, and all other pertinent information should be submitted and approved in a similar manner.
- G. Measurements given on shop drawings or standard catalog sheets, as established from contract drawings and as approved by ENGINEER, shall be followed. When it is necessary to verify field measurements, they shall be checked and established by CONTRACTOR. The field measurements so established shall be followed by CONTRACTOR and by all affected trades.
- H. Indicate special utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

1.5 PRODUCT DATA

- A. Product Data: Submit to ENGINEER for review for the limited purpose of checking for conformance with information given and the design concept expressed in the Contract Documents. Produce copies and distribute in accordance with Paragraph 1.2 - Submittal Procedures.
- B. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.
- C. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

1.6 SAMPLES

- A. Submit full-size, fully fabricated samples cured and finished as specified and physically identical with the material or product proposed. Samples include partial sections of manufactured or fabricated components, cuts or containers or materials, color range sets, and swatches showing color, texture, and pattern.
- B. Mount, display, or package samples in the manner specified to facilitate review of qualities indicated. Prepare samples to match ENGINEER's sample. Include the following:

1. Generic description of the sample.
 2. Sample source.
 3. Product name or name of manufacturer.
 4. Compliance with recognized standards.
 5. Availability and delivery time.
- C. Submit samples for review of kind, color, pattern, and texture, for a final check of these characteristics with other elements, and for a comparison of these characteristics between the final submittal and the actual component as delivered and installed.
- D. Refer to other specifications sections for requirements for samples that illustrate workmanship, fabrication techniques, details of assembly, connections, operation, and similar construction characteristics.
- E. Preliminary Submittals: Where samples are for selection of color, pattern, texture, or similar characteristics from a range of standard choices, submit a full set of choices for the material or product.
1. Preliminary Submittals will be reviewed and returned with ENGINEER's mark indicating selection and other action.
- F. Except for samples illustrating assembly details, workmanship, fabrication techniques, connections, operation and similar characteristics, submit 3 sets; one will be returned marked with the action taken.
- G. Maintain sets of samples, as returned, at the site, for quality comparisons throughout the course of construction.
- H. Unless noncompliance with Contract Document provisions is observed the submittal may serve as the final submittal.
- I. Sample sets may be used to obtain final acceptance of the construction associated with each set.

1.7 MANUFACTURER'S INSTRUCTIONS

- A. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to ENGINEER for delivery to OWNER in quantities specified for Product Data.
- B. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.8 MANUFACTURER'S FIELD REPORTS

- A. Submit report in duplicate, within 7 days of observation, to ENGINEER and OWNER for Information.
- B. Submit for information for the limited purpose of assessing conformance with information given and the design concept expressed in the Contract Documents.

1.9 CONSTRUCTION SCHEDULE

A. Bar Chart Schedule:

1. Prepare a fully developed, horizontal bar chart type construction schedule. Schedule shall be prepared electronically in Microsoft Project with critical path and links shown. Submit color copies of the schedule within 30 days of the date established for commencement of the work.
2. Provide a separate item bar for each significant construction activity. Provide a continuous vertical line to identify the first working day of each week. Use the same breakdown of units of the work as indicated on schedule of values.
3. Prepare schedule of sheet, or series of sheets, of stable transparency, or other reproducible media, of sufficient width to show data for entire construction period.
4. Secure time commitments for performing critical elements of the work from parties involved. Coordinate each element on schedule with other construction activities; include minor elements involved in the sequence of the work. Show each activity in proper sequence. Indicate graphically sequences necessary for completion of related portions of the work.
5. Coordinate construction schedule with schedule of values, list of subcontracts, submittal schedule, progress reports, payment requests, and other schedules.
6. Indicate completion in advance of the date established for substantial completion. Indicate substantial completion of schedule to allow time for ENGINEER's procedures necessary for certification of substantial completion

B. Schedule Updating: Provide an updated construction schedule at each progress meeting. Color copies of the updated schedule shall be prepared for all attendees.

1.10 SUBMITTAL SCHEDULE

- A. After development and acceptance of the construction schedule, prepare a complete schedule of submittals. Submit schedule within 10 days of the date required for establishment of construction schedule.
- B. Coordinate submittal schedule with the list of subcontracts, schedule of values, and the list of products as well as construction schedule.
- C. Prepare schedule in chronological order; include submittals required during the first 90 days Provide the following information:
 1. Scheduled date for the first submittal.
 2. Related section number.
 3. Submittal category.
 4. Name of subcontractor.

5. Description of the part of the work covered.
 6. Scheduled date for Resubmittal.
 7. Scheduled date ENGINEER's final release or approval.
- D. The submittal schedule shall reflect critical path shop drawings that must be expedited.
 - E. Following response to initial submittal, print and distribute copies to ENGINEER, OWNER, subcontractors, and other parties required to comply with submittal dates indicated. Post copies in the project meeting room and field office.
 - F. When revisions are made, distribute to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the work and are no longer involved in construction activities.
 - G. Schedule Updating: Provide an updated submittal schedule at each progress meeting.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 ENGINEER'S ACTION

- A. Except for submittals for record, information or similar purposes, where action and return is required or requested, ENGINEER will review each submittal, mark to indicate action taken, and return promptly.
 1. Compliance with specified characteristics is CONTRACTOR's responsibility.
- B. Action Stamp: ENGINEER will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, as follows, to indicate the action taken:
 1. Final Unrestricted Release: Where submittals are marked "No Exceptions Taken" that part of the work covered by the submittal may proceed provided it complies with the requirements of the Contract Documents; final acceptance will depend upon the compliance.
 2. Final-But-Restricted Release: When submittals are marked "Make Corrections Noted" that part of the work covered by the submittal may proceed, provided it complies with notation or correction on the submittal and requirements of the Contract Documents; final acceptance will depend on that compliance.
 3. Returned for Resubmittal: When submittal is marked "Rejected" or "Revise and Resubmit" do not proceed with the part of the work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal in accordance with the notations; resubmit without delay. Repeat if necessary to obtain a different action mark.

- a. Do not permit submittals marked "Rejected" or "Revise and Resubmit" to be used at site, or elsewhere where work is in progress.
4. Additional Information Needed: When submittal is marked "Submit Specified Item" CONTRACTOR shall submit requested information.
5. Other Action: Where a submittal is primarily for information or record purposes, special processing or other activity, the submittal will be returned, marked "Acknowledge Receipt".
6. The approval of ENGINEER shall not relieve CONTRACTOR of responsibility for errors on drawings or submittals as ENGINEER's checking is intended to cover compliance with drawings and specifications and not enter into every detail of the shop work.

END OF SECTION

SECTION 01370

LEAD BASED PAINT REMOVAL

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The scope of work for this project covers the supplying of all labor, tools, materials, equipment, services and appurtenances to accomplish the work described below and shown on the Drawings. The work shall be performed to the complete satisfaction of the Owner or the Engineer, in accordance with the current EPA and OSHA regulations, State Labor and Industry and Department of Environmental Resources regulations (if applicable) and any other applicable state and local government.

- B. Work under this project includes but is not limited to the following:
 - 1. Demolition and removal of the lead-based paint materials including the following:
 - a. All items to be demolished or modified in the existing pump stations, electrical rooms, and motor rooms including process piping, valves, motors, base plates, conduit, electrical equipment, and all other related items.
 - b. All surfaces to be prepared and painted including the ceiling of the lower level pump room, the new electrical room and all other related areas.
 - 2. The Contractor will be responsible for the abatement and demolition of any lead-based paint materials and any other painted surfaces in the locations identified above to the extent needed to properly remove and dispose of the items.
 - 3. The Contractor will be responsible for the abatement of any other lead-based paint that is disturbed as part of any demolition work or new work included in this project.
 - 4. The Contractor will be responsible for the removal, storage, transportation, and disposal of all lead-based paint and hazardous materials generated by this work.
 - 5. Some existing paint has been determined to contain lead. Available lead testing results are provided in Appendix B for the process piping in the Barton existing pump room.
 - 6. The Owner previously abated the lead based paint in the lower level pump room at Barton Pump Station on the walls and ceiling only.
 - 7. Coordination of all lead-based paint abatement work with the Owner and the Contractor.

1.2 CONTROL OF WORK

- A. All work which does not conform to the requirements of this Section will be considered unacceptable.

- B. Unacceptable work, whether the result of poor workmanship, use of defective materials, damage through carelessness, or any other cause found to exist prior to the final acceptance of the work, shall be removed immediately and replaced in an acceptable manner.
- C. If the Owner or Engineer finds the materials furnished or the work performed has resulted in an unacceptable finished product the affected work or material shall be removed and replaced or otherwise corrected by and at the expense of the Contractor.

1.3 STIPULATIONS

- A. For bidding and project execution purposes, it shall be assumed that all existing surfaces in the locations identified in paragraph 1.01.B.1 are coated with lead based paint (LBP) unless noted otherwise in this specification Section or Appendix.
- B. The procedures specified in this section are guidelines for minimum performance. The Contractor is responsible for his own methods of operations and conformance to regulatory codes, rules and guidelines. The Contractor is required to obtain all permits, licenses and approvals (if required) to perform the work, including any rights to use patented systems.

1.4 QUALITY ASSURANCE

- A. Compliance with Standards and Regulations
 - 1. The Contractor is solely responsible for compliance with all Federal, State, and Local laws and regulations and all Industry Standard practices associated with the abatement, demolition, storage, transport, and disposal of Hazardous Wastes, as well as all general conditions, special conditions, and all other sections within the Contract Document.
 - 2. Contractor shall demonstrate to the satisfaction of the Owner or Engineer that the project was completed in accordance with this Section and any applicable EPA and MDEQ standards and regulations.
- B. Worker Requirements
 - 1. The Contractor shall furnish proof that each employee has had previous instruction on the hazards of lead exposure, on use and fitting of respirators, on protective dress, on use of decontamination procedures, on entry and exit from work areas, and on all aspects of work procedures and protective measures and all other requirements.
 - 2. Submit verification, signed by an occupational health physician, that each employee has been recently examined as required by OSHA regulations. Medical examination will be required prior to entering the work area.
 - 3. Submit names and training certificates of the superintendent and foreman who will be performing work related to this project.
 - 4. Provide verification that the Contractor has provided the following information to the examining physician:
 - a. A copy of OSHA Standard (29 CFR 1910.1025)

- b. A description of the affected employee's duties as they relate to the employee's exposure.
- c. The employee's current or anticipated exposure level.
- d. A description of any personal protective and respiratory equipment to be used.
- e. Prior lead determination and information from previous medical examinations of the affected employee that is not otherwise available to the examining physician.

1.5 PLACEMENT OF WARNING SIGNS

- A. Post warning signs in and around the work area. Locate signs at such a distance that personnel may read the sign and take necessary protective steps required before entering the work area.
- B. Inform other employers on-site of the nature of the Contractor's work and requirements pertaining to regulated areas in order to comply with OSHA regulation 29 CFR 1910.120. Such notification shall be coordinated with, and approved by the Owner.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 LEAD ABATEMENT

- A. All demolition and abatement work to be coordinated with Owner so as not to disrupt the Owner's daily operating procedures.
- B. The Contractor shall protect all process equipment from lead dust during abatement.
- C. The Contractor shall be responsible for the removal, storage, transportation, and dispose of all lead based paint materials.

3.2 REMOVAL

- A. Removal work shall not commence until:
 - 1. Work has been coordinated with the Owner.
 - 2. Arrangements have been made for disposal of waste at an acceptable site.
 - 3. Work areas and parts of the building required to remain in use are effectively segregated.
 - 4. Tools, equipment, and material waste receptors are on hand.
 - 5. Arrangements have been made for building security.

6. All preparatory steps have been taken and applicable notices posted and permits obtained (if required).

3.3 DAMAGES

- A. The Contractor shall protect adjacent areas from contamination.

3.4 DAILY CLEANUP

- A. A thorough cleanup of the entire area under active abatement shall occur daily during the entire abatement process

3.5 STORAGE OF LIQUID AND SOLID WASTE

- A. The Contractor must make provisions for the safe storage of waste on-site prior to disposal. For safety reasons, waste storage areas must be treated as abatement areas and access restricted.

3.6 CONTROLLING OFFSITE DISPERSAL

- A. Basic control measures to minimize the dispersal of lead dust and debris from the work area are:
 1. Control and limit access to the abatement work areas.
 2. Limit tracking of dust and debris.
 3. Implement a program of ongoing cleanup.

3.7 CLEANUP AND CLEARANCE TESTING

- A. The Contractor shall perform air, wipe, water, and/or Toxicity Characteristics Leaching Procedure (TCLP) sample collection during the abatement under the supervision of the Owner or the Engineer.
- B. Final cleanup shall proceed as follows:
 1. The entire abatement area shall be washed down with a Tri-Sodium Phosphate (TSP) solution. To avoid recontaminating the cleaned area, this solution should be changed according to the manufacturer's recommendations. The dirty water from this operation is considered hazardous and shall be disposed of in watertight containers as required by Paragraph 2.09 below.
- C. After this phase of the final cleanup is complete, a visual inspection will be performed by the Owner or the Engineer to ensure that all visible dust and debris have been removed from the work surfaces and the work area. Any unsatisfactory results will cause the Contractor to re-clean the affected surfaces until the inspector is satisfied with the results.
- D. Clearance testing may now take place by taking wipe samples of the abated area. The clearance criterion is 200 micrograms per square foot. Clearance testing is the responsibility of the Contractor.
- E. Any areas which do not meet these criteria shall be re-cleaned and retested until the standards are met.

3.8 DISPOSAL OF LEAD WASTE

- A. The lead paint chips, all wastewater from cleaning operations, all plastic used for containment, and all rags, cloths or sponges used for cleaning shall be disposed of as hazardous waste. These materials shall be removed in sealed, labeled containers at an authorized disposal site in accordance with all applicable hazardous waste regulations.
- B. The waste materials shall be handled as potentially hazardous waste in accordance with applicable sections of the Natural Resources and Environmental Protection Act, 1994 PA 451. No separate payment for disposal shall be made and the cost of this work is to be included in the work. The Contractor shall furnish to the Owner a certificate of disposal of this material at an appropriate disposal facility, issued by the office of the receiving disposal facility.
- C. A waste manifest shall be forwarded to the Owner after the disposal.

END OF SECTION

SECTION 01420

REFERENCES

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Reference Standards
- B. Abbreviations and Acronyms

1.02 REFERENCE STANDARDS

- A. Applicability of Standards: Except where 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. Such standards are made a part of the Contract Documents by reference.
- B. For products or workmanship specified by association, trade, or Federal Standards; comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
 - 1. Applicable Codes – Latest adopted editions of:
 - a. Michigan Building Code / International Building Code.
 - b. The National Electrical Code, NFPA 70, with amendments.
 - c. International Fire Code.
 - d. International Code Council (ICC) ANSI A117.
 - e. Michigan Mechanical and Plumbing Codes.
- C. Conform to reference standard by date of issue current on date of Contract Documents.
- D. Should specified reference standards conflict with Contract Documents, request clarification from ENGINEER before proceeding.
- E. The contractual relationship of the parties to the Contract shall not be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.03 ABBREVIATIONS AND ACRONYMS

- A. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. The following acronyms or abbreviations as referenced in Contract Documents are defined to mean the associated names. Names and addresses are subject to change and are believed to be, but are not assured to be, accurate and up to date as of date of Contract Documents.

AA Aluminum Association
 818 Connecticut Avenue, N.W.
 Washington, DC 20006

AABC	Associated Air Balance Council 1518 K St. NW, Suite 503 Washington DC, 20005
AASHTO	American Association of State Highway and Transportation Officials 444 North Capitol St, NW, Suite 249 Washington, DC 20001
ACI	American Concrete Institute Box 19150 Reford Station Detroit, MI 48219
AGC	Associated General Contractors of America 1957 E. Street, N.W. Washington, DC 20006
AISC	American Institute of Steel Construction 400 North Michigan Avenue Eighth Floor Chicago, IL 60611
AISI	American Iron and Steel Institute 1000 16th Street, N.W. Washington, DC 20036
ANSI	American National Standards Institute 1430 Broadway New York, NY 10018
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers 1791 Tullie Circle, N.E. Atlanta, GA 30329
ASME	American Society of Mechanical Engineers 345 East 47th Street New York, NY 10017
ASTM	American Society for Testing and Materials 1916 Race Street Philadelphia, PA 19103
AWS	American Welding Society 550 LeJeune Road, N.W. Miami, FL 33135
AWWA	American Water Works Association 6666 West Quincy Avenue Denver, CO 80235
BIA	Brick Institute of America 11490 Commerce Park Drive Reston, VA 22091

BARTON AND SOUTH INDUSTRIAL PUMP STATIONS ELECTRICAL IMPROVEMENTS

CFR	Code of Federal Regulations Office of the Federal Register National Archives and Records Administration Washington, DC 20408
CRSI	Concrete Reinforcing Steel Institute 933 Plum Grove Road Schaumburg, IL 60195
DHI	Door and Hardware Institute 7711 Old Springhouse Road McLean, VA 22102
EJCDC	Engineers' Joint Contract Documents Committee American Consulting Engineers Council 1015 15th Street, N.W. Washington, DC 20005
FM	Factory Mutual System 1151 Boston-Providence Turnpike P.O. Box 688 Norwood, MA 02062
FS	Federal Specification General Services Administration Specifications and Consumer Information Distribution Section (WFSIS) Washington Navy Yard, Bldg. 197 Washington, DC 20407
ICBO	International Conference of Building Officials 5360 S. Workman Mill Road Whittier, CA 90601
IEEE	Institute of Electrical and Electronics Engineers 345 East 47th Street New York, NY 10017
IMIAC	International Masonry Industry All-Weather Council International Masonry Institute 815 15th Street, N.W. Washington, DC 20005
ISA	The Instrumentation, Systems, and Automation Society 67 Alexander Drive P.O. Box 12277 Research Triangle Park North Carolina 27709
MBMA	Metal Building Manufacturers Association 1300 Summer Avenue Cleveland, OH 44115-2851

NAAMM	National Association of Architectural Metal Manufacturers 221 North LaSalle Street Chicago, IL 60601
NCMA	National Concrete Masonry Association P.O. Box 781 Herndon, VA 22070
NEMA	National Electrical Manufacturers' Association 2101 'L' Street, N.W. Washington, DC 20037
NFPA	National Fire Protection Association Battery March Park Quincy, MA 02269
PCA	Portland Cement Association 5420 Old Orchard Road Skokie, IL 60077
PCI	Prestressed Concrete Institute 201 North Wells Street Chicago, IL 60606
PS	Product Standard U. S. Department of Commerce Washington, DC 20203
SDI	Steel Deck Institute P.O. Box 9506 Canton, OH 44711
SDI	Steel Door Institute 712 Lakewood Center North 14600 Detroit Avenue Cleveland, OH 44107
SSPC	Steel Structures Painting Council 4400 Fifth Avenue Pittsburgh, PA 15213
UL	Underwriters' Laboratories, Inc. 333 Pfingston Road Northbrook, IL 60062

- B. Government Agencies: Names and titles of state and Federal government standard or specification producing agencies are frequently abbreviated. The following acronyms or abbreviations referenced in the Contract Documents indicate names of standard or specification producing agencies of the federal government. Names and addresses are subject to change but are believed to be, but are not assured to be, accurate and up to date as of the date of the Contract Documents.

CE	Corps of Engineers (US Department of the Army) Chief of Engineers - Referral Washington, DC 20314
CFR	Code of Federal Regulations (Available from the Government Printing Office) N. Capitol Street between G and H St. NW
DOT	Department of Transportation 400 Seventh Street, SW Washington, DC 20590
EDA	Economic Development Administration US Department of Commerce 121 N Canal Street, Suite 855 Chicago, IL 60606
EPA	Environmental Protection Agency 401 M Street, SW Washington, DC 20460
MDEQ	Michigan Department of Environmental Quality
MDOT	Michigan Department of Transportation
MIOSHA	State of Michigan OSHA
OSHA	Occupational Safety and Health Administration (US Department of Labor) Government Printing Office Washington, DC 20402

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01450

QUALITY CONTROL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Quality Control and Control of Installation
- B. References
- C. Testing and Inspection Services
- D. Manufacturers' Field Services

1.2 QUALITY CONTROL AND CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. Should manufacturers' instructions conflict with Contract Documents, request clarification from ENGINEER before proceeding.
- D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform Work by persons qualified to produce required and specified quality.
- F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.
- G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.
- H. All materials and equipment shall be new, unless otherwise noted.

1.3 REFERENCES

- A. Conform to reference standard by date of issue current on date of Contract Documents.
- B. Should specified reference standards conflict with Contract Documents, request clarification from the ENGINEER before proceeding.
- C. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of the ENGINEER shall be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.4 TESTING AND INSPECTION SERVICES

- A. CONTRACTOR shall be responsible for providing, paying for, coordinating and scheduling the services of an independent testing firm (acceptable to OWNER) to perform all materials and compaction testing and related tasks.
- B. The independent firm will perform tests, inspections and other services specified in individual specification sections and as required by the ENGINEER.
- C. Acceptable testing companies for selection by the CONTRACTOR are:
 - 1. CTI (Brighton, Michigan; Telephone: (248) 486-5100)
 - 2. SME (Plymouth, Michigan; Telephone: (734) 454-9900)
 - 3. PSI (Plymouth, Michigan; Telephone: (734) 453-7900)
 - 4. Haengel and Associates (Canton, Michigan; Telephone: (734) 455-9771)
 - 5. TEC (Ann Arbor, Michigan; Telephone: (734) 623-0400)
- C. Testing, inspections and source quality control may occur on or off the project site. Perform off-site testing as required by the ENGINEER or the OWNER.
- D. Reports will be submitted by the independent firm to the ENGINEER and CONTRACTOR, in duplicate, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.
- E. CONTRACTOR shall coordinate with ENGINEER and/or OWNER; cooperate and coordinate with independent firm; furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.
 - 1. Notify ENGINEER and independent firm a minimum of 24 hours prior to expected time for operations requiring services.
 - 2. Make arrangements with independent firm and pay for additional samples and tests required for CONTRACTOR's use.
- F. Independent testing firm will provide the testing services listed below. Any additional required by the Contract Documents beyond what is listed, shall be provided by the CONTRACTOR.
 - 1. Backfill
 - a. Sieve analysis per source.
 - b. Proctor per source.
 - c. Compaction testing at 400 SF intervals per lift, as required.

2. Aggregate Base
 - a. Sieve analysis per source.
 - b. Proctor per source.
 - c. Compaction testing once per 1,000 SF of placement.
3. Concrete
 - a. All concrete tests shall be performed for each truck or fraction thereof, of each mix design of concrete placed in any day.
 - b. Temperature
 - c. Slump
 - d. Air entrainment
 - e. Comprehensive strength, per load. Four (4) cylinders each with laboratory testing.
4. Grout and Mortar
 - a. Comprehensive strength, per load. Four (4) cylinders each with laboratory testing.
5. Painting
 - a. Refer to specification Section 09100.
- G. CONTRACTOR shall not perform the work without the independent firm on site performing the required tests.
- H. Testing and employment of testing agency or laboratory shall not relieve CONTRACTOR of obligation to perform Work in accordance with requirements of Contract Documents.
- I. The independent firm on instructions by the ENGINEER shall perform re-testing or re-inspection required because of non-conformance to specified requirements. Payment for re-testing or re-inspection will be the responsibility of the CONTRACTOR.
- J. Agency Responsibilities:
 1. Test samples of mixes submitted by CONTRACTOR.
 2. Provide qualified personnel at site. Cooperate with ENGINEER and CONTRACTOR in performance of services.
 3. Perform specified sampling and testing of products in accordance with specified standards.
 4. Ascertain compliance of materials and mixes with requirements of Contract Documents.

5. Promptly notify ENGINEER and CONTRACTOR of observed irregularities or non-conformance of Work or products.
 6. Perform additional tests required by ENGINEER.
- K. Agency Reports: After each test, promptly submit two (2) copies of the report to the ENGINEER and to the CONTRACTOR. When requested by the ENGINEER, provide interpretation of test results. Include the following:
1. Date issued.
 2. Project title and number.
 3. Name of inspector.
 4. Date and time of sampling or inspection.
 5. Identification of product and specifications section.
 6. Location in the Project.
 7. Type of inspection or test.
 8. Date of test.
 9. Results of tests.
 10. Conformance with Contract Documents.
- L. Limits On Testing Authority:
1. Agency or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.
 2. Agency or laboratory may not approve or accept any portion of the Work.
 3. Agency or laboratory may not assume any duties of CONTRACTOR.
 4. Agency or laboratory has no authority to stop the Work.

1.5 MANUFACTURERS' FIELD SERVICES

- A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, as applicable, and to initiate instructions when necessary.
- B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01500

TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SECTION INCLUDES:

- A. Temporary Utilities.
 - 1. Temporary electricity.
 - 2. Temporary lighting for construction purposes.
 - 3. Internet service.
 - 4. Temporary water service.
 - 5. Temporary sanitary facilities.
- B. Construction Facilities.
 - 1. Field offices and sheds.
- C. Temporary Controls.
 - 1. Dust Control.
 - 2. Barriers
 - 3. Protection of the Work
 - 4. Security measures.
 - 5. Water control.
- D. Removal of utilities, facilities, and controls.

1.2 TEMPORARY ELECTRICITY

- A. Provide and pay for power service required from utility source as needed for construction operation.
- B. Provide temporary electric feeder from electrical service at location as directed. Provide all necessary meters, disconnections and transformers. A separate meter shall be installed by the CONTRACTOR for the purpose of establishing compensation for electrical power usage.
- C. Complement existing power service capacity and characteristics as required.
- D. Provide power outlets for construction operations, with branch wiring and distribution boxes located as required. Provide flexible power cords as required.
- E. Provide main service disconnect and over-current protection at convenient location.

1.3 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

- A. Provide and maintain incandescent lighting for construction operations.
- B. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps as required.
- C. Maintain lighting and provide routine repairs.

1.4 INTERNET SERVICE

- A. Provide, maintain, and pay for internet service to field office at time of project mobilization.

1.5 TEMPORARY WATER SERVICE

- A. Water is available at the construction site. CONTRACTOR shall make arrangements with the OWNER to have water available.
- B. CONTRACTOR shall install an approved backflow preventer at the source prior to use. A meter shall be installed by the CONTRACTOR for the purpose of establishing compensation for water use.

1.6 TEMPORARY SANITARY FACILITIES

- A. Provide and maintain required facilities and enclosures. Existing facility use is not permitted. Provide at the time of project mobilization. Provide chemical toilets and provisions for replacement of chemicals and disposal of wastes for the duration of the Contract.

1.7 FIELD OFFICES AND SHEDS

- A. Prepare a drawing for submittal and approval showing construction facility layouts including temporary facilities, storage areas, parking, construction work and other related activities.
- B. The ENGINEER does not require a field office.
- C. Existing facilities shall not be used for field offices or for storage.
- D. Locate offices and sheds a minimum distance of 30 feet (10m) from existing and new structures.
- E. Construction: Portable or mobile buildings, or buildings constructed with floors raised above ground, securely fixed to foundations with steps and landings at entrance doors.
 - 1. Construction: Structurally sound, secure, weather tight enclosures for office and storage spaces. Maintain during progress of Work; remove when no longer needed.
 - 2. Temperature Transmission Resistance of Floors, Walls, and Ceilings: Compatible with occupancy and storage requirements.
 - 3. Exterior Materials: Weather resistant, finished in color acceptable to ENGINEER.

4. Interior Materials in Offices: Sheet type materials for walls and ceilings, pre-finished or painted; resilient floors and bases.
 5. Lighting for Offices: 50 ft-C (538 lx) at desk top height, exterior lighting at entrance doors.
 6. Fire Extinguishers: Appropriate type fire extinguisher at each office and each storage area.
 7. Interior Materials in Storage Sheds: As required to provide specified conditions for storage of products.
- F. Environmental Control:
1. Heating and Ventilating for Offices: Automatic equipment to maintain comfort conditions.
 2. Storage Spaces: Heating and ventilation as needed to maintain products in accordance with Contract Documents; adequate lighting for maintenance and inspection of products.
- G. Storage Areas and Sheds: Size to storage requirements for products of individual Sections, allowing for access and orderly provision for maintenance and for inspection of products.
- H. Preparation: Fill and grade sites for temporary structures to provide drainage away from buildings.
- I. Maintenance and Cleaning:
1. Periodic cleaning and maintenance for office and storage areas.
 2. Maintain approach walks free of mud, water, and snow.
- J. Removal: At completion of Work remove buildings, foundations, utility services, and debris. Restore areas.

1.8 DUST CONTROL

- A. No dust migration off site shall be permitted.
- B. All haul roads, detour roads, and other public and private roads, driveways and parking lots used by the CONTRACTOR must be maintained in a dust free condition during the life of this Contract. The control of the dust shall be accomplished by the application of dust control materials and methods of application as approved and as directed by the ENGINEER. Such dust control materials shall be applied as often as is necessary to control the dust.
- C. Should the CONTRACTOR be negligent of his duties in providing dust control, the OWNER may, with or without notice, cause the same to be done and deduct the cost of such work from any monies due or to become due the CONTRACTOR under this Contract, but the performance of such work by the OWNER, or at his insistence, shall service in no way to release the CONTRACTOR from his liability for dust control.

- D. Dust Palliative may be any of the following:
 - 1. Road oil of 30% asphalt base applied at the rate of 0.5 gallons per square yard.
 - 2. Type 1-calcium chloride applied at the rate of 6 pounds per ton of aggregate.
 - 3. Water, as required.
 - 4. Other methods as approved by the ENGINEER.
- E. Street Cleaning
 - 1. CONTRACTOR shall provide street cleaning with water for City roads and parking areas affected by spillage of excavated material or other material associated with the work.
 - 2. CONTRACTOR shall provide street cleaning by the end of each workday when spillage has occurred, and upon request by OWNER.
 - 3. CONTRACTOR shall sweep and clean City streets adjacent to water plant site when there is visible dust or debris on the street surfaces that came from the construction site, from vehicles coming to or from the construction site, or is in any way associated with CONTRACTOR's work on this contract.

1.9 BARRIERS

- A. Provide barriers to protect existing facilities and adjacent properties from damage from construction operations.
- B. Provide protection for plant life designated to remain. Replace damaged plants.
- C. Protect non-owned vehicular traffic, stored materials, site and structures from damage.

1.10 PROTECTION OF INSTALLED WORK

- A. Protect installed Work and provide special protection where specified in individual specification Sections.
- B. Provide temporary and removable protection for installed Products. Control activity in immediate work area to minimize damage.
- C. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- D. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- E. Prohibit traffic from landscaped areas.

1.11 WATER CONTROL

- A. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.
- B. Protect site from puddling or running water.

1.12 REMOVAL OF UTILITIES, FACILITIES AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, materials, prior to Substantial Completion inspection.
- B. Remove underground installations. Grade site as indicated.
- C. Clean and repair damage caused by installation or use of temporary work.
- D. Restore existing facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01550

VEHICULAR ACCESS AND PARKING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Vehicular Access
- B. Security
- C. Parking Areas

1.2 DESCRIPTION

- A. CONTRACTOR shall provide temporary construction roads, walks, and appurtenances required during the Project for use by CONTRACTOR, OWNER's operations, deliveries, other CONTRACTORS working on the Project, and emergency vehicles. Temporary roads and parking areas shall be designed and maintained by CONTRACTOR and be fully usable in all weather conditions. Temporary roads that are used by the OWNER shall be designed and maintained to meet the loading requirements of AASHTO H-20 wheel loads.
- B. Use of Existing Access Roads/Drives:
 - 1. CONTRACTOR will be allowed to use OWNER's existing roads/drives upon obtaining OWNER's written permission.
 - 2. Prevent interference with traffic on existing roads, drives and parking areas. At all times, keep access roads and entrances serving the site clear and available to OWNER, OWNER's employees, chemical deliveries, emergency vehicles, and other CONTRACTORS. Do not use these areas for parking or storage of materials.
 - 3. CONTRACTOR shall indemnify and hold harmless OWNER from expenses caused by CONTRACTOR's operations over existing roads and parking areas.
 - 4. Schedule deliveries to minimize use of driveways and entrances.

1.3 SECURITY

- A. The CONTRACTOR shall abide by and implement all site security measures in use at the Ann Arbor Water Treatment Plant, whether in use at Bid time or subsequently implemented by the OWNER.
- B. CONTRACTOR's security procedures shall include but shall not be limited to:
 - 1. Maintain daily sign-in/sign-out log of personnel and visitors.
 - 2. Maintain daily log of vehicle license plate numbers on site.
 - 3. Provide and use photo ID's for all CONTRACTOR personnel. ID's shall identify the personnel's name, company, and role on the project.

4. Allow OWNER to conduct background checks on CONTRACTOR's personnel upon request.
- C. Use of OWNER's security measures does not relieve CONTRACTOR of its responsibility to secure its own working spaces and materials.

1.4 CONTRACTOR PARKING

- A. CONTRACTOR personnel and subcontractor personnel shall park without blocking access to deliveries through the gate.
- B. CONTRACTOR may park a limited number of construction vehicles within the staging area, provided a suitable parking area is constructed.
- C. CONTRACTOR shall provide an off-site parking and staging area for his employee vehicles, equipment and materials, and his subcontractor's workers as necessary, at no additional cost to OWNER.
- D. Disruption to the neighborhood (idling engines, radios, lights, etc.) before or after approved construction hours is prohibited.

1.5 MAINTENANCE OF ACCESS

- A. CONTRACTOR shall maintain gate, driveway and parking to continuously provide access for OWNER staff vehicles, deliveries for OWNER, emergency vehicles, and parking areas for OWNER's personnel.
- B. Public roads shall be passable at all times and no parking which disrupts traffic is permitted.
- D. When roads and parking without hard surfacing become contaminated with soil and create a nuisance, remove contaminated material and replace with clean aggregate as required.
- E. Clean paved roads, driveways and parking areas over which CONTRACTOR's vehicles travel. Cleaning shall be done a minimum five times per week or more frequently as directed by ENGINEER, and shall be by mechanical sweeper and water trucks. Areas to be cleaned include:
 1. Pavement, including driveways and parking areas, within the pump station site limits.
 2. Public roads that require sweeping and cleaning due to CONTRACTOR's operations.
- F. Dust resulting from CONTRACTOR's activities shall be controlled by CONTRACTOR to prevent nuisances at site and nearby areas. Apply water to minimize airborne dust. Do not use water when water will cause hazardous or objectionable conditions such as ice, mud, ponds, and pollution.
- G. Provide temporary, heavy-duty steel roadway plates to protect existing manholes, handholes, valve boxes, vaults, and similar buried facilities.

1.6 RESTORATION

- A. Restore to pre-construction conditions existing roads, walks, and parking areas damaged by CONTRACTOR, subject to approval of owner of roads, walks, and parking areas.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01580

PROJECT IDENTIFICATION

PART 1 - GENERAL

1.1 SECTION INCLUDES:

- A. Project Sign

1.2 PROJECT SIGN

- A. The CONTRACTOR shall erect a sign at each Project site identifying the Project. The sign shall be erected prior to CONTRACTOR's mobilization on site, and shall be in accordance with the Specifications and details included in this Section. The project sign and sign panel shall be furnished, erected, and maintained by the CONTRACTOR at the location designated by the OWNER. Wording and colors shall be as shown on the detail in the Contract Drawings.
- B. One project sign shall be provided at the Barton Pump Stations and one project sign shall be provided at the South Industrial Pump Station.

1.3 PAYMENT PROCEDURES

- A. The cost of the fabrication, erection, maintenance, and removal of the project sign, including all labor and materials, shall be included in the CONTRACTOR's Lump Sum Bid.

1.4 MAINTENANCE

- A. The project sign shall be maintained by the CONTRACTOR, in good condition, at all times, for the duration of construction.
- B. The removal of the project sign from the construction site by the CONTRACTOR shall be at the completion of construction, when ordered by the OWNER.

PART 2 - PRODUCTS

2.1 PROJECT SIGN

- A. The project sign shall be fabricated, erected and maintained by the CONTRACTOR in accordance with the following requirements:
 - 1. The sign panel shall be baked enamel aluminum sheet laminated onto two (2) sides of a truss type corrugate sheet of polymer core.
 - 2. The sign shall be standard white with die cut black vinyl lettering laminated onto the panel. The vinyl lettering shall be suitable for exterior applications.
 - 3. The City's logo shall be in color.

4. The supports for the project sign shall be at least two 4" by 4" treated wood posts. The sign panel shall be securely fastened to the sign supports with at least four (4) 3/8" galvanized bolts, nuts and washers. The positioning and alignment of the sign shall be as determined by the OWNER.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01600

PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES:

- A. Basic Product Requirements
- B. Product Options
- C. Product Substitution Procedures
- D. Product Delivery Requirements
- E. Product Storage and Handling Requirements

1.2 BASIC PRODUCT REQUIREMENTS

- A. Provide products of qualified manufacturers suitable for intended use. Provide products of each type by a single manufacturer unless specified otherwise.
- B. Do not use materials and equipment removed from existing premises, except as specifically permitted by the Contract Documents.
- C. Provide interchangeable components of the same manufacturer for similar components.

1.3 PRODUCT OPTIONS

- A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards or description.
- B. Products Specified by Naming One or More Manufacturers: Products of one of manufacturers named and meeting specifications, no options or substitutions allowed.
- C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named in accordance with the following article.

1.4 PRODUCT SUBSTITUTION PROCEDURES

- A. Instructions to Bidders specify requirements for submitting requests for Substitutions during the bidding period. This section specifies procedures and requirements affecting substitutions proposed by the CONTRACTOR after the Contract Date.
- B. Where the term "substitutions" is used in this section, it means materials, equipment, or methods of construction which differ from the requirements in the Contract Documents. The term "substitutions" does not include:
 - 1. Requirements provided by Addenda issued prior to the Contract date.
 - 2. Changes made at the direction of ENGINEER.

3. Changes ordered by governing authorities.
 4. Options described in the Contract Documents.
- C. Substitutions will be considered in the event that:
1. They are related to "or equal" or "or approved equal" provisions in the Contract Documents.
 2. The specified requirements cannot be provided within the Contract Time due to causes beyond the Contractor's control.
 3. The OWNER will gain a substantial advantage if substitutions are approved.
 4. Substitutions will be considered when a product becomes unavailable through no fault of the CONTRACTOR.
- D. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.
- E. A request constitutes a representation that the CONTRACTOR:
1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
 2. Will provide the same warranty for the Substitution as for the specified product.
 3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to OWNER.
 4. Waives claims for additional costs or time extension which may subsequently become apparent.
 5. Will reimburse OWNER and/or ENGINEER for review or redesign services associated with re-approval by authorities.
 6. Will reimburse the OWNER and/or ENGINEER for any costs incurred in the evaluation of any "or equal" or substitution proposal. Such costs shall include, but are not limited to, related charges of the ENGINEER made necessary by the evaluation and acceptance or rejection, as the case may be, of the proposed "or equal" or substitute material or equipment.
- F. Substitutions will not be considered when they are indicated or implied on Shop Drawing or Product Data submittals, without separate written request, or when acceptance will require revision to the Contract Documents.
- G. Substitution Submittal Procedure:
1. Submit three copies of request for Substitution for consideration. Limit each request to one proposed Substitution.
 2. Submit Shop Drawings, Product Data, and certified test results attesting to the proposed product equivalence. Burden of proof is on proposer.

3. Submit itemized comparison between the specified product and the substitution product demonstration equivalent.
 4. The ENGINEER will notify CONTRACTOR, in writing, of decision to accept or reject request.
 5. Such submittals do not relieve the CONTRACTOR of obligation to later furnish shop drawings, product data, samples, and other submittals required by the Contract Documents.
- H. If any "or equal" or substitute material or equipment differs materially from the material or equipment named or specified, and that difference was not expressly identified in the CONTRACTOR's request, or results in changes in the work, the ENGINEER has authority to require removal and replacement of that "or equal" or substitute material or equipment. The CONTRACTOR shall bear the delay and costs resulting from (a) any such removal and replacement of "or equal" or substitute materials or equipment; (b) making "or equal" or substitute materials or equipment conform to the requirements of the Contract Documents; and (c) any changes in the work and/or in other work required to accommodate the "or equal" or substitute material or equipment, or both.

1.5 PRODUCT DELIVERY REQUIREMENTS

- A. Transport and handle products in accordance with manufacturer's instructions.
- B. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.
- C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.6 PRODUCT STORAGE AND HANDLING REQUIREMENTS

- A. Store and protect products in accordance with manufacturers' instructions.
- B. Store with seals and labels intact and legible.
- C. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.
- D. For exterior storage of fabricated products, place on sloped supports above ground.
- E. Provide off-site storage and protection when site does not permit on-site storage or protection.
- F. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation and degradation of Products.
- G. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.
- H. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- I. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained under acceptable condition.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01730

SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

- A. Includes, but is not limited to, all demolition and removals of existing materials, equipment necessary to complete the work specified and as shown on the Contract Drawings. Items for removal include process piping, valves, concrete, resteel, walls, doors, windows, structural steel, metals, masonry, electrical equipment, mechanical equipment, storage shed, and all related items.
- B. There are some equipment, materials and related components designated for demolition that has lead paint. Contractor shall be responsible for all necessary procedures for removal, handling, transportation, and disposal of hazardous materials.

1.2 SECTION INCLUDES

- A. Selective removal and off-site disposal of following:
 - 1. Portions of building structure shown on Drawings or required to accommodate new construction.
 - 2. Removal of all items marked "remove" or "demolish" on Drawings.
 - 3. Removal and protection of existing fixtures and equipment items identified for salvage by the Owner.
 - 4. Removal, protection, and reinstallation of existing fixtures and equipment items shown or marked as "remove and reinstall".

1.3 RELATED SECTIONS

- A. Section 02220 – Site Demolition
- B. Section 01370 – Lead Based Paint Removal

1.4 DEFINITIONS

- A. Remove: Remove and dispose of items shown or scheduled. Discard demolished or removed items except for those shown to remain, those shown as reinstalled, those shown as salvaged, and historical items that are to remain Owner's property.
- B. Remove and Salvage: The Owner may elect to retain some equipment. Carefully remove and clean salvage items, pack or crate to protect against damage. Transport to a location identified by the Owner.
- C. Remove and Reinstall: Remove items shown; clean, service and otherwise prepare them for reuse; store and protect against damage. Reinstall items in same location or in location shown.

- D. Existing to Remain: Protect construction or items shown to remain against damage during selective demolition operations. When permitted by Engineer, Contractor may elect to remove items to suitable, protected storage location during selective demolition and properly clean and reinstall items in their original locations.

1.5 SUBMITTALS

- A. Shop Drawings: Submit Shop Drawings covering the items included under this Section. Shop Drawing submittals shall include:
 - 1. Proposed dust-control measures.
 - 2. Proposed noise-control measures.
 - 3. Proposed haul routes between site and disposal areas before commencing this Work.
- B. Submit schedules listed below to Engineer and Owner.
 - 1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity.
 - 2. Inventory list of removed existing equipment not reused in Contract Work. Submit lists to Owner. Owner to determine or select items for retention by Owner.
 - 3. Inventory list of removed and salvaged items.
 - 4. Inventory list of Owner-removed items.
 - 5. Interruption of utility service.
 - 6. Coordination for shutoff, capping, and continuation of utility service
 - 7. Use of stairs.
 - 8. Detailed sequence of selective demolition and removal work to ensure uninterrupted progress of Owner's on-site operations.
 - 9. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed work.
 - 10. Locations of temporary partitions and means of egress.
- C. Inventory list of existing equipment to be removed and not reused in Work. Owner to determine or select items or retention by Owner

1.6 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Demolition operations shall comply with OSHA and EPA requirements and EPA notification regulations insofar as they apply to demolition Work under this Contract.

2. Comply with hauling and disposal regulations of authorities having jurisdiction.
 3. If hazardous materials are found during demolition operations, comply with all applicable local, state and national requirements for removal and disposal.
- B. Facility Access:
1. Do not close, block or obstruct streets, walks or other occupied or used facilities without written permission from authorities having jurisdiction.
 - a. Use alternative routes around closed or obstructed routes if required by governing regulations.
 2. Coordinate with Owner's continuing occupation of portions of existing building, and Owner's partial occupancy of completed new addition.
 3. Plan and present the Contractor's plan for achieving the partial occupation by Owner in a submittal and in a meeting with the Owner and Engineer.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Disassemble or cut large equipment items into smaller pieces to promote safe removal and transportation
1. Transport and unload items requested by Owner to a designated location at the project site.
 2. Haul away and dispose of debris and materials neither retained by Owner, nor reused or reinstalled.
 3. Arrange for disposal areas.
 4. Traffic: Conduct selective demolition operations and debris removal to ensure minimum interference with roads, streets, walks, and other adjacent occupied or used facilities.
- B. Unloading Salvage Items: Where shown on Drawings as "Remove and Salvage," carefully remove shown items, clean, store and turn over to Owner and obtain receipt. Owner will designate site for receiving items.
- C. Handling: Contractor shall take every precaution to prevent spillage of materials being hauled in public streets.
1. It shall be Contractor's responsibility to immediately clean spillage that may accidentally occur.
 2. Do not burn removed material on or within Project Site.

1.6 PROJECT CONDITIONS

- A. Materials Ownership:
1. Salvage Materials: Demolished materials shall become Contractor's property, except for items or materials shown as reused, salvaged, reinstalled, or otherwise shown to remain Owner's property. Remove demolished material promptly from Site with further disposition at Contractor's option.

2. Historical artifacts, relics, and similar objects, including but not limited to, cornerstones and their contents, commemorative plaques and tablets, antiques, and other articles of historical significance remain property of Owner. Notify Owner's Representative when these items are found and obtain method of removal and salvage from Owner.
 3. Transport items of salvageable value to Contractor to Contractor's area as they are removed.
- B. Environmental Requirements: Use water sprinkling, temporary enclosures, and other suitable methods to limit dust and dirt rising and scattering in air to lowest practicable level. Comply with governing regulations relating to environmental protection. Do not use water when it may create hazardous or objectionable conditions including ice, flooding, and pollution.
1. Existing drains shall be protected from debris. Protect drains prior to beginning any demolition work.
- C. Existing Conditions: Owner will be continuously occupying building areas immediately adjacent to selective demolition areas.
- D. Owner assumes no responsibility for actual condition of items or structures scheduled for demolition.
- E. Owner will maintain conditions existing at Contract commencement insofar as practical. However, variations within structure may occur by Owner's removal and salvage operation before selective demolition work begins.

1.8 SEQUENCING

- A. Conduct selective demolition work in manner that minimizes need for disruption or interference of Owner's normal on-Site operations.
- B. Coordinate with Owner's continuing occupation of portions of existing building, with Owner's partial occupancy of completed new addition, and with sequencing and startup of the new addition.
- C. Include coordination for shutoff, capping, and continuation of utility services, together with details for dust and noise control protection to ensure uninterrupted on-site operations by Owner.

1.9 SCHEDULING

- A. Schedule: Submit schedule showing proposed methods and sequence of operations for selective demolition work to Owner's representative for review before commencement of Work.
- B. Arrange selective demolition schedule so as not to interfere with Owner's on-site operations.
- C. Give minimum of 15 days advance notice to Owner of demolition activities, which affect Owner's normal operations.
- D. Give minimum of 15 days advance notice to Owner if shutdown of service is necessary during changeover.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Site Verification of Conditions: Before beginning selective demolition work inspect areas of Work. Survey existing conditions and correlate with requirements shown to determine extent of selective demolition required. Photograph existing structure surfaces, equipment, or surrounding properties, which could be misconstrued as damage resulting from selective demolition work. File with Owner's representative before starting Work.
- B. Inventory and record condition of items scheduled as "remove and reinstall or items scheduled as "remove and salvage."
- C. Verify disconnection and capping of utilities within the affected area of Work.
- D. If unanticipated mechanical, electrical, or structural elements conflict with intended function or design, investigate, and measure nature and extent of conflicts. Promptly submit detailed written reports to Owner's Representative. Pending receipt of directive from Owner's Representative, rearrange selective demolition schedule to continue general job progress without delay.

3.2 UTILITY SERVICES

- A. Where utility services are scheduled for removal, relocation, or abandonment, install bypass connections and temporary service to maintain continuity of services to other building parts before proceeding with selective demolition.
- B. Do not interrupt existing utilities serving occupied or used facilities, except when authorized in writing by authorities having jurisdiction.
- C. Maintain existing utilities shown as remaining. Keep in service, and protect existing utilities against damage during selective demolition operations.
- D. Locate, identify, stub off and disconnect utility services that are not to remain active.
 - 1. Owner will arrange to shut off designated utilities when requested by Contractor.
 - 2. Arrange to shut off utilities with utility companies.
 - 3. Provide a thrust block for disconnected and capped utilities.
- E. Cut off pipe or conduit in walls or partitions scheduled for removal. Cap, valve, or plug and seal remaining portion of pipe or conduit after bypassing.

3.3 PREPARATION

- A. Drain, purge, or remove, collect and dispose of chemicals, gases, explosives, acids, flammable, or other dangerous material before proceeding with selective demolition operations.

- B. Cover and protect furniture, equipment, and permanent fixtures from soiling or damage while demolition Work is done in rooms or areas where items remain in place.
- C. Protect existing finish work that remains in place and becomes exposed during demolition operations.
- D. Protect floors with suitable coverings when necessary.
- E. Where selective demolition occurs immediately adjacent to occupied portions of building, or to separate areas of noisy or extensive dirt or dust operations, construct and maintain temporary, insulated, fire-rated solid dustproof partitions.
 - 1. Construct dustproof partitions of minimum 4-inch studs, 5/8-inch-thick drywall (joints taped on occupied side), 1/2-inch fire-retardant plywood on demolition side, and fill partition cavity with sound-deadening insulation.
 - 2. Equip partitions with dustproof doors and security locks if required.
- F. Provide weatherproof closures for exterior openings resulting from demolition Work. Provide temporary weather protection during interval between demolition and removal of existing construction on exterior surfaces, and installation of new construction to ensure that no water leakage or damage occurs to structure or interior areas of existing building.
- G. Provide and ensure free and safe passage of Owner's personnel and general public to and from occupied portions of building around selective demolition areas.
 - 1. Provide temporary barricades and other forms of protection to protect Owner's personnel and general public from injury.
 - 2. Build temporary covered passageways required by authorities having jurisdiction.
- H. Provide interior and exterior shoring, bracing, or support to prevent movement, settlement, or collapse of demolished structures or elements, or adjacent facilities or Work to remain.
- I. Cease operations and notify Owner's Representative immediately if safety of structure seems endangered. Take precautions to support structure until determination is made for continuing operations.
- J. Remove protection at completion of Work.

3.4 DEMOLITION

- A. Special Techniques: Demolish concrete and masonry in small sections. Cut concrete and masonry at junctures with construction to remain using power-driven masonry saw or hand tools; do not use power-driven impact tools.
- B. Demolish foundation walls to depth of not less than 48 inches below proposed ground surface. Demolish and remove below-grade wood or metal construction.
- C. For interior slabs on grade, use power saw or removal methods that do not crack or structurally disturb adjacent slabs or partitions.

- D. Completely fill below-grade areas and voids resulting from demolition Work. Either:
 - 1. Provide fill consisting of approved earth, gravel, or sand.
 - 2. Fill shall be free of trash, debris, stones over 6-inch diameter, roots, or other organic matter.

OR

- 3. Fill below-grade areas and voids with Flowable Fill.
- E. Explosives: Use of explosives is not allowed.
- F. Interface with Other Work: Locate demolition equipment throughout structure and promptly remove debris to avoid imposing excessive loads on supporting walls, floors, or framing.
- G. Site Tolerances: Provide services for effective air and water pollution controls required by local authorities having jurisdiction.

3.5 REPAIR\RESTORATION

- A. Repair damages caused by demolition more extensive than required.
- B. Return structures and surfaces to condition existing before commencing selective demolition Work.
- C. Repair adjacent construction or surfaces soiled or damaged by selective demolition Work.
- D. Promptly repair damages caused to adjacent facilities by demolition Work at no cost to Owner.

3.6 CLEANING

- A. Contractor shall maintain an order of neatness and good housekeeping comparable to that observed by Owner.
- B. Keep tools, scaffolding, and other demolition equipment in neat and orderly arrangement.
- C. Remove dirt and debris resulting from Contractor's demolition operations from site daily. Dirt and debris shall not collect or interfere with Owner's facility operations.
- D. Upon completion of demolition Work, remove tools, equipment, and demolished materials from site. Remove protection and leave interior areas broom clean.

END OF SECTION

SECTION 01740

CLEANING AND WASTE MANAGEMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Progress Cleaning
- B. Final Cleaning

1.2 GENERAL

- A. Execute cleaning, during progress of the Work, and at completion of the Work.
- B. Adequate periodic cleaning will be a condition for recommendation of progress payments.
- C. Waste Disposal
 - 1. Properly dispose all waste materials, surplus materials, debris, and rubbish off the Project Site.
 - 2. Provide suitable containers for storage of waste materials and debris.
 - 3. Do not burn or bury rubbish and waste materials on the Project Site.
 - 4. Do not dispose of volatile or hazardous wastes such as mineral spirits, oil, or paint thinner in storm or sanitary drains.
 - 5. Do not discharge wastes into streams or waterways.
 - 6. Comply with all federal, state, and local anti-pollution laws, ordinances, codes, and regulations when disposing waste materials, debris, and rubbish.

1.3 PROGRESS CLEANING

- A. CONTRACTOR shall periodically clean the work site at least once weekly
- B. Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the work.
- C. Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended.
- D. Remove debris from concealed spaces before enclosing the space.
- E. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials.
- F. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration.

- G. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- H. Schedule cleaning operations so that resulting dust, debris and other contaminants will not fall on wet, newly painted surfaces and will not contaminate building systems or electrical or control panels.

1.4 FINAL CLEANING

- A. Complete the following cleaning and waste-removal operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
 - 1. Clean and remove from the Project rubbish, waste material, debris, and other foreign substances.
 - 2. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
 - 3. Hose clean sidewalks and loading areas.
 - 4. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
 - 5. Leave watercourses, gutters, and ditches open and clean.
 - 6. Repair pavement, roads, sod, and all other areas affected by construction operations and restore them to original condition or to minimum condition specified.
 - 7. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of spatter, grease, stains, fingerprints, films, and similar foreign substances.
 - 8. Clean, wax and polish wood, vinyl, and painted floors.
 - 9. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, and similar spaces.
 - 10. Sweep concrete floors broom clean in unoccupied spaces.
 - 11. Clean transparent materials, including mirrors and glass in doors and windows. Windows on the new pump station and on the existing administration/lab building shall be cleaned by a professional window cleaner. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
 - 12. Remove tags and labels that are not permanent.
 - 13. Touch up and otherwise repair and restore chipped, scratched, dented, or otherwise marred surfaces to specified finish and match adjacent surfaces. 1) Do not paint over "UL" or similar labels, including mechanical and electrical nameplates.

14. Wipe surfaces of mechanical and electrical equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
 15. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
 16. Replace disposable air filters and clean permanent air filters. Clean the exposed surfaces of diffusers, registers, and grills.
 17. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
- B. Maintain the cleaning until OWNER occupies the Project or portion thereof.
 - C. Leave Project clean and in a neat and orderly condition satisfactory to ENGINEER.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Use only those cleaning materials which will not create hazards to health or property and which will not damage surfaces.
- B. Use only those cleaning materials and methods recommended by manufacturer of the surface material to be cleaned.
- C. Use cleaning materials only on surfaces recommended by cleaning material manufacturer.

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01770

CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Substantial Completion
- B. Final Inspection
- C. Request for Final Payment

1.2 SUBSTANTIAL COMPLETION

- A. Substantial completion shall be the date as certified by the Engineer when the construction of the Project, or a specified part thereof, is sufficiently completed, in accordance with the Contract Documents, so that the Project, or specified part, can be fully utilized for the purposes for which it was intended.
- B. Substantial completion of the project will not be granted until successful completion of the operational demonstration as detail in Section 01810, Commissioning.
- C. Multiple Certificates of Substantial completion will not be granted for different portions of the Work.
- D. Before requesting inspection for Certification of Substantial Completion, complete the following. List exceptions in the request.
 - 1. In the Application for Payment that coincides with, or first follows, the date Substantial Completion is claimed, show 100 percent completion for the portion of the work claimed as substantially complete. Include supporting documents for completion as indicated in these Contract Documents and a statement showing an accounting of changes to the contract price.
 - 2. If 100 percent completion cannot be shown, include a list of incomplete items, the value of incomplete construction, and reasons the work is not complete.
 - 3. Advise Owner of pending insurance changeover requirements.
 - 4. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications, and similar documents.
 - 5. Obtain and submit releases enabling Owner unrestricted use of the work and access to services and utilities; include occupancy permits, operating certificate, and similar releases.
 - 6. Complete final cleanup requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.
 - 7. Provide all required demonstration and training sessions.

- E. Substantial completion shall also include the following:
1. Delivery of spare parts.
 2. Complete and approve O&M Manuals.
 3. Completed training sessions.
 4. Cleaning.
 5. Schedule to correct the remaining punch list items.
- F. Inspection Procedures: On receipt of a request for inspection, Engineer will either proceed with inspection or advise Contractor of unfilled requirements.
1. Engineer will prepare the Certificate of Substantial Completion following inspection, or advise Contractor of construction that must be completed or corrected before the certificate will be issued.
 2. Engineer will repeat inspection when requested and assured that the work has been substantially completed.
 3. Results of completed inspection for the basis of requirements for final acceptance.
 4. Date of Substantial Completion will begin the warranty period unless noted otherwise.

1.3 FINAL ACCEPTANCE

- A. Before requesting final inspection for certification of final acceptance and final payment, complete the following. List exceptions in the request.
1. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations where required.
 2. Submit an updated final statement, accounting for final additional changes to the contract price.
 3. Submit a copy of Engineer's final inspection list of items to be completed or corrected, stating that each item has been completed or otherwise resolved for acceptance. The list shall be endorsed and dated by the Engineer.
 4. Submit final meter readings for utilities, a measured record of stored fuel, and similar data as of date of Substantial Completion, or when Owner took possession of and responsibility for corresponding elements of the work.
 5. Submit consent of surety to final payment.
 6. Submit a final liquidated damages settlement statement.
 7. Submit evidence of final, continuing insurance coverage complying with insurance requirements.

8. Submit record drawings, maintenance manuals, damage or settlement survey, property survey, and similar final record information.
 9. Deliver tools, spare parts, extra stock, and similar items.
 10. Make final changeover of permanent locks and transmit keys to Owner. Advise Owner's personnel of changeover in security provisions.
 11. Complete commissioning and training of Owner's personnel.
 12. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.
 13. Complete final cleaning in accordance with Section 01740, Cleaning and Waste Management.
- B. Reinspection Procedure: Engineer will inspect the work upon receipt of notice that work, including inspection list items from earlier inspections, has been completed, except items whose completion has been delayed because of circumstances acceptable to the Engineer.
1. Upon completion of reinspection, Engineer will prepare a certificate of final acceptance, or advise Contractor of work that is incomplete or of obligations that have not been fulfilled but are required for final acceptance.
 2. If necessary, reinspection will be repeated.

1.4 REQUEST FOR FINAL PAYMENT

- A. Submit request for final payment in accordance with the Agreement and General Conditions, as may be modified by the Supplementary Conditions, using procedure specified in Section 01290, Payment Procedures.
- B. Request for final payment shall include:
1. Documents required for progress payments in Section 01290, Payment Procedures.
 2. Documents required in the General Conditions, as may be modified by the Supplementary Conditions.
 3. Releases or Waivers of Lien Rights:
 - a. When submitting releases or waivers of Lien rights, provide release or waiver by Contractor and each Subcontractor and Supplier that provided Contractor with labor, material, or equipment.
 - b. Provide list of Subcontractors and Suppliers for which release or waiver of Lien is required.
 - c. Each release or waiver of Lien shall be signed by an authorized representative of entity submitting release or waiver to Contractor, and shall include Subcontractor's or Supplier's corporate seal if applicable.

- d. Release or waiver of Lien may be conditional upon receipt of final payment.
4. Consent of Surety.
5. Documentation that all punch list items are complete.
6. Warranties.
7. Operation and Maintenance Manuals.
8. Record Drawings being maintained by the Contractor.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01780

CLOSEOUT SUBMITTALS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Project Record Documents
- B. Spare Parts and Maintenance Products
- C. Preventative Maintenance Instructions
- D. Warranties and Bonds

1.2 PROJECT RECORD DOCUMENTS

- A. Maintain on site one clean, undamaged set of the following record documents; record actual revisions to the Work:
 - 1. Drawings.
 - 2. Specifications.
 - 3. Addenda.
 - 4. Change Orders and other modifications to the Contract.
 - 5. Reviewed Shop Drawings, Product Data, and Samples.
 - 6. Manufacturer's instruction for assembly, installation, and adjusting.
- B. Ensure entries are complete and accurate, enabling future reference by Owner.
- C. Store record documents separate from documents used for construction.
- D. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
 - 1. Manufacturer's name and product model and number.
 - 2. Product substitutions or alternates utilized.
 - 3. Changes made by Addenda and modifications.
- E. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
 - 1. Measured depths of foundations in relation to finish floor datum.
 - 2. Measured horizontal and vertical locations of all underground and exposed utilities and appurtenances, including thrust blocks, referenced to permanent surface improvements.

3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the work.
 4. Measured horizontal and vertical locations of all concealed and exposed electrical conduits. Conduits shall be shown in plain view on the record drawings with their size and contents indicated.
 5. Field changes of dimension and detail.
 6. Details not on original Contract drawings.
- F. Indicate the date of revisions to the plans in the appropriate box on the plans.
- G. Submit documents to Engineer with claim for final Application for Payment.

1.3 SPARE PARTS AND MAINTENANCE PRODUCTS

- A. Provide spare parts, maintenance, and extra products in quantities specified in individual specification sections. All wearable items should be supplied to provide at least two years of operation and maintenance.
- B. Deliver to project site and place in location as directed; obtain sign receipt from the City prior to final payment.
- C. Cover and protect parts from moisture.
- D. Crate in containers designed for prolonged storage suitable for handling with hoisting equipment containers: wooded, cardboard, or palletized.
- E. Stencil on containers:
 1. Manufacturer/supplier name.
 2. Unit name.
 3. Spare part name.
 4. Manufacturer catalogue number.
 5. Other identifying information.
 6. Precautionary information.

1.4 PREVENTATIVE MAINTENANCE SCHEDULE

- A. Submit as a separately bound document, in addition to the operation and maintenance data, an equipment maintenance schedule for each piece of equipment. Provide four (4) printed copies and two (2) electronic (.pdf) copies. Each piece of equipment shall be individually tabbed. Include the following:
 1. Identity of Equipment.
 2. Routine manufacturer recommended preventative maintenance
 - a. Daily

- b. Weekly
 - c. Monthly
 - d. Quarterly
 - e. Semi-Annually
 - f. Annually
- B. Equipment maintenance schedule in standard manufacturer format for all equipment.

1.5 WARRANTIES AND BONDS

- A. Contractor is responsible for maintaining and protecting equipment until final acceptance.
- B. Obtain warranties and bonds executed in duplicate by responsible subcontractors, suppliers, and manufacturers. All warranties shall begin at the Date of Substantial Completion, or at the date of acceptance by the Owner, whichever is later.
- 1. There shall be only one Date of Substantial Completion for the entire project.
- C. Execute and assemble all transferable warranty documents and bonds from subcontractors, suppliers, and manufacturers into one binder.
- D. Submit as a separately bound document.
- E. Verify that documents are in proper form, contain full information, and are notarized. Manufacturer's warranties shall be in the name of the Owner.
- F. Provide Table of Contents and assemble in three-ring binders with durable plastic cover.
- G. Submit prior to Final Application for Payment.
- H. Time of submittals:
- 1. Make warranty submittal within ten days after Date of Substantial Completion, prior to final Application for Payment.
 - 2. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within ten days after acceptance, listing the date of acceptance as the beginning of the warranty or bond period.
- I. Rejection of Warranties: Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
- J. Submit warranties per Table 01780-A, Required Warranties. Where warranty requirements in the specified section or general conditions supersede the requirements of this table, the warranty requirements in the specified section or general conditions shall apply.

Table 01780-A, Required Warranties

Equipment	Specification Section
Hoisting Equipment	14620
Sump Pumps	15441
Gas Fired Unit Heaters	15621
Lighting System	16200
Electric Motors	16221
Switchboards	16425
Dry-Type Transformers	16461
Motor Starters	16481
Solid State Motor Controllers (Soft Starts)	16482
Motor Control Centers	16483
Instrumentation Analytical Element	17320
Machinery Monitoring and Protection	17325
Computerized SCADA System	17720

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01781

OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Operation and maintenance data/manuals.

1.2 SUBMITTALS

- A. Submit operations and maintenance data for all equipment.
- B. Quantity Required and Timing of Submittals:
 - 1. Preliminary Submittal:
 - a. Printed Copies: 4 copies, exclusive of copies required by Contractor.
 - b. Electronic Copies: 1 copy.
 - c. Submit to Engineer by the earlier of: ninety days following approval of Shop Drawings and product data submittals, or thirty days prior to starting training of operations and maintenance personnel, or ten days prior to field quality control testing at the Site.
 - d. Furnish preliminary operation and maintenance data submittal in acceptable form and content, as determined by Engineer, before associated materials and equipment will be eligible for payment.
 - 2. Final Submittal: Provide final submittal prior to Substantial Completion, unless submittal is specified as required prior to an interim Milestone.
 - a. Printed Copies: 4 copies.
 - b. Electronic Copies (Searchable PDF): 2 copies

1.3 OPERATION AND MAINTENANCE DATA/MANUALS

- A. Binding and Cover:
 - 1. Bind each operation and maintenance manual in durable, permanent, stiff-cover binder(s), comprising one or more volumes per copy as required. Binders shall be minimum one-inch wide and maximum of three-inch wide. Binders for each copy of each volume shall be identical.
 - 2. Binders shall be locking three-ring/"D"-ring type, or three-post type. Three-ring binders shall be riveted to back cover and include plastic sheet lifter (page guard) at front of each volume.
 - 3. Do not overfill binders.
 - 4. Covers shall be oil-, moisture-, and wear-resistant, including identifying information on cover and spine of each volume.

5. Provide the following information on cover of each volume:
 - a. Title: "OPERATING AND MAINTENANCE INSTRUCTIONS".
 - b. Name or type of material or equipment covered in the manual.
 - c. Volume number, if more than one volume is required, listed as "Volume ___ of ___", with appropriate volume-designating numbers filled in.
 - d. Name of Project and, if applicable, Contract name and number.
 - e. Name of building or structure, as applicable.
 6. Provide the following information on spine of each volume:
 - a. Title: "OPERATING AND MAINTENANCE INSTRUCTIONS".
 - b. Name or type of material or equipment covered in the manual.
 - c. Volume number, if more than one volume is required, listed as "Volume ___ of ___", with appropriate volume-designating numbers filled in.
 - d. Project name and building or structure name.
 7. The manuals' cover sheets and spines shall all be matching. The Contractor shall prepare a template for use by the various subcontractors.
- B. Pages:
1. Print pages in manual on 30-pound (minimum) paper, 8.5 inches by 11 inches in size.
 2. Provide each page with binding margin at least one inch wide. Punch each page with holes suitable for the associated binding.
- C. Drawings:
1. Bind into the manual drawings, diagrams, and illustrations up to and including 11 inches by 17 inches in size, with reinforcing specified for pages.
 2. Documents larger than 11 inches by 17 inches shall be folded and inserted into clear plastic pockets bound into the manual. Mark pockets with printed text indicating content and drawing numbers. Include no more than three drawing sheets per pocket.
- D. Copy Quality and Document Clarity:
1. Contents shall be original-quality copies. Documents in the manual shall be either original manufacturer-printed documents or first-generation photocopies indistinguishable from originals. If original is in color, copies shall be in color. Manuals that contain copies that are unclear, not completely legible, off-center, skewed, or where text or drawings are cut by binding holes, are unacceptable. Pages that contain approval or date stamps, comments, or other markings that cover text or drawing are unacceptable. Faxed copies are unacceptable.

2. Clearly mark in ink to indicate all components of materials and equipment on catalog pages for ease of identification. In standard or pre-printed documents, indicate options furnished or cross out inapplicable content. Using highlighters to so indicate options furnished is unacceptable.

E. Organization:

1. Table of Contents:
 - a. Provide table of contents in each volume of each operations and maintenance manual.
 - b. Provide a master table of contents covering the complete set of volumes.
 - c. In table of contents and at least once in each chapter or section, identify materials and equipment by their functional names. Thereafter, abbreviations and acronyms may be used if their meaning is clearly indicated in a table bound at or near beginning of each volume. Using material or equipment model or catalog designations for identification is unacceptable.
2. Use dividers and labeled index tabs between equipment items and between major categories of information, such as operating instructions, preventive maintenance instructions, and other major subdivisions of data in each manual.
3. Each equipment item shall have an individual cover sheet with the following information:
 - a. Name or type of material or equipment.
 - b. Manufacturer's name, address, telephone number, fax number, and Internet website address.
 - c. Manufacturer's local service representative's or local parts supplier's name, address, telephone number, fax number, Internet website address, and e-mail addresses, when applicable.
 - d. Manufacturer's shop order and serial number(s) for materials, equipment or assembly furnished as well as City Equipment Identification numbers, if applicable.
 - e. City Equipment Identification Numbers, if applicable.

1.4 ELECTRONIC REQUIREMENTS

- A. Electronic Copies of Operation and Maintenance Manuals:
 1. Each electronic copy shall include all information included in printed copy.
 2. Submit each electronic copy on a separate compact disc (CD), unless another electronic data transfer method or format is acceptable to Engineer.
 3. File Format:
 - a. The O&M Manuals will be placed into the Owner's Content Management System. All electronic files shall be compatible with this system.

- b. Files shall be in “portable document format (PDF)”. Files shall be entirely electronically searchable and created from the original document. Scanned/Image PDF’s will not be accepted.
- c. Submit separate file for each separate document in the printed copy.
- d. Within each file, provide bookmarks for the following:
 - 1) Each chapter and subsection listed in the printed copy document’s table of contents.
 - 2) Each figure.
 - 3) Each table.
 - 4) Each appendix.
- 4. Also provide drawings and figures in one of the following formats: “.bmp”, “.tif”, “.jpg”, or “.gif”. Submit files in a separate directory on the CD.
- 5. Technical drawings will be provided in both AutoDesk DWG format and PDF format.

1.5 CONTENT

- A. Submit complete, detailed written operating instructions for each material or equipment item including: function; operating characteristics; limiting conditions; operating instructions for start-up, normal and emergency conditions; regulation and control; operational troubleshooting; and shutdown. Also include, as applicable, written descriptions of alarms generated by equipment and proper responses to such alarm conditions.
- B. Submit written explanations of all safety considerations relating to operation and maintenance procedures.
- C. Submit complete, detailed, written preventive maintenance instructions including all information and instructions to keep materials, equipment, and systems properly lubricated, adjusted, and maintained so that materials, equipment, and systems function economically throughout their expected service life. Instructions shall include:
 - 1. Written explanations with illustrations for each preventive maintenance task such as inspection, adjustment, lubrication, calibration, and cleaning. Include pre-startup checklists for each equipment item and maintenance requirements for long-term shutdowns.
 - 2. Recommended schedule for each preventive maintenance task.
 - 3. Lubrication charts indicating recommended types of lubricants, frequency of application or change, and where each lubricant is to be used or applied.
 - 4. Table of alternative lubricants.
 - 5. Troubleshooting instructions.

6. List of required maintenance tools and equipment.
 7. Spare parts.
- D. Complete bills of material or parts lists for materials and equipment furnished. Lists or bills of material may be furnished on a per-drawing or per-equipment assembly basis. Bills of material shall indicate:
1. Manufacturer's name, address, telephone number, fax number, and Internet website address.
 2. Manufacturer's local service representative's or local parts supplier's name, address, telephone number, fax number, Internet website address, and e-mail addresses, when applicable.
 3. Manufacturer's shop order and serial number(s) for materials, equipment or assembly furnished.
 4. For each part or piece include the following information:
 - a. Parts cross-reference number. Cross-reference number shall be used to identify the part on assembly drawings, Shop Drawings, or other type of graphic illustration where the part is clearly shown or indicated.
 - b. Part name or description.
 - c. Manufacturer's part number.
 - d. City Equipment Identification Number.
 - e. Quantity of each part used in each assembly.
 - f. Current unit price of the part at the time the operations and maintenance manual is submitted. Price list shall be dated.
- E. Complete instructions for ordering replaceable parts, including reference numbers (such as shop order number or serial number) that will expedite the ordering process.
- F. Manufacturer's recommended inventory levels for spare parts, extra stock materials, and consumable supplies for the initial two years of operation. Consumable supplies are items consumed or worn by operation of materials or equipment, and items used in maintaining the operation of material or equipment, including items such as lubricants, seals, reagents, and testing chemicals used for calibrating or operating the equipment. Include estimated delivery times, shelf life limitations, and special storage requirements.
- G. Submit manufacturer's installation and operation bulletins, diagrams, schematics, and equipment cutaways. Avoid submitting catalog excerpts unless they are the only document available showing identification or description of particular component of the equipment. Where materials pertain to multiple models or types, mark the literature to indicate specific material or equipment supplied. Marking may be in the form of checking, arrows, or underlining to indicate pertinent information, or by crossing out or other means of obliterating information that does not apply to the materials and equipment furnished.

- H. Submit original-quality copies of each approved and accepted Shop Drawing, product data, and other submittal, updated to indicate as-installed condition. Reduced drawings are acceptable only if reduction is to not less than one-half original size and all lines, dimensions, lettering, and text are completely legible on the reduction.
- I. Submit complete electrical schematics and wiring diagrams, including complete point-to-point wiring and wiring numbers or colors between all terminal points.
- J. Programmable Logic Controllers: If programmable logic controllers are furnished
 - 1. Submit complete logic listings in one consistent format.
 - 2. Format Requirements:
 - a. For ladder diagram logic, include complete cross-referencing of all logic elements. Annotate all elements with clearly understandable tags or descriptive labels.
 - b. For function block diagram, label each function block with understandable tags or descriptive labels. Describe purpose and action of each function block.
 - c. For sequential function chart, include extensive comments for each step to describe program step function.
 - d. For instruction list and structured text, include extensive comments for each program line to describe program line function.
 - 1. Submit complete programmable logic controller listing of all input/output address assignments, tag assignments, and pre-set constant values, with functional point descriptions.
 - 2. Submit complete manufacturer's programming manuals.
- K. Copy of warranty bond and service contract as applicable.
- L. When copyrighted material is used in operations and maintenance manuals, obtain copyright holder's written permission to use such material in the operation and maintenance manual.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

NOT USED

END OF SECTION

SECTION 01810

START-UP AND COMMISSIONING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Commissioning Plan
- B. Functional Completion Testing
- C. Startup
- D. Commissioning
- E. Performance Testing
- F. Operational Demonstration

1.2 DEFINITIONS

- A. Commissioning: Commissioning is the series of activities or processes necessary to ensure that equipment and systems are designed, installed, functionally tested, started up and capable of being operated and maintained to perform in conformity with the design intent for the facility improvements. Commissioning includes, but is not limited to factory testing, field testing, dry testing, wet testing, performance testing, Manufacturer's checkout, and operational demonstration.
- B. Factory Testing: Factory testing is performance testing, operation testing, or documentation verification conducted in the production facility, specialized test facility, or by the equipment manufacturer or supplier. Such testing shall conform to the requirements of the individual sections of the Contract Documents. "Witnessed" factory testing shall mean that the testing is witnessed by the Owner or his designated representative.
- C. Field Testing: Field testing is performance testing, operation testing, or documentation verification conducted in the field after installation, to provide comparison with the results obtained in the factory testing.
- D. Dry Testing: Dry testing is performed by the Contractor without introducing either process material or other test material into the component, system, or unit process.
- E. Wet Testing: Wet testing is testing performed by the Contractor utilizing the intended product in the component, system, or unit process. Tankage shall be filled to operating levels where available.
- F. Performance Testing: Performance Testing is testing performed by the Contractor to demonstrate the specified throughput of the equipment and unit process systems while maintaining regulatory compliance with Federal, State, and Local government regulations and minimum compliance with the equipment or unit process systems performance requirements and guarantees.

- G. **Manufacturer's Checkout:** Manufacturer's checkout shall be performed directly by the manufacturer. Checkout by the local equipment representative or salesman is not permitted. Checkout shall include, but not be limited to, wiring and power supply, installation, tolerances, clearances, rotation, etc.
- H. **Startup:** Startup shall be defined as the operation of equipment or unit process systems using clean water, air, or other fluids and gases as necessary to demonstrate the operation of the equipment or systems with other equipment that is a part of the Facility. Startup shall be performed by the Contractor, manufacturer, and local equipment representative.
- I. **System:** A "system" includes all required items of equipment, devices, and appurtenances connected so that their operation or function compliments, protects, or controls the operation or function of the others.
- J. **Operational Demonstration:** A commissioning activity performed by the Contractor wherein the Contractor operates and maintains a fully functional component system, unit process for a period of time after stable operation has been achieved. For purposes of this project, the period of time shall be 30 days, unless noted otherwise for specific pieces of equipment.
- K. **Commissioning Plan:** The Commissioning Plan incorporates all aspects of functional completion testing, startup, commissioning, performance testing, training, and reliability tests to ensure the facility operates properly and meets design intent and performance.

1.3 QUALITY ASSURANCE

- A. Contractor shall appoint a Performance Testing Manager who shall:
 - 1. Manage, coordinate, and supervise Contractor's start-up, testing, and commissioning activities including but not limited to field testing, dry testing, wet testing, performance testing with process liquids and solids, manufacturer's checkout and the Operational Demonstration.
 - 2. Assist in coordinating and documenting Site quality control Work specified in individual Specification Sections.
 - 3. Prepare, or review and approve, all submittals for the Work under this Section and related Work contained within the Contract Documents.
 - 4. Coordinate activities of subcontractors, manufacturers and suppliers relative to the start-up, testing, and commissioning activities.
- B. Performance Testing Manager shall be at the Site a minimum of eight hours per day during all testing and be available at all times, 24 hours per day, seven days per week to perform these duties.
- C. Performance Testing Manager shall supervise the Contractor's Operations ENGINEER and Operations Specialists who shall be dedicated to the start-up, testing, and commissioning Work.

1.4 SUBMITTALS

- A. **Field Installation Reports** – Submit reports by Manufacturer's Representative in accordance with the Contract Documents.

- B. Detailed Commissioning Plan – Submit detailed commissioning plan in accordance with the Contract Documents 90 days in advance of starting, testing and placing equipment into operation.
- C. Start up and Testing Documentation: Contractor shall prepare and submit all documentation for review and approval. The documentation shall include, but not be limited to, the following:
1. Develop blank testing forms specific to each item of equipment or system to be filled out during start-up and testing.
 - a. All forms must be approved by Engineer and Owner prior to use.
 - b. Motor testing form shall at a minimum include flow, suction pressure, discharge pressure, amperage, voltage, and kW.
 2. Field testing plans, dry testing plans and wet testing plans that describe in detail the proposed testing procedures that will show the equipment and systems performance is in accordance with the requirements of the Contract Documents.
 3. Field testing, dry testing and wet testing reports including recorded test data, performance tolerances, observations, measurements taken, problems and modifications or corrective action taken for the equipment and systems to perform in accordance with the Contract Documents.
 4. Certification by the preparer that he/she is the person responsible for the data, and that the data is authentic and accurate.
 5. Certification by the Contractor or equipment or unit process systems supplier that the equipment or the unit process systems were operated continuously for the specified period and that the equipment or unit process systems operated in compliance with the specified operating conditions, parameters and performance, and that the equipment or unit process systems are suitable for Operational Demonstration in accordance with Section 01752.
- D. Develop performance testing plans and operational demonstration plans describing in detail, coordinated, sequential testing and demonstration of each system to be tested. Performance testing plan and operational demonstration plan shall be specific to the system or equipment item to be tested, and shall identify by specific equipment or tag number each device or control station to be manipulated or observed during testing, and specific results to be observed or obtained. Subcontractors and suppliers shall be present during testing, and for the planned testing duration. Performance testing plans and operational demonstration plans shall include:
1. Summary of results of field testing, dry testing and wet testing.
 2. Calibration of all field instruments and control devices.
 3. Description of and information on temporary systems, equipment, and devices proposed for performance Testing and Operational Demonstrations, including calibration data for temporary instrumentation and controls.
 4. Description of data reduction required, if any, and proposed time between collection of data and submittal of results to Engineer.

5. Summary of criteria for acceptance of test results. Summary shall include performance tolerances (if any) included in the Contract Documents. Where performance tolerances are not included in the Contract Documents, testing plans shall include proposed performance tolerances for approval by Owner and Engineer.
 6. Following Engineer's approval of performance testing plans and operational demonstration plans, Contractor shall reproduce performance testing and operational demonstration plans in sufficient quantity for Contractor's purposes plus five copies to Engineer and five copies to Owner. Do not start performance testing or operational demonstrations until required quantity of approved plans are provided.
- E. Testing Schedule: Provide a testing schedule that sets forth the planned sequence for performance testing and operational demonstration work. Testing schedule shall be part of the Progress Schedule and shall conform to requirements for Progress Schedule.
1. Detail the equipment and systems to be tested.
 2. Show planned start date, duration, and completion of each test.
 3. Testing schedule shall submitted no later than eight weeks in advance of the date performance testing and operational demonstrations are to begin. ENGINEER will not witness performance testing and operational demonstration work until test schedule is accepted by Engineer.
 4. Testing schedule shall be updated weekly and resubmitted to Engineer. Updates shall indicate actual dates of performance testing and operational demonstration Work, indicating equipment, systems and treatment train for which testing is in progress, and that are satisfactorily completed in accordance with the Contract Documents.
- F. Following a successful Operational Demonstration, a summary report containing the following, at a minimum, shall be provided by the CONTRACTOR:
1. Equipment, systems and plant treatment trains started-up and commissioned.
 2. Start-up and commissioning dates.
 3. Equipment, systems and performance criteria tested, clearly showing requirements and field data that verifies requirements were met.
 4. Names of witnesses for start-up and commissioning.
 5. Any repairs, corrections, or modifications required for the equipment or unit process systems to successfully complete start-up and commissioning.
 6. Loop diagrams accurately depicting the installed condition of instrumentation and controls.
 7. Any other important Operational Demonstration information.
 8. Report Appendix containing the following, as a minimum:
 - a. A summary of all testing data used and calculations, including source, formulas with all terms defined.

- b. Copies of all raw field data sheets, including those indicating sampling point locations, and notes.
- c. Production and operational data.
- d. Calibration sheets for equipment.
- e. Copies of calibration records for instrumentation.

1.5 COMMISSIONING PLAN

- A. The Contractor shall be responsible for preparing, coordinating, and executing the Plan.
 - 1. The Contractor shall use the resources of the equipment and unit process systems suppliers in this work, particularly for specific equipment and unit process systems.
 - 2. An initial draft Plan for the Facility shall be completed and submitted by the Contractor to the Engineer for review at least 90 days prior to the expected commencement of commissioning. The Engineer will require 45 days to review the submittal and return with any exceptions noted. The Contractor shall incorporate the Engineer's comments into the revised Plan within 30 days of receiving comments, and reissue the Plan to the Engineer and Owner.
- B. The Contractor shall provide a dedicated field staff to support the Plan activities. A full-time Startup Manager shall be responsible for day to day activities and shall be the primary contact with the Engineer regarding Plan activities. Support staff shall include but not be limited to designated mechanical, electrical and instrumentation and control Engineers and technicians, and operating staff.
 - 1. The Contractor may require assistance from the Owner's operating and maintenance staff in commissioning and performance testing activities specified herein. Activities requiring Owner's staff shall be specifically noted in the Plan.
- C. The Plan shall define:
 - 1. A chronological schedule of all testing and inspection activities.
 - 2. A checklist of all inspection and testing activities broken down by location, discipline, system, and device or item.
 - 3. All blank forms proposed by the Contractor for verification or recording of the functional completion testing, startup, commissioning and performance testing.
 - 4. An index which cross references the forms to their intended application(s).
 - 5. A list of all supplier certifications, including those required by the applicable technical specifications. Provisions shall also be included for retesting, in the event it is required.
 - 6. A list of participants in functional completion testing, startup, commissioning, and performance testing.
 - 7. A list of special test equipment required for functional completion testing, startup, commissioning, and performance testing.

8. Sources of the test media (water, power, air.) for functional completion testing.
 9. The proposed method of delivery of the media to the equipment to be tested during functional completion testing, startup, commissioning, and performance testing.
 10. Temporary or interim connections for the sequencing of multiple units during functional completion testing, startup, commissioning, and performance testing.
- D. The Contractor shall designate, in the Plan, a Testing and Checkout Coordinator, to coordinate and manage the activities defined in the Plan.

1.6 ROLES AND RESPONSIBILITIES

- A. Contractor shall provide competent, qualified representatives of material, equipment, and system manufacturers to provide services specified, including supervising installation, adjusting, starting-up, and testing of materials and equipment.
- B. The Contractor shall provide all outside services, materials, labor, supplies, test equipment and other items necessary to perform the Testing, Startup and Commissioning specified herein. In addition, the Contractor shall arrange for and provide the participation or assistance of survey crews, quality control technicians, Supplier's representative(s), and required governmental agency representatives.
- C. The Contractor shall provide the services of the Supplier's representative(s) as follows:
1. Assistance during installation as specified in Divisions 1 through 17 and as specified herein.
 2. Field Testing as specified in Divisions 1 through 17 and as specified herein.
 3. Startup as specified in Divisions 1 through 17 and as specified herein.
 4. Commissioning as specified in Divisions 1 through 17 and as specified herein.
- D. The Supplier's representative's activities required by this Section are in addition to the requirements for vendor training and other services specified elsewhere in the Contract Documents. Timing for the performance of these services is to be defined in the Contractors Checkout Plan, specified herein, and shall not be concurrent.
- E. The Engineer will review and comment on the Contractor's deliverables, participate in the physical inspection activities, witness the shop and field testing, witness functional testing, maintain the permanent record of all testing results, and provide verification of conformance to the specifications. The Engineer's right to perform inspections, witness tests or monitor or assess the Work and activities does not relieve the Contractor of its obligation to comply with the requirements of the Contract Documents nor does it imply completion of the Work.

1.7 FUNCTIONAL COMPLETION TESTING

- A. Functional Completion Testing shall be completed as construction and installation of equipment is completed to demonstrate that the equipment is ready for equipment and systems startup.

- B. Functional Completion Testing shall be done in a coordinated manner based on the Plan prepared by the Contractor.
- C. The Owner's operating and maintenance staff shall be allowed to observe for the purposes of familiarization and training.
- D. Functional Completion Testing procedures and documentation forms shall be developed by the Contractor. The procedures shall include a listing of items inspected for Functional Completion Testing.
- E. If any equipment or unit process systems do not meet Functional Completion Testing requirements, it shall be the responsibility of the Contractor and/or equipment suppliers to make the necessary corrections or replacements and repeat the test.
- F. The equipment and unit process systems shall not be started up or put into service until the Functional Completion Testing is completed as evidenced by a completed Functional Completion Testing certificate for the equipment or subsystem.
- G. Modifications to the equipment and unit process systems required to meet Functional Completion Testing requirements shall be provided, and all retesting shall be performed at no additional cost to the Owner.
- H. A Functional Completion Testing Certificate shall be prepared by the Contractor for each piece of equipment or system and submitted to the Engineer and Owner for review.

1.8 COMMISSIONING

- A. All equipment shall be commissioned.
- B. Commissioning activities for the project shall not be initiated until the requirements of Startup are completed for the equipment or unit process systems.
- B. The requirements of this section shall be satisfactorily completed prior to beginning Performance Testing for equipment and unit process systems.
- C. Commissioning shall be used by the Contractor and equipment or unit process suppliers to adjust, fine tune, modify and prepare the equipment or system for continuous operation and Performance Testing.
- D. Equipment shall not be operated without the guidance of qualified personnel having the knowledge and experience necessary to conduct proper operation thereof and obtain valid results.
- E. All required adjustments, tests, operation checks, and Startup and Commissioning activities shall be provided by qualified personnel.
- F. Contractor shall be responsible for planning, supervising, and executing the Startup and Commissioning of the equipment and unit process systems with the assistance of equipment or unit process systems suppliers in accordance with the Plan.
- G. The Contractor shall be responsible for commissioning under the direction of its Startup Manager.
- H. The Owner's operating and maintenance staff shall be allowed to observe for the purposes of familiarization and training.

- I. For equipment or unit process systems that do not meet Commissioning requirements, it shall be the responsibility of the Contractor and/or equipment or unit process systems suppliers to make the necessary corrections or replacements and repeat Commissioning at no additional cost to the Owner.
- J. The equipment or unit process systems shall not be Performance Tested or otherwise placed into service until Commissioning is completed as evidenced by a completed Commissioning certificate for the equipment or unit process systems.
- K. Commissioning Certificates for each piece of equipment or unit process shall be completed and submitted by the Contractor to the Engineer and Owner for review.

1.9 PERFORMANCE TESTING AND OPERATIONAL DEMONSTRATION

- A. Contractor shall demonstrate the operation of all equipment and systems. Contractor shall provide all labor, materials, services, equipment, and incidentals required for Performance Testing and Operational Demonstrations as indicated in the Contract Documents. This Performance Testing and Operational Demonstrations shall be conducted, coordinated and recorded by the Contractor in accordance with the requirements specified herein and in cooperation with the Owner and Engineer. The pump station will not be considered Substantially Complete until the completion of the performance testing and operational demonstration.
- B. This Work is additional to any other installation, shop and factory testing, field testing, dry testing, wet testing, performance testing, balancing or adjustments required elsewhere in the Contract Documents.
- C. Conduct Performance Testing and Operational Demonstration testing for each item of process, mechanical, instrumentation and controls, plumbing, heating, ventilating, and air conditioning (HVAC); electrical systems and equipment, and other systems and equipment, to demonstrate compliance with the performance requirements of the Contract Documents.
- D. Objectives of Performance Testing and Operational Demonstrations are to:
 - 1. Demonstrate to the satisfaction of the OWNER and ENGINEER that structures, equipment and systems tested comply with all functional and performance requirements in the Contract Documents.
 - 2. Establish baseline operating conditions for OWNER's use in establishing standard operating procedures and preventative maintenance programs.
 - 3. The Performance Testing shall maintain conformance with performance tolerances for a period of not less than 7 days. If a testing failure occurs (whether process, mechanical, electrical, instrumentation) during the 7 day testing period, the malfunction shall be repaired, and the 7 day testing period shall restart.
 - 4. The Operational Demonstrations shall maintain conformance with the performance tolerances for a period of not less than 30 days. If a testing failure occurs (whether process, mechanical, electrical, instrumentation) during the 30 day testing period, the malfunction shall be repaired, and the 30 day testing period shall restart.

E. Utilities and Consumables:

1. Contractor shall provide the following: fuel, compressed air, temporary conduit, cable and wire, piping and appurtenances, and all other items and Work required for completing Performance Testing and Operational Demonstrations.
2. Owner will provide the electricity, chemicals, and plant water for the initial Performance Testing and Operational Demonstrations. Contractor shall provide all temporary electrical equipment, including but not limited to conduit and cable, piping and appurtenances required to convey electricity, chemicals, and plant water to the required testing location. If re-testing is required, cost of utilities and consumables furnished by Owner for initial testing shall be paid by Contractor at Owner's cost or standard rates, as applicable.

F. Sequence: The following general sequence applies to Performance Testing and Operational Demonstrations:

1. Furnish submittals required prior to Performance Testing, in accordance with the Contract Documents.
2. Furnish acceptable operations and maintenance manuals in accordance with the Contract Documents.
3. Complete the Work associated with starting and placing equipment and systems in operation in accordance with the Contract Documents.
4. Training of operations and maintenance personnel in accordance with Section 01820, Demonstration and Training. Training must occur prior to the Operational Demonstration.
5. Proceed with Performance Testing in accordance with the Contract Documents, simulating the range of actual operating conditions to the greatest extent possible.
6. Complete site quality control Work specified in the Contract Documents for individual equipment items and systems. Field inspection, testing, and adjustments shall be signed off by approved representative of the Manufacturer, indicating that the equipment, components, systems, or unit processes meets the Manufacturer's requirements.
7. Following acceptance of the Performance Testing by the Engineer and Owner, Contractor shall initiate a 30-day Operational Demonstrations, as described herein.
8. Successful completion of Operational Demonstration is part of the requirements to achieve Substantial Completion.
9. The Operational Demonstration for a piece of equipment shall be successfully completed prior to beginning the Operational Demonstration for a second piece of equipment.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 STARTUP

- A. The Contractor's Performance Testing Manager and Manufacturer's Representative shall inspect equipment and systems prior to each start-up and verify their readiness for start-up. Conditions hazardous to equipment or personnel shall be corrected by the Contractor's Performance Testing Manager prior to start-up of equipment.
- B. Start-up operations shall not precede using temporary power or temporary instrumentation and control wiring. All electrical and control connections shall be permanent and complete, and all such electrical components and equipment fully functional.
- C. Use of repair parts during start-up operations shall not be permitted, except in such situations where the actual on-site verification of such repair parts' operability is specified.
- D. The Contractor's Performance Testing Manager shall verify that all initial copies of the maintenance and operating instructions have received, from the Engineer, an acceptable disposition as defined in Section 01330, Submittal Procedures, and the only outstanding item is the field verification of the maintenance and operating instructions.
- E. Contractor's Performance Testing Manager shall compare, and make adjustments to conform to; the Manufacturer's recommendations for the following minimum start up requirements:
 - 1. Motors:
 - a. Check each motor for comparison to amperage nameplate value.
 - b. Correct conditions that produce excessive current flow and conditions that exist due to equipment malfunction.
 - 2. Valves:
 - a. Inspect manual and automatic control valves, and clean bonnets and stems.
 - b. Tighten packing glands to ensure no leakage, but allow valve stems to operate without galling.
 - c. Replace packing in valves to retain maximum adjustment after system is determined to be complete.
 - d. Replace packing on valves that continue to leak.
 - e. Remove and repair bonnets that leak.
 - f. After cleaning, coat packing gland threads and valve stems with surface preparation of "Molycote" or "Fel-Pro".

- g. Verify that control valve seats are free from foreign matter and are properly positioned for intended service.
3. Tighten flanges and other pipe joints after system has been placed in operation.
 - a. Replace gaskets that show signs of leakage after tightening.
4. Inspect all joints for leakage:
 - a. Promptly remake each joint that appears to be faulty; do not wait for rust or other corrosion to form.
 - b. Clean threads on both parts, and apply compound and remake joints.
5. After system has been placed in operation, clean strainers, drives, pockets, orifices, valve seats, and headers in fluid system to ensure freedom from foreign matter.
6. Remove rust, scale, and foreign matter from equipment and renew defaced surfaces.
7. Inspect fan wheels for clearance and balance.
8. Check each electrical control circuit to ensure that operation complies with the Contract Documents.
9. Inspect each pressure gauge, thermometer, and other instruments for calibration.
 - a. Replace items that are defaced, broken, or that read incorrectly.
10. Repair damaged insulation.
11. Vent gasses trapped in systems.
12. Verify that liquids are drained from all parts of gas or air systems.

3.2 COMMISSIONING

- A. On successful completion of startup, the Contractor shall begin commissioning of the equipment and systems, wherein the equipment and systems are subjected to full operation. Adjustments shall be made as necessary and the equipment and system shall be optimized and brought into compliance with design criteria in preparation for performance testing and the Operational Demonstration specified within the Contract Documents.
- B. The various vendors, equipment suppliers and manufacturers shall provide on-site supervision and assistance for Commissioning services for the new facility.
- C. The Contractor shall coordinate all Commissioning activities for equipment and systems in accordance with the accepted commissioning plan.

- D. Commissioning shall show that the equipment and unit process systems are capable of continuous operation using process liquids and solids, chemicals, and utilities; and that the flows, operating parameters and performance requirements have been demonstrated for a minimum of seven days of continuous operation, or the period required in the equipment specifications, whichever is longer.
- E. If the commissioning fails, the Contractor will be responsible for redoing the commissioning at no additional costs to the Owner.
- F. Shutdowns that occur because of power outages, acts of God, or failure of support systems not part of this Contract will not be a cause of failure of continuous operation during the Operational Demonstration.

3.3 PERFORMANCE TESTING AND OPERATIONAL DEMONSTRATION

- A. Contractor shall perform Operational Demonstration of the work. Unless otherwise specified, the Operational Demonstration shall be a continuous 30-day, (720 hours) period during which the work is operated and maintained in a continuously on-line, fully functional process status.
- B. The Operational Demonstrations shall encompass the entire work, or the portion thereof designated for Substantial Completion. The Operational Demonstrations shall include all the equipment and systems.
- C. Filling, draining, cleaning, stabilizing, adjusting, or other start-up activity time shall not be counted as Operational Demonstration time.
- D. During the entire 30 day Operational Demonstration period, the operation of equipment will be assumed by the Owner's personnel, under the direction of the Contractor. The Contractor shall provide labor and sufficient material to fully operate and maintain the work 24 hours per day, 7 days per week for the entire duration of the Operational Demonstrations.
- E. Prior to the Operational Demonstrations, all parts of the work designated for the operational demonstration shall have passed all required tests as specified. No testing shall be allowed during the Operational Demonstrations.
- F. During the Operational Demonstration period, Contractor shall obtain baseline operating data on equipment with motors greater than one horsepower. Baseline data shall include amperage, bearing temperatures, and vibration data obtained at intervals in the approved testing plan. Methods of measurement shall be in accordance with industry standards applicable for the motors being tested.
- G. All required maintenance and servicing prior to the date of Substantial Completion shall be performed by the Contractor at the specified interval and as necessary. All maintenance and servicing shall be noted in the Operational Demonstration Log.
- H. All outages of equipment or system(s) should be noted in the Operational Demonstration Log. Plant outages are considered a part of normal plant operation and will not invalidate the Operational Demonstration. The Contractor is responsible for the safe and orderly shutdown and restart of equipment as necessary in the event of an outage.
- I. Contractor and Performance Testing Manager shall attend Operational Demonstration coordination meetings as called by the Engineer to review operating conditions of equipment and systems.

- J. If during the Operational Demonstration, any part of the work fails to fully conform to the requirements of the Contract Documents, the Operational Demonstration shall be considered to have failed, and the work shall not be considered to be Substantially Complete, and the Engineer shall so notify the Contractor in writing. If, during the Operation Demonstration, the provisions of the General Conditions are evoked to stop the work, the Operational Demonstration will also be considered to have failed.
- K. Re-testing Because of Disputed Testing Results or Procedures: In the case of an otherwise satisfactory Operational Demonstration, when there is doubt, dispute, or difference between Engineer and Contractor regarding testing results, methods, or equipment used in the Operational Demonstration testing, Engineer may order Contractor to repeat the testing. If repeat testing using such modified methods or equipment required by Engineer confirms the previous test, all costs of repeat test will be paid by Owner. Otherwise all costs, including costs of the Engineer, labor, testing agencies, and inspections, shall be paid by Contractor.
- L. Post-test Inspection: After completing Operational Demonstration testing, check equipment for proper alignment and realign, as required. Check equipment for loose connections, unusual movement, and other indication of improper operating characteristics. Disassemble and inspect equipment and devices that exhibit unusual or unacceptable operating characteristics. Repair or replace defective Work to conform to the Contract Documents at no additional cost to Owner.
- M. Upon failure of the Operational Demonstration, the Contractor shall promptly remedy any defects in the work and shall promptly reschedule and re-start the complete 30-day, (720 hours) Operational Demonstration time period. No Operational Demonstration time will be considered to have accrued to any part of the work by reason of a failed Operational Demonstration.
- N. During the Operational Demonstration, the Owner may require or permit the Operational Demonstration to be suspended:
1. As provided in the General Conditions.
 2. Upon the written request of the Contractor, to correct or adjust the work, when in the judgment of the Engineer such required correction or adjustment is insufficient to deem the Operational Demonstration to have failed.
 3. If the Operational Demonstration is suspended for any reason except failure, Operational Demonstration time shall accrue to the work from the time of the beginning of the Operational Demonstration to the time of the suspension.
 4. If the Operational Demonstration is suspended at the request of the Contractor, the Contractor shall continue operation and maintenance of the work without additional charges to the Owner, according to the extent required by the Contract Documents and the Owner. No Operational Demonstration time shall accrue to the Work during the period of suspension.
- O. Completion of the Operational Demonstration does not relieve the Contractor of its other requirements for Substantial Completion as required by the Contract Documents.

END OF SECTION

SECTION 01820

DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Training
- B, Instructor Manual
- C. Trainee Manual

1.2 SUBMITTALS

- A. Submit the following in accordance with Section 01330:
 - 1. Submit two copies of the outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.
 - 2. Submit resumes, including three outside references, for each instructor proposed for training program. The qualifications of the instructor shall include the type of training instructor has received for the specific equipment and previous training work experience.
 - 3. Submit two (2) electronic copies of each training module within seven (7) calendar days following the delivery of each training module. Submit copies thirty (30) days prior to training.
 - 4. On each copy of the training module, provide an applied label with the following information:
 - a. Name of Project
 - b. Training Session Name
 - c. Name of Engineer
 - d. Name of Construction Manager
 - e. Name of Contractor
 - 5. At completion of training, submit complete training manual(s) for Owner's use prepared and bound in format matching operation and maintenance manuals and in a PDF electronic file. Include a table of contents with links to corresponding training components.
 - a. The PDF electronic file format shall be electronically searchable and shall adhere to the same requirements defined in Section 01781, Paragraph 1.4.

1.3 COORDINATION

- A. Contractor to coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations and to ensure availability of the Owner's personnel. Contractor shall schedule training sessions at least 60 days in advance.

- B. Contractor shall provide a minimum of three (3) general training sessions. Each of the training sessions shall cover all topics. General training sessions may be on non-consecutive weeks to accommodate shift changes at the plant.
- C. Detailed instrumentation and controls training shall be provided separately in accordance with Section 17720, Computerized SCADA System.
- D. Training sessions shall be provided prior to the operational demonstration.
- E. Contractor to coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- F. Contractor to coordinate content of training modules with content of accepted emergency, operation, and maintenance manuals. Do not submit instruction program(s) for review until the operation and maintenance data required under Section 01781 has been reviewed and accepted by Engineer.

PART 2 - PRODUCTS

2.1 INSTRUCTOR MANUAL

- A. The Contractor shall prepare an Instructor Manual or each curriculum that includes all of the information specified below and written at the journeyman level for electrician specialists, mechanical specialists and instrument technicians, and for water treatment plant operators, or other disciplines, depending upon the target audience.
- B. The Instructor Manual shall be consistent with the nomenclature and contents of the accepted Contractor's O&M Manuals required in Specification Section 01781. The O&M Manuals cannot be substituted for the Instructor Manual.
- C. The purpose of the Instructor Manual is to define the concepts and information that will be taught to each target audience and to describe the methods and materials to be used during the training. The Instructor Manual is designed to provide specific guidance to the Instructor regarding all aspects of the training program. The Instructor Manual shall include:
 - 1. Description of the equipment.
 - 2. Parts and equipment graphics.
 - 3. Safety procedures.
 - 4. Startup checks and procedures.
 - 5. Overview of routine operation, including startup and shutdown and operating parameters.
 - 6. Routine, preventive, and corrective maintenance procedures.
 - 7. Lubrication (schedule and type).
 - 8. Assembly and disassembly procedures.
 - 9. Troubleshooting procedures.

10. Parts list.
 11. Special maintenance practices.
 12. Emergency shutdown.
- D. All manuals shall be presented in electronic format per the requirements of Specification Section 01330. All equipment shall be cross-referenced to the equipment tag identification numbers.
- E. Each Instructor Manual shall contain:
1. Instructor Manual cover page.
 2. Instructor Manual table of contents.
 3. Lesson Plan cover page.
 4. Lesson Plan summary.
 5. Lesson Plan text, including:
 - a. Identity of the target audience (a separate Lesson Plan is required for each target audience, such as mechanical O&M personnel, electronic/electrical O&M personnel, etc.).
 - b. Length of the training program and each topic to be covered.
 - c. Performance and/or training objectives.
 - d. Outline of the material to be covered.
 - e. Training strategies to be used and interaction with the trainees.
 - f. Audio visual and/or support materials required, and when used or referred to during instruction.
 - g. A list of resource and/or reference materials.
 6. A copy of all training aids, including electronic files.
 7. A copy of trainee materials (handouts, reference materials, etc.) in electronic format.
- F. The Contractor shall submit the equipment manufacturer's lesson plans for acceptance by the Engineer no less than ninety (90) days prior to the date that the training is to take place.
- G. With the exception of cutaway models or other items expressly exempted by the Engineer, all training aids and trainee materials contained in the Instructor Manual or used in the delivery of training shall become the property of the Owner and may be duplicated by the Owner for its own use.

- H. The Contractor shall provide required acceptance and/or copyright releases obtained from those who own proprietary and/or copyrighted materials provided by the Contractor so that the materials can be reproduced by the Owner.

2.2 TRAINEE MANUAL

- A. Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required in the individual Specification Sections.
- B. The Contractor shall submit a Trainee Manual for each curriculum that includes all of the information specified below and written at the journeyman level for electrician specialists, mechanic specialists and instrument technicians, and for water treatment plant operators, or other disciplines, depending upon the target audience.
- C. The Trainee Manual shall be consistent with the nomenclature and content of the accepted Contractor O&M Manuals required in Specification Section 01781. The O&M Manual cannot be substituted for the Instructor Manual or Trainee Manual.
- D. The purpose of the Trainee Manual is to provide an organized package of information for use by trainees during the training sessions and as reference Water Treatment Plant (New) material for operation and maintenance in the future. The Trainee Manual shall include:
 - 1. Description of the equipment.
 - 2. Parts and equipment graphics including “exploded” views.
 - 3. Safety procedures.
 - 4. Pre-startup checks.
 - 5. Startup procedures.
 - 6. Operation and monitoring procedures including normal operating parameters, and the operating limits of the equipment.
 - 7. Shutdown procedures.
 - 8. Troubleshooting procedures.
 - 9. Non-routine emergency procedures.
 - 10. Safety/Protective equipment required by Trainees.
- E. All manuals shall be presented in electronic format per the requirements of Specification Section 01330. All equipment shall be cross-referenced to the equipment tag identification numbers.
- F. The Contractor shall provide at least one hard copy of each Trainee Manual for each trainee. Hard copies shall be on 8.5” x 11” paper in a 3-hole D-ring binder.

PART 3 - EXECUTION

3.1 FACILITIES FOR TRAINING

- A. Use Owner's designated training facilities for specified field training programs. Facilities shall include the project site, which shall be used for hands-on training programs. Coordinate use of Owner's facilities with Owner.

3.2 TRAINING

- A. Training shall include the following:
 - 1. Equipment Overview (required for all types of operations and maintenance training):
 - a. Describe equipment's operating (process) function and performance objectives.
 - b. Describe equipment's fundamental operating principles and dynamics.
 - c. Identify equipment's mechanical, electrical, and electronic components and features. Group related components into subsystems and describe function of subsystem and subsystem's interaction with other subsystems.
 - d. Identify all support equipment associated with operation of subject equipment, such as air intake filters, valve actuators, motors, and other appurtenant items and equipment.
 - e. Identify and describe safety precautions and potential hazards related to operation.
 - f. Identify and describe in detail safety and control interlocks.
 - 2. Operations Training:
 - a. Describe operating principles and practices.
 - b. Describe routine operating, start-up, and shutdown procedures.
 - c. Describe abnormal or emergency start-up, operating, and shutdown procedures that may apply.
 - d. Describe alarm conditions and responses to alarms.
 - e. Describe routine monitoring and recordkeeping procedures.
 - f. Describe recommended housekeeping procedures.
 - g. Describe how to determine if corrective maintenance or an operating parameter adjustment is required.

3. Maintenance Training:
 - a. Describe preventative maintenance inspection procedures required to: inspect equipment in operation, identify potential trouble symptoms and anticipate breakdowns, and forecast maintenance requirements (predictive maintenance).
 - b. Define recommended preventative maintenance intervals for each component.
 - c. Describe lubricant and replacement part recommendations and limitations.
 - d. Describe appropriate cleaning practices and recommend intervals.
 - e. Identify and describe use of special tools required for maintenance of equipment.
 - f. Describe component removal, installation, and disassembly and assembly procedures.
 - g. Perform “hands-on” demonstrations of preventive maintenance procedures.
 - h. Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.
 - i. Define recommended torqueing, mounting, calibrating, and aligning procedures and settings, as appropriate.
 - j. Describe recommended procedures to check and test equipment following corrective maintenance.
 4. Equipment Troubleshooting:
 - a. Define recommended systematic troubleshooting procedures.
 - b. Provide component-specific troubleshooting checklists.
 - c. Describe applicable equipment testing and diagnostic procedures to facilitate troubleshooting.
 - d. Describe common corrective maintenance procedures with “hands on” demonstrations.
 5. Instrumentation/Controls Training:
 - a. Instrumentation and controls training shall be provided in accordance with Section 17720, Computerized SCADA System.
- B. Equipment to be covered during training shall be per the requirements of the individual sections of the Contract Documents. A list of required training topics is listed in Table 01820-A, Training Summary Table.

01820-A, Training Summary Table

Equipment	Specification Section
Hoisting Equipment	14620
Sump Pumps	15441
Gas Fired Unit Heaters	15621
Lighting System	16200
Electric Motors	16221
Switchboards	16425
Dry-Type Transformers	16461
Motor Starters	16481
Motor Control Centers	16483
Soft Starts	16655
Instrumentation Analytical Element	17320
Machinery Monitoring and Protection	17325
Computerized SCADA System	17720

3.3 SCHEDULE

- A. The Contractor shall coordinate the manufacturer's training services with the Owner and the Engineer, providing a minimum of sixty (60) days prior notice of training, subject to the acceptance of the Engineer and the Owner.
- B. Training shall occur prior to the operational demonstration.
- C. A training session for all equipment items shall be performed and completed in one business day. Contractor shall provide a meal for all attendees.

END OF SECTION

SECTION 02220

SITE DEMOLITION

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Includes, but not limited to, all demolition and removals of existing materials, equipment, or work necessary to complete the Work as shown and specified. Items include all underground conduit, conductors, pavement, structural steel, storage building, concrete, poles, and all related items.
- B. Demolitions and removals, which may be specified under other Sections, shall conform to requirements of this Section.

1.2 RELATED SECTIONS

- A. Section 01440 – Work Restrictions
- B. Section 01730 – Selective Demolition
- C. Section 02300 - Earthwork

1.3 REFERENCES

- A. Comply with all applicable requirements of the following reference standards:
 - 1. OSHA Standard, Title 29, Code of Federal Regulations, Part 1926, Section .850 through .860.
 - 2. OSHA Standard, Title 29, Code of Federal Regulations, Part 1926, Section .650.
 - 3. OSHA Standard, Title 29, Code of Federal Regulations, Part 1926, Section .62 – Lead Standard.
 - 4. MDOT, 2012 Standard Specifications for Construction.
 - 5. United States Environmental Protection Agency (USEPA) Publication SW-846, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, henceforth SW-846.

1.4 SUBMITTALS

- A. Submit the following in accordance with Section 01330 – Submittal Procedures.
 - 1. Demolition Plan: Submit a comprehensive demolition plan describing the proposed sequence, methods and equipment for demolition, removal and disposal of structures, relocating an installing underground utilities, pavements, etc.
- B. Do not proceed with demolition until the Owner has approved the demolition plan.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. CONTRACTOR is responsible for determining the applicability of disposal locations for debris generated throughout the course of Work.
- B. CONTRACTOR is responsible for all analytical testing required by the disposal facilities that CONTRACTOR receives approval from for debris disposal.

1.6 PROJECT CONDITIONS

- A. Unknown Conditions
 - 1. Locations of existing utilities below grade are estimated from existing documents and from surface utilities such as manholes, valve boxes and catch basins.
 - 2. CONTRACTOR is responsible for locating all utilities within the pump stations sites. Existing alignment, elevation, materials of construction and size shall be verified prior to beginning demolition.
 - 3. Should unforeseen piping or other utilities be encountered during excavation, notify the ENGINEER immediately. Cooperate with utility Owner in keeping adjacent services and facilities in operations. Repair damaged utilities immediately.
- B. Perform demolition and removal Work to prevent damage or injury to structures, occupants thereof, and adjacent features which might result from falling debris or other causes, and so as not to interfere with the use, and free and safe passage to and from adjacent structures.
 - 1. Closing or obstructing of roadways, sidewalks, and passageways adjacent to the Work by the placement or storage of materials will not be permitted, and all operations shall be conducted with a minimum interference to traffic on these ways.
 - 2. Erect and maintain barriers, lights, sidewalk sheds, and other necessary protective devices.
 - 3. Repair damage to facilities to remain, or to property belonging to the OWNER or occupants of the facilities.
 - 4. CONTRACTOR shall stop demolition work if demolition debris falls outside of the work limits and shall clear away the debris immediately. Demolition work may resume once debris outside of the work limits is removed. CONTRACTOR shall notify the ENGINEER of debris outside of the work limits.

1.7 SCHEDULING

- A. Provide 30-days advanced notice before beginning demolition work.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Concrete - Concrete required for plugging shall be as specified in Section 03300, Cast-in-Place Concrete.

- B. Flowable Fill – Flowable Fill for the pressure grouting of existing utilities shall conform to the MDOT special provision for flowable fill. The compressive strength of the flowable fill must be a minimum of 50 psi at 3 days, and 75 to 150 psi at 28 days.

PART 3 – EXECUTION

3.1 GENERAL

- A. All materials and equipment removed from existing work shall become the property of CONTRACTOR, except for those which OWNER has identified and marked for their use. All materials and equipment marked by the OWNER to remain the property of the OWNER shall be carefully removed by CONTRACTOR so as not to be damaged, and shall be cleaned and stored on or adjacent to the Site in a protected location specified by the ENGINEER or loaded onto trucks provided by the OWNER.
- B. CONTRACTOR shall dispose all demolition materials, equipment, debris, and all other items not marked by the OWNER to remain, off the Site and in conformance with all existing applicable laws and regulations.
- C. CONTRACTOR shall remove demolition materials from the site daily. CONTRACTOR shall not stockpile materials or equipment on-site.
- D. Surfaces of walls, floors, ceilings, or other areas which are exposed by any of the removals specified herein, and which will remain as architecturally finished surfaces shall be repaired and re-finished by CONTRACTOR with the same or matching materials as the existing adjacent surface or as may be otherwise approved by the ENGINEER.
- E. Pollution Controls: Use water sprinkling, temporary enclosures, and other suitable methods to limit the amount of dust and dirt rising and scattering in the air to the lowest practical level. Comply with governing regulations pertaining to environmental protection.
 - 1. Do not use water when it may create hazardous or objectionable conditions such as ice, flooding, and pollution.
 - 2. Clean adjacent structures, facilities, and improvements of dust, dirt, and debris caused by demolition operations. Return adjacent areas to conditions existing prior to the start of the Work.

3.2 PAVEMENT REMOVAL

- A. Cut and remove from the work all pavement or sidewalk that would be damaged by the work. Cutting of concrete pavement, where permitted, shall be done with a concrete saw, in a manner meeting the approval of the ENGINEER. Asphalt pavements shall be cut by a tool leaving a square neat cut. Pavements shall be cut back so the pavement opening is 6 inches wider on each side than the width of the trench, and care shall be taken during construction operations so as not to cave the banks or undermine remaining pavement. Any reinforcement encountered shall not be cut out, but shall be left protruding at least two feet from the face of the cut and shall be bent out of the way to be replaced later and spliced to new reinforcement.
- B. All strips of the existing pavement which are less than 2 ft wide and which are between the cut pavement and the concrete gutter shall be removed and replaced.
- C. In cutting through sidewalks, driveways, or curb and gutter, the CONTRACTOR shall remove full slabs of sidewalk or driveway or full lengths of curb and gutter to the nearest regular joint on each side of the excavation.

3.3 PIPING DEMOLITION

- A. CONTRACTOR shall be responsible for the controlled removal of the water in the piping prior to demolition.
- B. CONTRACTOR shall not begin removal or abandonment operations until replacement piping has been constructed, disinfected, tested and service lines have been transferred to replacement piping.
- C. All existing piping designated for abandonment in place shall be plugged at each end with a cap constructed of concrete block and non-shrink grout. The pipe shall then be pressure grouted with flowable fill full leaving no voids or air spaces.

END OF SECTION

SECTION 02240

DEWATERING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. If necessary, the CONTRACTOR shall supply all labor, materials, tools and equipment required to lower and control the groundwater levels and hydrostatic pressures to permit all excavation and construction specified under this contract to be performed in the dry. The control of all ice, snow and surface water shall be considered as part of the work under this Section.
- B. The work under this Section shall include all costs of mobilization, supply, installation, operation, maintenance, supervision, and final dismantling and removal from the site of any and all dewatering equipment.
- C. The CONTRACTOR or his dewatering subcontractor shall be currently and appropriately licensed by the State of Michigan to undertake the work covered under this Section and shall submit such information to the ENGINEER.

1.2 RELATED SECTIONS

- A. Section 02300 – Earthwork.

1.3 SUBMITTALS

- A. The CONTRACTOR shall submit complete plans and description of the overall dewatering system he proposed to use for the work under this Section for review by the ENGINEER, showing the details of the dewatering system prior to initiation of any excavation within 3 feet of the prevailing groundwater levels.
- B. Review by the ENGINEER of the dewatering system proposed by the CONTRACTOR will be only with respect to the basic principles of the methods the CONTRACTOR intends to employ. Review by the ENGINEER of the dewatering system will be based on the demonstrated performance of the system to satisfy the requirements for dewatering as specified herein.

1.4 SITE CONDITIONS

- A. The CONTRACTOR shall take all the steps that he considers necessary to familiarize himself with the site conditions, the ground conditions and the groundwater conditions. Copies of the logs of the borings and a soils report are among the data available and a part of these Contract Documents. The data described above is furnished for information only, and it shall be expressly understood that the OWNER and/or the ENGINEER will not be held responsible for any interpretation or conclusions drawn therefrom by the CONTRACTOR.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.1 GENERAL

- A. It is the intent of this Section that an adequate dewatering system shall be installed to lower and control the groundwater in order to permit excavation, grading, construction of the structures and the placement of the fill materials, all to be performed under dry conditions. The dewatering system shall be adequate to pre-drain the water-bearing strata above and below the bottom of the structure foundations, the drains, the sewers and all other excavations. In addition, the system to be used shall reduce the hydrostatic head in the water-bearing strata below the structure foundations, the drains, sewers, and all other excavations to the extent that the water level and piezometric water levels in the construction area are substantially a minimum of 3 feet below the prevailing excavation surface at all times. Appropriate screens and filters shall be used to prevent loss of soil through the dewatering equipment.
- B. Prior to any excavation below the groundwater level, the dewatering system shall be placed into operation to lower the water levels as required and shall be operated continuously 24 hrs. per day, 7 days per week until all drains, sewers and structures have been satisfactorily constructed including placement of fill materials and no longer requiring dewatering. An adequate weight of fill material or of structure shall be in place to prevent buoyancy or flotation prior to discontinuing operation of the dewatering system.
- C. The CONTRACTOR shall obtain written approval from the ENGINEER before discontinuing the operation of the dewatering system.
- D. The CONTRACTOR shall be solely responsible for the arrangement, location and depths of the dewatering system necessary to accomplish the work described under this Section. The dewatering shall be accomplished in a manner that will reduce the hydrostatic head below any excavation to the extent that the water level and piezometric water levels in the construction area are substantially a minimum of 3 feet below the prevailing excavation surface, will prevent the loss of fines, seepage, boils, quick conditions or softening of the foundation strata, will maintain stability of the sides and bottom of the excavation and will result in all construction operations being performed in the dry.
- E. The control of all surface and subsurface water, ice and snow is considered as part of the dewatering requirements. The control shall be adequate such that the stability of excavated and constructed slopes are not adversely affected by water, that erosion is controlled, and that flooding of excavations or damage to the existing and/or new structures or portions thereof does not occur. Surface water or roof runoff shall not be directed toward the excavations.
- F. The CONTRACTOR shall dispose of all water removed from the excavations in such a manner as will not endanger public health, property, any portion of the work under construction or completed either by him or any other CONTRACTOR, shall not recharge the water bearing strata and shall be performed in such a manner as will cause no inconvenience whatsoever to the OWNER, ENGINEER, or to others engaged on work about the site. Water shall be conveyed in conduits or open water channels to avoid erosion in foundation areas. However, open channels adjacent to existing footings shall not be permitted.

- G. The CONTRACTOR shall provide complete standby equipment, installed and available, for immediate operation as may be required, to adequately maintain dewatering on a continuous basis in the event that all or any part of the dewatering system may become inadequate or fail.
- H. If the dewatering requirements are not satisfied due to inadequacy or failure of the dewatering system, loosening of the foundation strata or instability of the slopes or damage to the foundations or structures may occur. The supply of all labor, materials and plant, and the performance of all work necessary to carry out any necessary additional work for the reinstatement of the structures or the foundations soils resulting from such inadequacy or failure shall be undertaken by the CONTRACTOR subject to the approval of the ENGINEER and at no additional expense to the OWNER.

3.2 OBSERVATION WELLS

- A. If site conditions necessitate, the CONTRACTOR shall supply, install, take measurements and maintain the observation wells (piezometers) at various locations near existing structures to insure complete drawdown.
- B. The observation wells shall be of a suitable design proposed by the CONTRACTOR and as reviewed by the ENGINEER.
- C. The CONTRACTOR shall be responsible for installing and maintaining all observation wells and observing and recording the elevation of the groundwater and piezometric water levels in all the observation wells daily. A record of the information obtained shall be given to the ENGINEER each day. The CONTRACTOR shall also permit the ENGINEER to make his own observations. Any observation well that becomes inactive, damaged or destroyed shall be replaced within 24 hrs by the CONTRACTOR at no additional expense to the OWNER. If an observation well becomes inactive, damaged, or destroyed, and if in the opinion of the ENGINEER the observations from that observation well are critical, further excavation shall be suspended at the discretion of the ENGINEER and at no additional expense to the OWNER. Excavation shall not recommence until that observation well is repaired or replaced to the satisfaction of the ENGINEER and reliable observations can be obtained from that well or its replacement well.
- D. The CONTRACTOR shall demonstrate by adding or removing water from all observation well risers that the observation wells are functioning properly.
- E. All observation wells shall be satisfactorily installed and proven to be functioning properly prior to commencement of dewatering in any section of the site.

3.3 CONTROL OF GROUNDWATER LEVELS

- A. The observation wells and test pits or holes shall be used as a primary basis of determining compliance with the requirements of this Section.

3.4 REMOVAL OF SYSTEM(S)

- A. After all requirements of this Section are met, the CONTRACTOR shall remove all materials and equipment used during this operation. All holes, wells, and pits shall be filled immediately with suitable material.

END OF SECTION

BARTON AND SOUTH INDUSTRIAL PUMP STATIONS ELECTRICAL IMPROVEMENTS

SECTION 02300

EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

- A. The CONTRACTOR shall perform all excavation and backfilling necessary to complete the work. This shall include the excavation of earth and rock, the removal and disposal of unsuitable material, dewatering, placement of suitable fill and backfill material, and the restoration and final grading for all earth surfaces.

1.2 RELATED SECTIONS

- A. Section 02240 - Dewatering
- B. Section 02250 – Excavation Support and Protection
- C. Section 02370 – Erosion and Sedimentation Controls

1.3 REFERENCES

- A. MDOT - Michigan Department of Transportation 2012 Standard Specifications for Construction

1.4 PROJECT REQUIREMENTS

- A. Work within rights-of-way.
 - 1. Where the governmental bodies having jurisdiction of the streets or rights-of-way have specific specifications relating to the requirements for work within their jurisdiction, such requirements must be met as a minimum requirement, and if these Specifications impose further limitation on the work, they shall also be met as the required work standard.
 - 2. During all operations of the CONTRACTOR in the streets and roadways, the CONTRACTOR shall maintain barricades, lights, and warning signs as required by the agency having jurisdiction.

1.5 EXISTING CONDITIONS

- A. Soil boring results, if taken on a site, are appended to these Specifications with locations noted. Boring logs are shown to be generally representative of the site and to assist in the design and construction of the work.

1.6 QUALITY ASSURANCE

- A. The CONTRACTOR's independent testing firm shall provide the following:
 - 1. Certify that the required soil bearing capacity of prepared excavation meets proposed design criteria.

2. Certify that materials proposed by the CONTRACTOR meet specifications. Certification test reports shall be submitted to the ENGINEER.
3. Conduct compaction testing of engineered fill below footings, foundations, slabs and along backfill for utility trenches. The testing frequency shall be one test per lift per 400 square feet of fill.
4. Any area failing compaction testing shall be compacted and re-tested at the CONTRACTOR's expense.

PART 2 - PRODUCTS

2.1 BACKFILL MATERIAL

- A. For areas not requiring "granular backfill" material, backfill shall be of the excavated material, with the exception that materials such as soft clay, topsoil, muck, cinders, vegetable matter, refuse, boulders and other objectionable and non-packing earth shall be excluded from the backfill and removed from the site. Stone larger than 3 inches in any dimension shall be excluded from the backfill and removed from the site by the CONTRACTOR.
- B. Where "granular material" backfill is required as specified herein, backfill material shall be defined as a material meeting granular material Class II as defined in MDOT Section 902.

PART 3 - EXECUTION

3.1 GENERAL EXCAVATION

- A. Excavation shall be performed by any practicable method consistent with the integrity and protection of the work and neighboring structures, workmen, and the public.
- B. All excavation, except where necessary to tunnel, bore or jack under roads, railroads, tree roots and other obstructions within the limits indicated on the Plans, may be open cut from the surface. Tunneling or boring under trees shall be considered as incidental to construction and will not be considered as cause for request for additional payment.
- C. Foreign material or unsuitable foundation material encountered such as wood, boulders, etc., which obstruct the excavation, shall be removed. Such materials found at the bottom of the excavation shall be removed and the foundation restored with approved materials.
- D. If excess excavation is made or the material becomes disturbed so as to require removal beyond the prescribed limits, the resulting space shall be filled with selected material solidly tamped into place, in not more than 6-inch layers to the satisfaction of the ENGINEER, before the construction work proceeds. At the direction of the ENGINEER, the excess excavation may be filled with 2000 psi concrete at the CONTRACTOR's expense.
- E. The excavation shall be kept dry during the work. Where water is encountered in the excavation, it shall be removed by pumping or well points. All necessary precautions shall be taken to prevent damage to existing wells and to completed or partially completed structures. The CONTRACTOR shall be responsible for all damages caused by him due to inadequate or improper protection.

3.2 EXCAVATION FOR SEWERS

- A. Trenches shall be excavated to the depth required with allowance for bedding the pipe. The trench shall be cut wider and deeper at each pipe joint location to provide for properly completing the pipe joint and to relieve the joint of all loadings.
- B. The width of the trench at the top of a rigid pipe shall be sufficient to allow the pipe to be laid and jointed properly and shall provide for a minimum net clearance of 6 inches and a maximum net clearance of 12 inches on each side of the barrel of the pipe and to allow the backfill to be placed and properly compacted.
- C. The width of trench at the top of a flexible pipe backfill when using concrete bedding shall be sufficient to allow the pipe to be laid and jointed properly with the minimum net clearance of 12 inches and a maximum net clearance of 18 inches on each side of the barrel of the pipe.
- D. Where the conditions of the ground require, or where the work is in close proximity of existing structures, the sides of excavation shall be securely held by bracing and/or sheeting which may be removed in units when the level of the backfill has reached a point where it is safe to pull the sheeting without disturbing the protected feature. No sheeting, bracing, or other timber shall be left in the excavation upon the completion of the main or other structures, except with the specific review and direction of the ENGINEER.
- E. Other underground mains, sewers or structures encountered in the excavation shall be adequately supported during the CONTRACTOR's operations, and before backfilling, shall be given permanent support as directed by the ENGINEER to meet the standards or requirements of the owning utility or agency.
- F. Water, sewer, gas and other utility services disturbed by the CONTRACTOR in his operations shall be repaired or replaced in a manner equal to the original condition by the CONTRACTOR at his own expense. Where these services are encountered and are undamaged, they shall be supported and/or protected by the CONTRACTOR at his expense against later settlement and/or damage after backfill. The CONTRACTOR shall consult the agency or the utility firm having jurisdiction over any duct line, gas main, etc., which may cross the excavation to determine method of supporting such duct or pipe.
- G. All excavated material shall be piled in a manner that will not endanger the work and that will avoid obstructing sidewalks and driveways. Hydrants under pressure, valve manhole covers, valve boxes, curb stop boxes, fire and police call boxes, or other utility controls shall be left unobstructed and accessible until the work is completed. Gutters shall be kept clean, or other satisfactory provisions made for street drainage, and natural water courses shall not be obstructed except as otherwise provided for herein on a temporary basis.

3.3 EXCAVATION FOR STRUCTURES

- A. Excavation for structures shall be extended sufficiently beyond the limits of the structure to provide ample room for form construction and for practicable construction methods to be followed.
- B. Requirements for excavation of sewers and water mains shall also apply to this Section.

3.4 EXCAVATION FOR PAVED SURFACES

- A. In excavating around manholes and catch basins or inlets, care shall be exercised to avoid removing the casings and pushing dirt into the structures. Dirt pushed into manholes, catch basins or inlets by the CONTRACTOR's operations shall be immediately removed so that the dirt will not be carried into the sewer by the flow of sewage or storm water.
- B. The CONTRACTOR shall take ample precautions to protect all trees and ornamental shrubbery not within the limits of the construction area, or within the construction areas shown on the Plans to be retained from injury by workmen, equipment, or any other agencies connected with the work, including subcontractors. Such protection shall be provided during the progress of the excavation, grading, or other phases of the work as necessary. Such trees or shrubbery shall be surrounded by protective posts or fencing before construction begins, when in the judgment of the ENGINEER, such precautionary measures are necessary. If, as a result of any phase of the work, trees are damaged or it is necessary to remove limbs in the way of construction, the repair of the damage and such limb removal shall be done by the CONTRACTOR as directed by the ENGINEER. All costs for the protective work shall be borne by the CONTRACTOR as incidental to the Contract work.

3.5 SHORING, SHEETING AND BRACING

- A. Where sheet piling, shoring, sheeting, bracing, or other supports are necessary, they shall be furnished, placed, maintained, and except as shown or specified otherwise, removed by the CONTRACTOR.
- B. All sheet piling, shoring, sheeting and bracing shall be designed by a professional engineer engaged by the CONTRACTOR with demonstrated competence and experience in such work. The sheeting system shall be designed to prevent bottom failure and hydrostatic uplift within the excavation. Provision shall also be made in the design for lateral pressures due to side slope and construction equipment or other surcharge loads, as applicable.
- C. The CONTRACTOR shall provide to the ENGINEER for his review, design calculation and arrangement drawings of the sheeting system prior to ordering any materials for bracing, sheeting, etc., and prior to the commencement of the excavation.
- D. All materials, except as otherwise specified, used for sheeting and sheet piling, lagging, braces, shores, and stringers, or waling strips shall be of approved quality and dimensions throughout.
- E. Materials for sheeting systems shall be furnished and driven or set in place by the CONTRACTOR, where necessary or wherever ordered by the ENGINEER, whether the same is or is not considered necessary by the CONTRACTOR. If, in the opinion of the ENGINEER, the materials furnished by the CONTRACTOR are not of proper quality or sufficient size or not properly placed to ensure the safety of the work or of adjacent structures and property, the CONTRACTOR shall, upon notice from the ENGINEER to that effect, forthwith procure, furnish and set in place or drive other and satisfactory materials, or place the material in a satisfactory manner; and if he shall fail or neglect to do so, the ENGINEER may order all or any part of the work to be stopped until such materials so used are furnished and placed; and the CONTRACTOR shall not be entitled to claim, demand, or receive any compensation for larger size or better quality or different disposal of materials ordered by the ENGINEER, nor any compensation for allowance of

any kind whatsoever for or on account of any damage or delay resulting from such stoppage of work.

- F. Steel sheet piling may be either new or used. It shall be of adequate strength, straight and properly braced. Steel sheet piling shall be of the interlocking type. Friction in the interlocks shall not be assumed to contribute to the strength of the sheet piling.
- G. The design, planning, installation and removal, if required, of all sheet piling, shoring, sheeting, and bracing shall be accomplished in such a manner as to maintain the required excavation or trench section and to maintain the undisturbed state of the soils below and adjacent to the excavation.
- H. Steel sheet piling for the excavation shall be driven straight and in-line. The piling shall be supported aboveground, before driving, by a guide frame at least 20 ft high which will keep the piling accurately in the required position and vertical. Each piece of piling shall be driven only a few feet at a time and driving shall proceed continuously around the perimeter so that the piles shall reach their full penetration together.
- I. Walers and bracing shall be supplied and installed as required to complete the sheeting system. Walers and braces shall be of adequate strength for the load imposed. Splices in walers shall develop the full strength of the member in bending, shear, and axial compression.
- J. If bracing members are to be removed during construction, the timing and procedure for removal shall not induce excessive stresses in the permanent structures or in steel sheet piling and bracing members.
- K. If the construction sequence of structures requires the transfer of bracing to the completed portions of any structure, the CONTRACTOR shall secure written acceptance of the ENGINEER prior to the installation of such bracing.
- L. In trenching operations the use of horizontal strutting below the barrel of pipe or the use of the pipe as support for trench racing will not be permitted. The use of a traveling shield for sewer construction shall require that the device be approved for use by a professional engineer. Sheet piling and timbers in trench excavations shall be withdrawn in a manner so as to prevent subsequent settlement of the pipe or additional backfill loadings which might overload the pipe.
- M. The neglect, failure, or refusal of the ENGINEER to order the use of sheeting, or sheet piling or steel, or to order the same to be left in place, or the giving or failure to give of any order or directions as to the manner or methods of driving or placing sheeting, sheet piling, bracing, shores, etc., shall not in any way relieve the CONTRACTOR of any or all obligations under this Contract. Sheeting left in place shall be cut off one (1) ft below existing grade.
- N. The rules of the OSHA and the State Department of Labor with respect to excavation and construction shall at all times be strictly observed.

3.6 BACKFILLING FOR SEWERS

- A. Backfilling shall consist of placement of the prescribed materials from a level 12 inches above the crown of the pipe. Placement shall be as follows:
 - 1. Under pavements, curb, paved driveways, and sidewalks, the backfill shall be granular material compacted in layers not to exceed 12 inches loose thickness

with backfilling carried up to subgrade. Compaction of backfill shall be such as to obtain 95% of the maximum unit density as determined at the optimum moisture content. After a period of about 60 days or less, if the backfill compaction is satisfactory to the ENGINEER, to provide for any slight settlement, the CONTRACTOR shall retrim neatly any broken edges of pavement and replace the top surface of the backfill within the pavement area with pavement surface equal to that surface which was removed. The pavement shall be replaced in accordance with the standard specifications of the agency having jurisdiction.

2. Backfill around lift stations, or buried underground structures shall be granular material compacted in 12-inch lifts. Compaction of backfill shall be such as to obtain 95% of the maximum unit density as determined at the optimum moisture content.
3. For all other areas, backfilling shall consist of placing excavated material as defined in Paragraph 2.1.A. of this Section, in 12-inch lifts to finish grade. Compaction of backfill shall be such as to obtain 90% of the maximum unit density as determined at the optimum moisture content.

3.7 FILLING AND BACKFILLING FOR STRUCTURES

- A. Embankments underlying structural footings, streets and drives, sidewalks and around structures shall be granular material meeting the requirements of the Michigan Department of Transportation for granular material compacted to 95% density.
- B. In all other areas, material required for embankments and backfilling shall be soil or soil-rock mixture free of organic and other deleterious matter and shall contain no more than 15% rocks or lumps larger than 2-1/2 inches in the greatest dimension, compacted to 90% density.
- C. Under all interior and exterior floor slabs, an 8-inch thick granular cushion shall be placed. This material shall be MDOT Class II granular material.
- D. Where embankment material is placed to achieve a new surface elevation, the top 4 inches shall be approved topsoil either salvaged from the site or hauled in by the CONTRACTOR.

3.8 FILLING AND BACKFILLING FOR PAVED SURFACES

- A. Embankments, including sand cushions and granular fills, shall be placed in successive layers not more than 6 inches in depth the full width of the cross section, each layer to be thoroughly compacted by means of vibratory compactors or by an approved pneumatic-tired roller or combination thereof, as required by the ENGINEER. Each layer shall be compacted to not less than 95% of the maximum unit density as determined at the optimum moisture content. All parts of the embankment shall be uniformly compacted and the CONTRACTOR shall so direct all earthmoving equipment used in the work so that the same shall be attained. Embankment or fill outside the limits of the subgrade where sand or gravel is not required shall be made with suitable material which is free from perishable organic matter, rubbish, stones, broken concrete, roots, or other foreign materials, at no additional compensation. Before any embankments are begun, the base shall be made firm and cleared of topsoil, sod or other perishable material. The sides of the embankment shall be neatly and evenly dressed to the slope shown on the Plans, or such other slope as the ENGINEER may direct.

- B. Upon completion of the placing of the curbs, and after the concrete has cured sufficiently, forms shall be removed and the excavated space behind the curb shall be backfilled with a good quality of surface soil, free of rubbish, stone, broken concrete, roots or other foreign material. Where adequate acceptable material for backfill behind the curb is not available, granular fill conforming to 2003 MDOT 902.08, Class II, shall be used. Where the area behind the curb is in cut, it shall be trimmed from the top of the curb on the slope shown on the Plans. If the area is in embankment or fill, an earth berm shall be placed immediately adjacent to the top of the curb and then the embankment of fill shall be finished to the slope shown on the Plans. All trimming and finishing shall be done in a neat, workmanlike manner. All excess concrete and debris shall be removed from the excavation behind the curb line before backfilling begins.
- C. In construction of non-rigid pavements, backfilling back of curb and gutter shall be completed before placement and compaction of the base course of the roadway.

3.9 PREPARATION OF SUBGRADE FOR PAVED SURFACES

- A. The bottom of the excavation for the pavement or top of the fill shall be known as the pavement subgrade and shall be smoothed, trimmed and compacted to the required line, grade and cross section to receive the road metal. It shall be thoroughly compacted by rolling with a roller of approved type weighing not less than 8 tons. The subgrade shall be compacted to at least 95% of the maximum density as designated by the test method AASHTO T-180. Inaccessible areas, where rolling is not practical, shall be thoroughly compacted by mechanical tampers capable of striking a blow equivalent to at least 250 foot-pounds per square foot. The subgrade thus formed shall be maintained in a smooth and compacted condition until the pavement has been placed. No base course, surfacing, curb, or curb and gutter, shall be placed until the subgrade has been reviewed by the ENGINEER. The subgrade shall be finished in an acceptable condition at least one day in advance of the pavement construction at all times. Six inches of compacted depth of granular material shall be used where uncompactable soil is encountered. The granular fill shall conform to the 2003 MDOT 902.08, Class II, compacted to 95% of its density.
- B. Immediately prior to placing the pavement, the subgrade shall be tested for conformity with the cross section shown on the Plans by means of an approved template riding on the curb and gutter sections or on side forms. If necessary, materials shall be removed or added, as required, to bring all portions of the subgrade to the correct elevation. Corrected portions shall then be thoroughly compacted and again tested with the template. Pavement material shall not be placed at any portion of the subgrade which has not been tested for correct elevation.
- C. The finished subgrade shall be maintained in a smooth and compacted condition until the pavement is placed. No storage piles of fine or coarse aggregate shall be placed directly upon the finished subgrade. Should the subgrade become rutted or disturbed in any manner, it shall be reshaped and recompact.

3.10 GRADING

- A. The CONTRACTOR shall grade the site to achieve the elevations as shown on the Plans. All disturbed areas beyond the grading limits shall be restored to prior condition.
- B. Surplus excavated material not needed shall be disposed of by the CONTRACTOR. Headwalls, culverts, drains, sewers and appurtenances filled or damaged by the CONTRACTOR during the course of his operations shall be cleaned, repaired, or replaced at his expense.

- C. All temporary earth changes shall be in conformance with the Soil and Erosion Control Act.

3.11 RESTORATION

- A. Headwalls, culverts, and drainage systems filled or damaged by the CONTRACTOR during the course of his operations shall be cleaned, re-laid or rebuilt with new materials to a condition equal to the original state, and of thickness equal to the original structure and to the original line and grade at the CONTRACTOR's expense.
- B. Where the excavation is located beside a ditch and/or where an existing ditch is filled or disturbed in the CONTRACTOR's operations, the CONTRACTOR shall clean, repair, or replace the ditch with properly pitched bottom and side slopes and of section and capacity not less than the original section.
- C. Where excavation has been through lawn areas, the CONTRACTOR shall restore the disturbed area by placing topsoil and seeding or sodding over the final backfill material.
- D. The CONTRACTOR shall remove excess dirt and other construction material from the site of the work and leave the site in a condition equal to its original state.
- E. The final condition of the streets and roadways shall be subject to the approval of the governmental body having jurisdiction thereof, as well as review by the ENGINEER.

END OF SECTION

SECTION 02370

EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish all labor, materials, equipment and incidentals required and perform all installation, maintenance, removal and area cleanup related to sedimentation control work as shown on the Drawings and as specified herein. The work shall include, but not necessarily be limited to; installation of temporary access ways and staging areas, silt fences, inlet protection devices, sediment removal and disposal, device maintenance, removal of temporary devices, temporary and permanent seeding, mulching and fertilization, and final cleanup. All erosion control devices shall remain in place throughout construction and until approval of final site stabilization is given by local or state authorities.
- B. The Contractor is responsible for implementing Best Management Practices (BMP's), as shown on the Contract Drawings and specified herein, to prevent and minimize erosion and resultant sedimentation in all cleared, grubbed, and active work areas during and after construction. This item covers the work necessary for the installation and maintenance of all structures and measures necessary for the prevention and control of soil erosion.
- C. Construction on this site shall disturb less than 1 acre and is greater than 500 feet from water's edge, therefore a grading/SESC permit is not required on this project. However, the project is still subject to the standards and responsibilities of City Code Chapter 63, regardless of the necessity for a permit.
- D. The following items from Rule 1709 promulgated under the authority of Part 91, Soil Erosion and Sedimentation Control, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, are particularly important:
 - 1. Design, construct, and complete the earth change in a manner that limits the exposed area of disturbed land for the shortest period of time.
 - 2. Remove sediment caused by accelerated soil erosion from runoff water before it leaves the site of the earth change.
 - 3. Temporary or permanent control measures shall be designed and installed to convey water around, through or from the earth change at a non-erosive velocity.
 - 4. Install temporary soil erosion and sedimentation control measures before or upon commencement of the earth change activity and maintain the measures on a daily basis. Remove temporary soil erosion and sedimentation control measures after permanent soil erosion measures are in place and the area is stabilized. ("Stabilized" means the establishment of vegetation or the proper placement, grading, or covering of soil to ensure its resistance to soil erosion, sliding, or other earth movement.)
 - 5. Complete permanent soil erosion control measures for the earth change within five (5) calendar days after final grading or upon completion of the final earth change. If it is not possible to permanently stabilize the earth change, then maintain temporary soil erosion and sedimentation control measures until permanent soil erosion control measures are in place and the area is stabilized.

- E. Due to the nature of the work required by this Contract, it is anticipated that the location and nature of the erosion and sedimentation control devices will be adjusted on several occasions to reflect the current phase of construction. The construction schedule adopted by the Contractor will impact the placement and need for specific devices required for the control of erosion. The Contractor shall develop and implement such additional techniques as may be required to minimize erosion and off-site sedimentation. The location and extent of erosion and sedimentation control devices shall be revised at each phase of construction that results in a change in either the quantity or direction of surface runoff from constructed areas. All deviations from the erosion and sedimentation control provisions shown on the Drawings shall have the prior acceptance of the Engineer.

1.2 RELATED SECTIONS

- A. Section 02300 – Earthwork
- B. Section 02900 – Planting

1.3 SUBMITTALS

- A. Submit to the Engineer, in accordance with Section 01300 - Submittals, technical product literature for all commercial products to be used for sedimentation and erosion control.

1.4 QUALITY ASSURANCE

- A. The Contractor shall be responsible for the timely installation and maintenance of all sedimentation control devices necessary to prevent the movement of sediment from the construction site to offsite areas or into the stream system via surface runoff or underground drainage systems. Measures in addition to those shown on the Drawings necessary to prevent the movement of sediment off site shall be installed, maintained, removed, and cleaned up at the expense of the Contractor. No additional charges to the Owner will be considered.

1.5 REFERENCES

- A. Chapter 63 – Stormwater Management and Soil Erosion and Sedimentation Control, of the City of Ann Arbor City Ordinance.
- B. City of Ann Arbor Public Services Department Standard Specifications Manual, latest edition.
- C. Michigan Department of Environmental Quality Water Division Soil Erosion and Sedimentation Control Program, Soil Erosion and Sedimentation Control (SESC) Training Manual, 2004 Edition, or latest.
- D. Michigan Department of Transportation (MDOT) 2012 Standard Specifications for Construction.

1.6 EROSION AND SEDIMENTATION CONTROL DEVICES

- A. The following erosion and sedimentation control devices shall be incorporated into the work. Other devices, as necessary and acceptable to the Engineer shall be installed as required.

1. Temporary Sediment Traps shall be constructed at the locations shown on the Drawings, at the termination of all Temporary Diversions diverting sediment laden runoff, and at other locations indicated by the Engineer. Temporary Sediment Traps shall be constructed by excavating the appropriate size rectangular basin and constructing a rock-fill dam on the discharge end to form a sediment trap. Temporary Sediment Traps shall be designed, installed and maintained in accordance with the requirements of Unit 4 of the SESC Training Manual.
2. Temporary Diversions shall be constructed at the locations shown on the Drawings, and at other locations indicated by the Engineer. Dimensions shall be as shown on the Drawings. All Diversions transporting sediment-laden runoff shall terminate in Temporary Sediment Basins. Temporary Diversions shall be designed, installed and maintained in accordance with the requirements of Unit 2 of the SESC Training Manual.
3. Silt Fence shall be constructed at the locations shown on the Drawings, and at other locations indicated by the Engineer. Silt Fence shall not be installed across streams, ditches, or waterways. Silt Fence shall be designed, installed and maintained in accordance with the requirements of Unit 4 of the SESC Training Manual.
4. Check Dams shall be constructed at the locations shown on the Drawings, and at other locations indicated by the Engineer. Check Dams shall be designed, installed and maintained in accordance with the requirements of Unit 2 of the SESC Training Manual.
5. Storm Drain Inlet Protection shall be constructed at the locations shown on the Drawings, and at other locations indicated by the Engineer. Storm Drain Inlet Protection measures shall be designed, installed and maintained in accordance with the requirements of Unit 4 of the SESC Training Manual.
6. Temporary and Permanent Channels shall be installed at the locations shown on the Drawings, and at other locations indicated by the Engineer. Channels, and Channel Linings, shall be designed, installed and maintained in accordance with the requirements of Unit 2 of the SESC Training Manual.
7. Rock Construction Exits shall be located at points where vehicles enter and leave a construction site, or at other locations indicated by the Engineer. Rock Construction Exits shall be designed, installed and maintained in accordance with the requirements of Unit 4 of the SESC Training Manual.

PART 2 -- PRODUCTS

2.1 MATERIALS

- A. Materials for use in erosion and sedimentation control devices shall be in accordance with the City of Ann Arbor Public Services Department Standard Specifications Manual, latest edition, and the Michigan Department of Environmental Quality Soil Erosion and Sedimentation Control (SESC) Training Manual, 2004 Edition, or latest edition.

2.2 TEMPORARY DIVERSIONS

- A. Temporary Diversions shall be constructed as shown on the Contract Drawings and as specified herein. Temporary Diversions shall be installed and maintained in accordance

with Part 3 of this Section. The cost of Temporary Diversions shall include the excavation and all maintenance and restoration activities required.

2.3 SILT FENCE

A. Silt Fence shall be a woven geotextile filter fabric made specifically for sediment control. Filter fabric shall not rot when buried and shall resist attack from soil chemicals, alkalides and acids in the pH range from 2 to 13, and shall resist damage due to prolonged ultraviolet exposure. Filter fabric shall be Type FX-11, as manufactured by Carthage Mills, Geotex 910SC as manufactured by Synthetic Industries, Inc., Amoco 2130 as manufactured by Amoco Fabrics & Fibers Co., or equal.

B. Filter fabric for the silt fence shall have the following minimum properties:

	<u>Value</u>	<u>Test Method</u>
Grab Tensile Strength	100 lbs	ASTM D 4632
Grab Elongation	15%	ASTM D 4632
Trapezoid Tear Strength	50 lbs	ASTM D 4533
Mullen Burst Strength	265 lbs	ASTM D 3786
Puncture Strength	58 lbs	ASTM D 4833
Retained Strength (500 hrs. accelerated UV exposure)	80%	ASTM D 4355
Filtration Efficiency	75%	VTM-51
Flow Rate	10 gal/min/ft ²	ASTM-D4491
Height	36 inches	

C. Posts for silt fence shall be steel and shall have the following properties:

ASTM Designation:	ASTM A702
Length:	5-Feet Long (T-Type)
Weight:	1.25#/Foot (min.)
Area of Anchor Plate:	14 Sq. In.

Note: Five (T) Fasteners shall be furnished with each post.

D. Wire Fabric for the silt fence shall have the following properties:

Wire Fabric Designation:	832-12-10-12.5 Class 1
Designation:	ASTM A116
Width:	32"
Number of Line Wires:	8
Stay Wire Spacing:	12"
Line and Stay Wires:	12.5 Ga.
Top and Bottom Wires:	10 Ga.
Wire Coating:	ASTM Class 1 Zinc Coating

E. Silt Fence shall be installed and maintained in accordance with Part 3 of this Section, and Unit 4 of the SESC Manual, to the satisfaction of the Engineer until the site has been

stabilized. The cost of Silt Fence shall include the fabric, posts, wire fabric, excavation and all maintenance and restoration activities required.

2.4 STONE FOR EROSION CONTROL AND RIP RAP

- A. Crushed stone for sediment filtration devices, access ways and staging areas shall conform to MDOT Sections 208 and 307.
- B. Riprap shall meet the requirements of MDOT Section 916 for plain riprap.

2.5 STRAW WITH NET TEMPORARY ROLLED EROSION CONTROL MAT (RECM)

- A. The Contractor shall place straw with net temporary RECM on all disturbed areas. The mat shall consist of clean wheat straw from agricultural crops made into a knitted straw mat that is machine assembled. The straw shall be evenly distributed throughout the mat. The mat shall be covered with a photodegradable synthetic mesh attached to the straw with degradable thread.
- B. The Contractor shall place the straw with net temporary channel and slope RECM where directed immediately after the channel or slope has been properly graded and prepared, fertilized, and seeded. If the mat is of single net construction, the netting shall be on top with the straw in contact with the soil.
- C. The Contractor will immediately repair or replaced any section of straw with net temporary channel and slope RECM which is not functioning properly or has been damaged in any way until a stable growth of grass has been established.
- D. Straw with net RECM shall be North American Green S150, American Excelsior Co. Curlex I, Contech SFB1, or equal with a minimum bare soil shear stress value of 1.5 lb/ft².

2.6 CURLED WOOD OR COCONUT FIBER ROLLED EROSION CONTROL MAT (RECM)

- A. The Contractor shall place curled wood or coconut fiber RECM on all disturbed areas with slopes greater than 1 on 3. The mat shall consist of machine-produced mat of curled wood excelsior or coconut fiber with a majority of the fibers 6 inches or longer with consistent thickness and the fibers evenly distributed over the entire area of the mat. The top of the mat shall be covered with a biodegradable synthetic mesh. The mesh shall be attached to the curled wood excelsior or coconut fiber with photodegradable synthetic yarn.
- B. The Contractor shall place the curled wood or coconut fiber channel and slope RECM where directed immediately after the channel or slope has been properly graded and prepared, fertilized, and seeded. If the mat is of single net construction, the mesh shall be on top with the fibers in contact with the soil.
- C. The Contractor will immediately repair or replace any section of curled wood or coconut fiber RECM which is not functioning properly or has been damaged in any way until a stable growth of grass has been established.
- D. Curled wood or coconut fiber RECM shall be American Excelsior Curlex II, North American Green C125, Contech EFB4 or equal matting with a minimum bare soil shear stress value of 2.0 lb/ft².

2.7 ROCK CONSTRUCTION EXITS

- A. Rock construction exits shall be constructed as shown on the Drawings and as specified herein. Rock construction exit shall be maintained in accordance with Part 3 of this Section to the satisfaction of the Engineer until the site has been stabilized. The cost of temporary gravel construction entrances shall include the gravel and all maintenance activities required.

2.8 TEMPORARY SOIL STABILIZER

- A. The temporary agent for soil erosion control shall consist of an especially prepared highly concentrated powder which, when mixed with water, forms a thick liquid such as "Enviroseal 2001" by Enviroseal Corporation, "Terra Control" by Quattro Environmental, Inc., or "CHEM-CRETE ECO-110" by International CHEM-CRETE Corporation, and having no growth or germination inhibiting factors. The agent shall be used for hydroseeding grass seed in combination with other approved amendments resulting in a highly viscous slurry which, when sprayed directly on the soil, forms a gelatinous crust.

2.9 STRAW MULCH

- A. Straw mulch shall be utilized on all newly graded areas to protect areas against washouts and erosion. Straw mulch shall be comprised of threshed straw of oats, wheat, barley, or rye that is free from noxious weeds, mold or other objectionable material. The straw mulch shall contain at least 50 percent by weight of material to be 10-in or longer. Straw shall be in an air-dry condition and suitable for placement with blower equipment.
- B. Latex acrylic copolymer, such as Soil Sealant with coalescing agent by Soil Stabilization Co., Merced, CA or equivalent shall be used as straw mulch tackifier.
- C. An asphalt tackifier shall only be used when temperatures are too low to allow the use of a latex acrylic copolymer and only with prior written approval from the Engineer.

PART 3 – EXECUTION

3.1 INSTALLATION AND MAINTENANCE

- A. Erosion and sedimentation control devices shall be established prior to or concurrent with the clearing operations in a given area. Where such practice is not feasible, the erosion and sedimentation control device(s) shall be established immediately following completion of the clearing operation.
- B. The Contractor shall furnish the labor, materials and equipment required for routine maintenance of all erosion and sedimentation control devices. Maintenance shall be scheduled as required for a particular device to maintain the removal efficiency and intent of the device. Maintenance shall include but not be limited to 1) the removal and satisfactory disposal of accumulated sediment from traps or silt barriers and 2) replacement of filter fabrics used for silt fences and stone used in temporary sediment traps, stone filters, gravel construction entrances, etc.. Sediment removed from erosion and sedimentation control devices shall be disposed of in locations that will not result in offsite sedimentation as acceptable to the Engineer, at no additional cost to the Owner.

- C. The Contractor shall provide temporary sedimentation traps at all locations shown on the Contract Drawings and as per the approved SESC Plan for the settling of water pumped from the excavations or intercepted by drainage ditches for keeping water out of the excavations or to protect existing structures. The Contractor shall remove accumulated sediment from the traps as necessary to maintain their effectiveness or as indicated by the Engineer. Sediment material removed from the traps shall be disposed by the Contractor in locations that will not result in off-site sedimentation as acceptable to the Engineer, at no additional cost to the Owner.
1. Inspect temporary sediment traps after each period of significant rainfall. Remove sediment and restore the trap to its original dimensions when the sediment has accumulated to one-half the design depth of the trap. Place the sediment that is removed in a designated disposal area and replace the contaminated part of the gravel facing.
 2. Check the structure for damage from erosion or piping. Periodically check the depth of the spillway to ensure it is a minimum of 1.5 ft. below the low point of the embankment. Immediately fill any settlement of the embankment to slightly above design grade. Any riprap displaced from the spillway must be replaced immediately.
 3. After all sediment-producing areas have been permanently stabilized, remove the structure and all unstable sediment. Smooth the area to blend with the adjoining areas and stabilize properly.
- D. The Contractor shall provide temporary diversions at all locations noted on the Contract Drawings and as per the approved SESC Plan. All temporary diversions shall outlet at a temporary sediment trap or other appropriate structure.
1. Inspect temporary diversions once a week and after every rainfall. Immediately remove sediment from the flow area and repair the diversion ridge. Carefully check outlets and make timely repairs as needed. When the area protected is permanently stabilized, remove the ridge and the channel to blend with the natural ground level and appropriately stabilize it.
- E. Silt fence shall be erected as shown on the Drawings, as per the approved SESC Plan and specified herein. Silt fence shall be erected and maintained to the satisfaction of the Engineer until a vegetative ground cover has been established. Replacement of the filter fabric, if required by the Engineer, will be at the Contractor's expense.
1. Silt fence shall be erected around all catch basins which are located downstream from any construction work. Should any catch basins be indicated to be relocated or modified, silt fence shall be utilized until work is completed on the catch basins. Upon completion of the modification, the area shall be rough graded, as shown on the Drawings, until the end of the project, at which time final grading shall occur.
 2. Inspect silt fence at least once a week and after each rainfall. Make any required repairs immediately.
 3. Should the fabric of a silt fence collapse, tear, decompose or become ineffective, replace it promptly.

4. Remove sediment deposits as necessary to provide adequate storage volume for the next rain and to reduce pressure on the fence. Take care to avoid undermining the fence during cleanout.
 5. Remove all fencing materials and unstable sediment deposits and bring the area to grade and stabilize it after the contributing drainage area has been properly stabilized. Removal of any silt fence shall be permitted only with the prior approval of the Engineer, or the local governing agency.
- F. Riprap shall be graded so that the smaller stones are uniformly distributed through the mass. The Contractor may place the stone by mechanical methods, augmented by hand placing where necessary or ordered by the Engineer. The placed riprap shall form a properly graded, dense, neat layer of stone. The placed riprap shall have a minimum depth of 24 inches. Type II Separator Geotextile, as specified in Section 02270 – Geosynthetics, shall be used under all riprap unless otherwise noted.
- G. Riprap and stone for erosion control shall be dumped and placed in such manner that the larger rock fragments are uniformly distributed throughout the rock mass and the smaller fragments fill the voids between the larger fragments. Rearranging of individual stones by equipment or by hand shall only be required to the extent necessary to secure the results specified above, to protect structures from damage when rock material is placed against the structures, or to protect the underlying Separator Geotextile from damage during installation.
- H. The Contractor shall provide gravel and riprap filter berm basins at all locations noted on the Contract Drawings and as per the approved SESC Plan.
1. Inspect gravel and riprap filter berm basins after each period of significant rainfall. Remove sediment and restore the basin to its original dimensions when the sediment has accumulated to one-half the design depth of the trap. Place the sediment that is removed in a designated disposal area and replace the contaminated part of the gravel facing.
 2. Check the structure for damage from erosion or piping. Any stone or riprap displaced from the berm must be replaced immediately.
 3. After all sediment-producing areas have been permanently stabilized, remove the structure and all unstable sediment. Smooth the area to blend with the adjoining areas and stabilize properly.
- I. Engineer may direct the Contractor to place Straw with Net, Curled Wood or Coconut Fiber RECM's and Synthetic TRM's in permanent channels or on slopes at other locations not shown on Drawings.
1. All temporary and permanent channel and slope lining RECM's and TRM's shall be unrolled in the ditch in the direction of the flow of water. Temporary linings shall overlap the buried end of the downstream blanket by a minimum of 6 inches. Permanent linings shall overlap a minimum of 3 feet. All anchor and transverse trenches shall be a minimum of 12 inches deep. All mats shall be stapled as per manufacturer's specifications.

2. During the establishment period, check grass, RECM and TRM-lined channels after every rainfall event. For grass-lined channel once grass is established, check periodically and after every heavy rainfall event. Immediately make repairs. It is particularly important to check the channel outlet and all road crossings for bank stability and evidence of piping and scour holes. Give special attention to the outlet and inlet sections and other points where concentrated flow enters. Remove all significant sediment accumulations to maintain the designed carrying capacity. Keep the grass in a healthy, vigorous condition at all times.
- J. The Contractor shall provide temporary slope drains at all location noted on the Contract Drawings, and as per the approved SESC Plan, and at other locations as may be directed by the Engineer.
1. Inspect the temporary slope drain and supporting diversion after every rainfall event and promptly make any necessary repairs. When the protected area has been permanently stabilized, temporary measures may be removed, materials disposed of properly, and all disturbed areas stabilized appropriately.
- K. The Contractor shall provide temporary gravel construction entrances at all locations noted on the Contract Drawings, and as per the approved SESC Plan, and at all other locations as may be directed by the Engineer.
1. Maintain the gravel pad in a condition to prevent mud or sediment from leaving the construction site. This may require periodic topdressing with 2-inch stone. After each rainfall, inspect each construction entrance and clean out as necessary. Immediately remove all objectionable materials spilled, washed, or tracked onto public roadways.
- L. The Contractor shall provide temporary or permanent ground cover adequate to restrain erosion on all disturbed areas that will be left unworked for periods exceeding 30 calendar days.
1. Reseed and mulch temporary seeding areas where seedling emergence is poor, or where erosion occurs, as soon as possible. Do not mow. Protect from traffic as much as possible.
 2. Generally, a stand of vegetation cannot be determined to be fully established until soil cover has been maintained for one full year from planting. Inspect seeded areas for failure and make necessary repairs and reseeds within the same season, if possible.
 3. Reseeding – If a stand has inadequate cover, re-evaluate choice of plant materials and quantities of lime and fertilizer. Re-establish the stand after seedbed preparation or over-seed the stand. Consider seeding temporary, annual species if the time of year is not appropriate for permanent seeding.
 4. If vegetation fails to grow, soil must be tested to determine if acidity or nutrient imbalance is responsible.
 5. Fertilization – Contractor shall refertilize in the second growing season.
- M. Additional Requirements
1. All storm sewer piping shall be blocked at the end of every working day until the inlet is constructed above grade.

2. All streets around the construction area shall be swept as necessary at the end of each day's work and after each rainfall event of ½-inch or greater to prevent accumulation of dirt and debris. Inlet protection shall be maintained on all stormwater inlets on site, in streets, or downstream of site until construction is complete.
3. The Contractor shall provide adequate means to prevent any sediment from entering any storm drains, curb inlets (curb inlet filter box), ditches, streams, or bodies of water downstream of any area disturbed by construction. Excavation materials shall be placed upstream of any trench or other excavation to prevent sedimentation of offsite areas. In areas where a natural buffer area exists between the work area and the closest stream or water course, this area shall not be disturbed.
4. Contractor shall provide adequate means to control dust on the site and prevent it from entering the process tanks on site.
5. The Owner or Engineer may direct the Contractor to place any additional sediment and erosion control devices at other locations not shown on the Drawings.

3.2 INSPECTIONS AND MAINTENANCE

- A. The Contractor shall designate a Certified Operator to perform inspections required by this Section. The following areas are to be inspected and maintenance performed, if needed, at least once every 7 calendar days and within 24 hours of a rainfall event that has a precipitation of 1/2 inch or greater.
 1. Disturbed areas of the construction site that have not undergone final stabilization
 2. Erosion and sediment control structures, dust control measures
 3. All locations where vehicles enter or exit the site
 4. Material storage and construction laydown areas that are exposed to precipitation and have not been finally stabilized
- C. Immediate action will be taken to correct deficiencies to BMP's. The State or Local Authorities reserves the right to stop all construction activities not related to maintaining BMP's until such deficiencies are repaired.
- D. In areas that have been finally stabilized, inspections and, if necessary, maintenance by Contractor will occur at least once per month for the duration of the contract or project, whichever is longer.
- E. During inspections the following will be observed and appropriate maintenance procedures taken:
 1. The conformance to specifications and current condition of all erosion and sediment control structures
 2. The effectiveness and operational success of all erosion and sediment control measures

3. The presence of sediments or other pollutants in storm water runoff at all runoff discharge points
4. If reasonably accessible, the presence of sediments or other pollutants in receiving waters
5. Evidence of dust being transported to any process tank on site
6. Evidence of off-site tracking at all locations where vehicles enter or exit the site

3.3 TEMPORARY MULCHING

- A. Apply temporary mulch to areas where rough grading has been completed but final grading is not anticipated to begin within 30 days of the completion of rough grading.
- B. Straw mulch shall be applied at rate of 100 lbs/1000 sq ft and tackified with latex acrylic copolymer at a rate of 1 gal/1000 sq ft diluted in a ratio of 30 parts water to 1 part latex acrylic copolymer mix.

3.4 REMOVAL OF TEMPORARY SEDIMENT CONTROL STRUCTURES

- A. At such time that temporary erosion and control structures are no longer required under this item, the Contractor shall notify the Engineer of its intent and schedule for the removal of the temporary structures, and obtain the Engineer's approval in writing prior to removal. Once the Contractor has received such written approval from the Engineer, the Contractor shall remove, as approved, the temporary structures and all sediments accumulated at the removed structure shall be returned upgrade. In areas where temporary control structures are removed, the site shall be left in a condition that will restore original drainage. Such areas shall be evenly graded and seeded as specified in Section 02920 – Lawns and Grasses.

3.5 FINAL CLEANUP

- A. Once the site has been fully stabilized against erosion and all sediment control measures have been removed, dispose of accumulated silt and waste materials in proper manner. Re-grade all areas disturbed during this process and stabilize against erosion with surfacing materials as indicated on the Drawings.

END OF SECTION

SECTION 02710

BASE COURSES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Aggregate Base Course

1.2 RELATED SECTIONS

- A. Section 02300 – Earthwork

1.3 SUBMITTALS

- A. Submit manufacturer's gradation report and certification letters to the OWNER at least 30 days prior to placing aggregate base courses.
- B. After installation, submit field quality control test results and delivery tickets for each load.

1.4 REFERENCES

- A. Michigan Department of Transportation 2012 Standard Specifications for Construction (MDOT).

1.5 QUALITY ASSURANCE

- A. The CONTRACTOR's testing subcontractor and laboratory shall provide the following services in accordance with Division 1 and Section 01450 – Quality Control.
 - 1. Sieve analysis per source
 - 2. Proctor per source
 - 3. Compaction test once per 1,000 SF of placement.

1.6 PROJECT CONDITIONS

- A. Aggregate base course shall not be placed when there are indications that the mixture may become frozen before the maximum unit weight is obtained, and in no case shall the aggregate be placed on a frozen subbase, or when the subgrade is wet.

PART 2 - PRODUCTS

2.1 AGGREGATES

- A. Aggregate base course shall meet the requirements of MDOT Section 902.06, 21AA Dense-Grade Aggregate, unless noted otherwise. Aggregate shall be natural; no slag, crushed concrete or salvaged aggregate will be permitted.

PART 3 - EXECUTION

3.1 INSPECTION

- A. The underlying course or subgrade shall be checked and accepted before placing and spreading operations are started. Notify ENGINEER, in writing, of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.
- B. Any ruts or soft, yielding places caused by improper drainage conditions, hauling, or any other cause, shall be corrected and rolled to the required compaction before the base course is placed thereon.
- C. To protect the underlying course or subgrade and to insure proper drainage, the spreading of the base shall begin along the centerline of the pavement on a crowned section or on the high side of the pavement with a one-way slope.

3.2 BASE COURSE INSTALLATION

- A. Aggregate base course shall meet the requirements of MDOT Section 302.

3.3 PROTECTION

- A. If the subbase or subgrade at any time prior to acceptance of the work becomes soft or unstable to the extent that it is forced up through or prevents compaction of the aggregate, such subbase or subgrade material and aggregate shall be immediately removed and disposed of.
- B. After the subbase or subgrade has been corrected, new material shall be placed and compacted as provided herein.
- C. When such work and materials are required as a result of the CONTRACTOR's operations, the CONTRACTOR shall restore the subbase or subgrade, and base course to the condition required by these specifications without additional compensation.

END OF SECTION

SECTION 02750

PAVEMENTS AND WALKS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The CONTRACTOR shall furnish all labor, materials, tools and equipment necessary to construct the various pavements and walks as described herein and/or shown on the Plans.
- B. This work shall include, but not necessarily be limited to, the following:
 - 1. Concrete Pavement
- C. Where MDOT occurs in statements in this Section, it shall mean Michigan Department of Transportation (2003 Ed.).

1.2 RELATED WORK

- A. Removal of the items listed in Subsection 1.01.B, if existing, is described in Section 2.03 - Demolition.
- B. Preparation of a stabilized subgrade is described in Section 2.04 - Earthwork.

PART 2 - PRODUCTS

2.1 SUBBASE

- A. Subbase shall meet the requirements of MDOT Specification 902.08, Class II.

2.2 AGGREGATE BASE COURSE

- A. Aggregate shall meet the requirements of MDOT Specifications 902.06, 21AA series.

2.3 CONCRETE PAVEMENT

- A. Concrete shall meet the requirements of Section 03300.

PART 3 - EXECUTION

(Not Used)

END OF SECTION

SECTION 02920

LAWNS AND GRASSES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fine Grading
- B. Topsoil
- C. Fertilizers
- D. Seeding
- E. Sodding

1.2 RELATED SECTIONS

- A. Section 02300 – Earthwork
- B. Section 02370 – Erosion and Sedimentation Controls

1.3 SUBMITTALS

- A. Certification of grass seed from seed vendor for each grass-seed 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.
- B. Certification of each seed mixture for sod, identifying sod source, including name and telephone number of supplier.
- C. Certification of all fertilizers.
- D. Certified analysis of the topsoil from each source.

1.4 REFERENCES

- A. Michigan Department of Transportation 2012 Standard Specifications for Construction (MDOT).
- B. American Sod Producers Association (ASPA)
- C. ASTM D5268 - Topsoil Used for Landscaping Purposes

1.5 DESCRIPTION

- A. The CONTRACTOR shall permanently prepare, fertilize, and seed or sod or riprap the areas designated on the Plans or disturbed by the CONTRACTOR. Sod shall be placed on areas having a slope of 3:1 (three horizontal and one vertical) or steeper. Grass seed shall be placed on areas having a slope flatter than 3:1. Sod may be placed in other areas at the CONTRACTOR's own option and expense. Riprap shall be placed where shown on the Plans or required by the ENGINEER.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Seed: Deliver seed in original sealed, labeled, and undamaged containers, bearing seed analysis and the date of the seed testing. The testing shall be within a period of six months prior to commencement of planting operations.
- B. Sod: harvest, deliver, store, and handle sod according to the requirements of the ASPA "Specifications for Turfgrass Sod Materials and Transplanting/Installing".
- C. Fertilizer: Delivered in bags or other convenient containers, each fully labeled, conforming to applicable state fertilizer laws, bearing the grade and the trade name of the producer.
- D. The CONTRACTOR is responsible for proper storage & security of all seeding materials.

1.7 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with planting only when existing and forecast weather conditions are suitable for work. At option and under full responsibility of CONTRACTOR, planting operations may be conducted under unseasonable conditions, but without additional compensation.

1.8 SCHEDULING

- A. Planting Season: Sow seed and install sod during normal planting seasons and per project schedule. Optimal time for seed is between April 1 and June 1, and between September 1 and October 15.

1.9 MAINTENANCE

- A. It is the responsibility of the CONTRACTOR to establish a dense lawn of permanent grasses, free from mound and depressions. Any portion of the sodded area that "browns-out" or does not firmly knit to the soil base, or any portion of a seeded area that fails to show a uniform germination, shall be re-sodded or re-seeded. Such re-sodding or re-seeding shall be at the CONTRACTOR's expense and shall continue until a dense lawn is established.
- B. The CONTRACTOR shall maintain all lawn areas until they have been accepted by the OWNER. Lawn maintenance shall begin immediately after the grass seed or sod is in place and continue until provisional acceptance.
 - 1. Lawns shall be protected and maintained by watering, mowing, and re-seeding as necessary for one year to establish a uniform weed-free stand of grasses and until specific lawn acceptance has been made. CONTRACTOR shall review lawn establishment on a minimum bi-weekly basis. Maintenance includes deposition of additional topsoil and re-sodding as may be required to correct all settlement and erosion until the date of final acceptance.
 - 2. At the time of the first cutting the lawn shall be 2-1/2 to 3-1/2 inches high, and the mower blades shall be set at 2-1/2 inches high. All lawns shall receive at least six mowings, with a minimum of 1 week between mowing, before acceptance.

3. Damage to seeded areas resulting from erosion shall be repaired by the CONTRACTOR at the CONTRACTOR's expense. Scattered bare spots in seeded areas will not be allowed over three (3) percent of the area nor greater than 3" x3" in size.
 4. OWNER will withhold \$4,000 from final payment and will release up to \$1,000 per quarter upon satisfactory completion of lawn and landscaping maintenance work.
- C. When the above requirements have been fulfilled, the OWNER will accept the lawn.

PART 2 - PRODUCTS

2.1 TOPSOIL

- A. Topsoil shall meet the requirements of ASTM D5268 Topsoil shall not be contaminated or excessively acidic or alkaline, and shall be free of stones 1 inch or larger in any dimension. Topsoil shall consist of natural loam, sandy loam, silty loam, or clay loam humus-bearing soils adapted to sustain plant life.
- B. Topsoil Source: Reuse surface soil stockpiled on the site. Verify suitability of surface soil to produce topsoil meeting requirements and amend when necessary. Supplement with imported topsoil when quantities are insufficient. Clean topsoil of roots, plants, sods, stones, clay lumps, and other extraneous materials harmful to plant growth.

2.2 FERTILIZER

- A. Fertilizer shall meet the requirements of the MDOT Section 917.

2.3 SEED

- A. Permanent seed shall meet the requirements of the MDOT Section 917 for seed mixture THM, as follows:
 1. 65% Kentucky Bluegrass, 98% pure with an 85% germination factor.
 2. 25% Creeping Red Fescue, 97% pure with an 85% germination factor.
 3. 10% Perennial Ryegrass, 96% pure with a 85% germination factor.
- B. Temporary seeds, their spreading rates and dates of application shall be as follows:
 1. April 1 to August 15:
Spring oats or barley, at 2 lbs/1000 sq ft, or 3 bu/acre;
Domestic rye grass, at .5 lb/1000 sq ft, or 20-25 bu/acre.
 2. June - July:
Sudangrass, at 1 lb/1000 sq ft, or 30-40 lbs/acre.
 3. August 1 to October 15:
Rye, at 1lbs/1000 sq ft, or 2-3 bu/acre; Perennial Ryegrass, at .5 lb/1000, or 20-25 lbs/acre.
 4. September 20 to October 15:
Wheat, at 3 lbs/1000 sq ft, or 2-3 bu/acre

2.4 SOD

- A. Sod shall meet the requirements of the MDOT Section 917.

2.5 MULCH

- A. Mulch shall meet the requirements of the MDOT Section 917 for straw mulch blankets.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Prior to sodding, OWNER must approve condition of the seedbed. Inadequate seedbed preparation shall result in the reworking of the area to the complete satisfaction of the OWNER.
- B. Do not proceed until unsatisfactory conditions have been corrected.
- C. The CONTRACTOR is solely responsible to determine the quantity of cut and fill required to complete the work and to locate a suitable source and amount of topsoil.

3.2 TOPSOIL PLACEMENT

- A. The application of topsoil shall occur only when conditions are favorable so as to minimize damage to the subgrade.
- B. Where undesirable soils exist within the subgrade, it will be the responsibility of the CONTRACTOR not to contaminate the topsoil during the replacement or finishing process. All undesirable soils or objects will be removed from the topsoil seedbed at the cost of the CONTRACTOR.
- C. Topsoil shall be placed and spread over the areas graded as shown on the plans in such a manner so that after compaction and natural settling the topsoil will conform to finished grades as shown.
- D. Provide a smooth transition between adjacent existing grades and new grades.
- E. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

3.3 FINE GRADING

- A. Areas to be planted shall be finish graded to provide surface drainage.
- B. Undulations and unsightly variations in grade which will not permit the use of normal mowing equipment without scalping shall be removed so that proper use of such equipment may be accomplished.
- C. Limit preparation to areas that will be planted in the immediate future.
- D. Loosen existing topsoil to a minimum depth of 4 inches. Remove stones, sticks, roots, rubbish, and other extraneous matter larger than 1 inch in any dimension.

- E. Mix soil amendments and fertilizers with new topsoil per recommendations from soil report. Delay mixing fertilizer if planting does not follow placing of topsoil within a few days. Either mix soil before spreading or apply soil amendments and fertilizers on surface of spread topsoil and mix thoroughly into top 4 inches of topsoil before planting

3.4 TEMPORARY SEEDING AND MULCHING

- A. The seedbed immediately before seeding shall be firm but not so compact as to prohibit covering seed, securing adequate germination, or root penetration. Tillage implements shall be used as necessary to provide at least a 3-inch depth of firm but friable soil, free of large clods and stones.
- B. Seed may be broadcast by hand, by cyclone-type mechanical seeders or applied with a drill, cultipacker-seeder, or other suitable equipment. Seed should be covered approximately 2-inches deep either during seeding operation or by following broadcast application with cultipacker or similar tool.
- C. Mulching shall be used with all seedings on disturbed soil areas and for temporary use without seeding during months unfavorable to seeding.
- D. Immediately after seeding, mulch with unweathered small grain straw (preferably wheat) or hay spread uniformly at the rate of 1-1/2 ton per acre, or 100 lbs (2-3 bales) per 1,000 sq ft.

3.5 PERMANENT SEEDING AND SODDING

- A. Topsoil shall be spread to a depth of 4 inches unless otherwise shown on the Plans. Placement of topsoil shall conform to MDOT Section 816.
- B. All areas to be seeded or sodded shall be fertilized in accordance with MDOT Section 816. CONTRACTOR shall provide all necessary soil tests to determine fertilizer needs.
- C. Permanent seeding shall conform to MDOT Section 816. Seeding rate shall be 300 lb/acre.
- D. Fertilizing shall conform to all local restrictions.
- E. Sodding shall conform to MDOT Section 816

3.6 MULCHING

- A. Straw mulch blankets shall be applied to all seeded areas. Blankets shall be attached with biodegradable wooden pegs per the manufacturer's recommendations.

3.7 PROTECTION

- A. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period until lawn is established.

END OF SECTION

SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Concrete work shall include the furnishing of all labor, materials, formwork, reinforcing, tools and equipment required to manufacture, transport, place, protect, repair, cure, and finish all concrete work for a complete and functioning installation in accordance with the Contract Documents.
- B. The CONTRACTOR shall be responsible for all items (openings, rebar, sleeves, inserts, anchorages, etc.) shown on the Plans and those which may not be shown on the Plans but are required to be placed in the concrete work.
- C. Progress of Work
 - 1. If unacceptable concrete strength or air content occurs and additional testing or remedial actions or modifications are required, further concrete work will not be permitted until such testing has revealed the probable cause of the low strength or low air levels and a program of remedial actions or modifications has been implemented.

1.2 DEFINITIONS

- A. The following supplemental definitions cover the meanings of certain words and terms as used in this Section.
 - 1. Reviewed or Permitted: Reviewed by the OWNER and/or OWNER's REPRESENTATIVE.
 - 2. Exposed Construction: Exposed to view. Situated so that it can be seen from eye level from any location after completion of the structure.
 - 3. Normal Weight Concrete: Concrete for which density is not a controlling attribute, made with aggregates of the types covered by "Specification for Concrete Aggregates" (ASTM C-33), and having unit weights in the range of 135 to 160 lb/cu ft.
- B. Other words and terms used in these specifications are defined in Cement and Concrete Terminology (ACI-SP-19).

1.3 STANDARDS

- A. The latest edition of the standards from the American Society for Testing and Materials, American Concrete Institute, American Welding Society, and Concrete Reinforcing Steel Institute, referred to in these Specifications, are listed below with their serial designation and are declared to be a part of these Specifications, the same as if fully set forth herein, except as modified in this Specification.
 - 1. American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103:

- A 82-85 Standard Specification for Cold-Drawn Steel Wire for Concrete Reinforcement
- A 184-86 Standard Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement
- A 185-85 Standard Specification for Welded Steel Wire Fabric for Concrete Reinforcement
- A 496-85 Standard Specification for Deformed Steel Wire for Concrete Reinforcement
- A 497-86 Standard Specification for Welded Deformed Steel Wire Fabric for Concrete Reinforcement
- A 615-87 Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
- C 31-87a (1980) Standard Method of Making and Curing Concrete Test Specimens in the Field
- C 33-86 Standard Specification for Concrete Aggregates
- C 39-86 Standard Method of Test for Compressive Strength of Cylindrical Concrete Specimens
- C 42-84a Standard Method of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
- C 94-86b Standard Specification for Ready-Mixed Concrete
- C 109-86 Standard Method of Test for Compressive Strength of Hydraulic Cement Mortars (using 2-inch (50-mm) cube specimens)
- C 138-81 Standard Method of Test for Unit Weight Yield, and Air Content (Gravimetric) of Concrete
- C 143-78 Standard Method of Test for Slump of Portland Cement Concrete
- C 144-87 Standard Specification for Aggregate for Masonry Mortar
- C 150-86 Standard Specification for Portland Cement
- C 172-82 Standard Method of Sampling Fresh Concrete
- C 173-78 Standard Method of Test for Air Content of Freshly Mixed Concrete by the Volumetric Method
- C 192-81 Standard Method of Making and Curing Concrete Test Specimens in the Laboratory
- C 231-82 Standard Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method
- C 260-86 Standard Specification for Air-Entraining Admixtures for Concrete

BARTON AND SOUTH INDUSTRIAL PUMP STATIONS ELECTRICAL IMPROVEMENTS

- C 309-81 Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
 - C 387-87 Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete
 - C 494-86 Standard Specification for Chemical Admixtures for Concrete
 - D 994-71 Standard Specification for Pre formed expansion Joint Filler for Concrete (Bituminous Type)
 - D 1751-83 Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)
 - E 329-77 Standard Recommended Practice for Inspection and Testing Agencies for Concrete, Steel, and Bituminous Materials as Used in Construction
2. American Concrete Institute, Box 19150, Redford Station, Detroit, Michigan 48219
- SP-1 5 Field Reference Manual: Specifications for Structural Concrete for Buildings ACI 301-89 with Selected ACI and ASTM References, 1989.
 - ACI 116 Cement and Concrete Terminology.
 - ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
 - ACI 212.3 Chemical Admixtures in Concrete
 - ACI 214 Recommended Practice for Evaluation of Strength Test Results of Concrete (Reapproved for 1989)
 - ACI 302.1 Guide for Concrete Floor and Slab Construction
 - ACI 303 Guide to Cast-In-Place Architectural Concrete Practice
 - ACI 304 Recommended Practice for Measuring, Mixing, Transporting, and Placing Concrete (Revised 1982)
 - ACI 302 Placing Concrete by Pumping Methods
 - ACI 305 Hot Weather Concreting
 - ACI 306 Cold Weather Concreting
 - ACI 308 Standard Practice for Curing Concrete
 - ACI 309 Recommended Practice for Consolidation of Concrete
 - ACI 31 5 Details and Detailing of Concrete Reinforcement (Revised 1986)
 - ACI 318 Building Code Requirements for Reinforced Concrete (Revised 1987)
 - ACI 318.1 Building Code Requirements for Structural Plain Concrete

ACI 347 Recommended Practice for Concrete Formwork

ACI 350 Concrete Sanitary Engineering Structures

ACI 503 Use of Epoxy Compounds with Concrete

3. American Welding Society, 550 N.W. LeJenne Road, P.O. Box 351040, Miami, FL 33135; "Structural Welding Code - Reinforcing Steel" (AWS D1.4-79).
4. Concrete Plant Manufacturers Bureau, 900 Spring Street, Silver Spring, MD 20910: "Concrete Plant Mixer Standards of the Plant Mixer Manufacturer's Division".
5. National Ready Mix Concrete Association, 900 Spring Street, Silver Spring, MD 20910: "Check List for Certification of Ready Mixed Concrete Production Facilities".
6. Concrete Reinforcing Steel Institute, 228 North LaSalle Street, Chicago, Illinois 60601: "Placing Reinforcing Bars," and "Reinforcement Anchorages and Splices," latest editions.

B. Field Reference Manual

1. The CONTRACTOR shall keep at least one copy of "Specifications for Structural Concrete for Buildings (ACI 301) with Selected ACI and ASTM References "ACI Field Reference Manual SP-15, in the field office at all times.

1.4 SUBMITTAL REQUIREMENTS

A. Shop Drawings: Submit in accordance with the General Conditions, covering the items included under this Section.

1. Shop Drawings of Reinforcement: Submit original Shop Drawings for fabrication, bending, and placement of concrete reinforcement. Comply with Reinforcement Shop Drawing Checklist below as applicable:

a. Reinforcement Shop Drawing Checklist:

- 1) Specify ASTM number and grade of reinforcing on submitted Shop Drawings (e.g., ASTM A 615, Grade 60).
- 2) Specify clear coverages and bar support spacing per Placing Reinforcement Specification in Article 2.09.
- 3) Specify lap lengths as shown on the Structural Drawings.
- 4) Submit Bar Bending Schedule.
- 5) Use closed stirrups and ties with 135-degree hooks, unless noted otherwise in Drawings.
- 6) Specify major Contract reference Drawings on submitted detail sheets. Use same section cut numbers and letters when practical.
- 7) Show stirrup spacing.
- 8) Show details for additional reinforcing items. Examples are reinforcing around openings, control joints, equipment pads, masonry reinforcement.

- 9) Show numeric elevation references on sections shown on submitted Shop Drawings.
- 10) Locate expansion and control joints.
- 11) Organize and present sheets in logical sequence.
- 12) Submit "small" submittal packages when practical.
- 13) Show inside and outside or near face and far face on walls.
- 14) Show bar spacings and quantities on Shop Drawing submittals.
- 15) Immediately contact OWNER and/or OWNER's REPRESENTATIVE if Contract Documents are unclear.
- 16) For epoxy coated reinforcement, coating applicator must furnish written certification that the coated reinforcing bars were cleaned, coated, and tested according to ASTM D3963.99.

b. Mix Designs: Submit the following for all concrete classes:

- 1) Water/cement ratio (total gallons of water per cubic yard)
- 2) Brand, type, and quantity of cement
- 3) Type and quantity of aggregates
- 4) Type and quantity of admixtures
- 5) Unit weight (wet density)
- 6) History of composition strength based on 28-day compression test. Test reports shall be current and within 90 days of submittal. Concrete supplier must demonstrate a familiarity with his supplied mix.
- 7) Submit laboratory test reports and certification letters for concrete mix design, cement, aggregates (particularly deleterious materials in coarse aggregate), four weeks before scheduled pouring.

B. Product Data: Submit data for proprietary materials and items, including admixtures, patching compounds, waterstops, joint systems, curing compounds, and other materials installed under this Section.

C. Submit samples of materials as requested by OWNER and/or OWNER's REPRESENTATIVE, including names, sources and descriptions.

D. Quality Assurance Submittals:

1. Submit written reports to ENGINEER documenting testing and inspection results.
2. Submit mill test reports on reinforcement.
3. Submit materials certificates in lieu of laboratory test reports on other materials. Manufacturer and CONTRACTOR shall sign material certificates certifying that each material item complies with, or exceeds, specified requirements. Submit certification from admixture manufacturers that chloride content complies with specification requirements.
4. CONTRACTOR shall be experienced with the placement, finishing, and curing of the specified concrete mixes and admixtures, and provide a minimum of five (5) reference projects.

1.5 PROJECT CONDITIONS

- A. Protection against Freezing: Cover completed Work with sufficient temporary cover to protect against possibility of freezing. Provide supplemental heat and maintain cover for curing period or until temperatures cannot affect concrete.
- B. Protect adjacent finish materials against spatter during concrete placement.

1.6 MANUFACTURERS

- A. Subject to compliance with the specified requirements, manufacturers which may be incorporated in Work include:
 - 1. Fiber Reinforcement:
 - a. "Fiberstrand 100", Euclid Chemical Co.
 - b. "Fibermesh", Fibermesh Co.
 - c. "Forta", Forta Corporation
 - d. "Grace Fibers", W.R. Grace & Co.
 - e. "Fibrasol F", Axim Technologies
 - 2. Air-Entraining Admixture:
 - a. AEA 15, Sika Corp.
 - 3. Corrosion Inhibitor and Bonding Agent:
 - a. Armatech 110-EpoCem, Sika Corporation
 - 4. Water-Reducing Admixture:
 - a. "Plastocrete 161", Sika Chemical Corporation
 - 5. High-Range Water-Reducing Admixture:
 - a. ViscoCrete 2100, Sika Corporation
 - 6. Water Reducing, Non-Chloride Accelerator Admixture:
 - a. Sika Corporation
 - 7. Water-Reducing, Retarding Admixture:
 - a. Sika Corporation
 - 8. Expansion and Isolation Joint Filler (excluding pavements):
 - a. "Sealtight Sponge Rubber", W.R. Meadows
 - b. "1300 Series Sponge Rubber", Williams Products

9. Expansion and Isolation Joint Sealant, one part polyurethane:
 - a. "Vulkem 45 or 116", Mameco International
 - b. "Sonolastic NP1", Sonneborn-Contech
 - c. "Dynaseal W-517 or 907", Williams Products
10. Non-Shrink Grout:
 - a. Dayton-Superior
 - b. Euclid Chemical Co.
 - c. Master Builders
 - d. U.S. Grout Corporation
11. Chemical Hardener:
 - a. "Burk-O-Lith", The Burke Co.
 - b. "Day-Chem Hardener", Dayton-Superior
 - c. "Surfhard", Euclid Chemical Co.
 - d. "Mastertop CST", Master Builders
 - e. "Lapidolith", Sonneborne-Rexnord
12. Moisture-Retaining Cover:
 - a. Polyethylene-coated burlap.
13. Epoxy Anchors:
 - a. "HIT HY150", Hilti Systems

PART 2 - PRODUCTS

2.1 CEMENT

- A. Cement shall be Portland cement Types I or III, and shall conform to ASTM C150 and contain less than 0.60 percent alkalis. Different cements shall not be used interchangeably in the same element or portion of the work.

2.2 ADMIXTURES

- A. The following admixtures will be permitted or required in the concrete as stated.
 1. Air-entraining admixture conforming to ASTM C260.
 2. Water reducing, retarding and accelerating admixtures conforming to ASTM C494 will be permitted in concrete made with Type I Cement. Water reducing admixture conforming to ASTM C494 will be permitted in concrete made with Type III Cement.

3. Fly Ash

- a. Fly ash shall be Type Class C or F, meeting the requirements of ASTM C618 and the carbon content shall be less than one percent.
- B. Admixtures used in the concrete shall be of the same composition as used in establishing the required concrete proportions (See paragraph 2.07 of this Section of the Specifications).
- C. Calcium chloride or admixtures containing calcium chloride will not be permitted in the concrete work.
- D. The name, manufacturer, and technical information for all admixtures shall be submitted for approval.
- E. All admixtures shall be used in accordance with the manufacturer's instructions.
- F. Admixtures shall be supplied by a single manufacturer to ensure compatibility.

2.3 WATER

- A. Mixing water for concrete shall be fresh, clean, and free from injurious amounts of oil, acid, alkalis, salts, sewage, organic matter, or other deleterious substances and meet the requirements of ASTM C94.

2.4 AGGREGATES

- A. Aggregates shall conform to ASTM C33. Coarse aggregates shall meet the grading requirements for size 67 for all concrete work unless noted otherwise.
- B. Fine and coarse aggregates shall be regarded as separate ingredients. Each size of coarse aggregate, as well as the combination of sizes when two or more are used, shall conform to the appropriate grading requirements of the applicable ASTM specifications.
- C. Aggregates shall be tested for reactivity. To minimize alkali-silica reactions, high alkali content shall not be permitted.

2.5 FIBER REINFORCEMENT

- A. Polypropylene fibers designed as secondary reinforcing. Fibers to comply with ASTM C1116, Type III, not less than $\frac{3}{4}$ -inch long.

2.6 STORAGE OF MATERIALS

- A. Cement shall be stored in weather-tight buildings, bins, or silos which will exclude moisture and contaminants.
- B. Aggregate stockpiles shall be arranged and used in a manner to avoid excessive segregation and to prevent contamination with other materials or with other sizes of like aggregates. To insure that this condition is met, any test for determining conformance to requirements for cleanness and grading shall be performed on samples secured from the aggregates at the point of batching. Frozen or partially frozen aggregates shall not be used.
- C. Natural or manufactured sand shall be allowed to drain until it has reached relatively uniform moisture content before it is used.
- D. To prevent excessive variations in moisture content, predampened aggregates must remain in the stockpiles for a minimum of 12 hours before use.

- E. Admixtures shall be stored in such a manner as to avoid contamination, evaporation, or damage. For those used in the form of suspensions or non-stable solutions, agitating equipment shall be provided to assure thorough distribution of the ingredients. Liquid admixtures shall be protected from freezing and from temperature changes which would adversely affect their characteristics.
- F. Moisture retaining covers shall be one of the following, complying with ASTM C17:
 - Waterproof Paper
 - Polyethylene Film, Burleen

2.7 PROPORTIONING

- A. General
 - 1. Concrete for all parts of the work shall be of the specified quality capable of being placed without excessive segregation. When hardened, concrete shall develop all characteristics required by these Specifications.
 - 2. Use Portland Cement Type I or III.
 - 3. Fly ash shall be used to partially supplant cement content in concrete. Replacement quantity shall be not less than 15%, nor more than 20% of cement content by weight.
 - 4. Concrete shall not have less than one inch slump as determined by ASTM C143.
 - 5. The nominal maximum size of the aggregate shall not be more than one-fifth of the narrowest dimension between sides of forms, one-third of the depth of slabs, nor three-fourths of the minimum clear spacing between reinforcing bars.
- B. Design Mixes
 - 1. Locations for concrete classes are attached at the end of this section.
 - 2. Properties for concrete classes are attached at end of this section.
 - 3. Adjustment of Concrete Mixes: Mix designs may be adjusted when characteristics of materials, job conditions, weather, test results, or other circumstances warrant, when approved by ENGINEER, at no additional cost to OWNER. Submit laboratory test data for revised mix design and strength results to ENGINEER before using in work.
 - 4. Admixtures:
 - a. Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) in concrete for placement and workability.
 - b. Use non-chloride accelerating admixture in concrete slabs placed at ambient temperatures below 50 degrees F (10 degrees C).
 - c. Add air-entraining admixture at manufacturer's prescribed rate to result in placed concrete having total air content specified.
 - d. Refer to the mix designs attached at the end of this section for other specific admixture usage.

2.8 FORMWORK

A. General

1. Forms shall be used to confine the concrete and shape it to the required dimensions. Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of the concrete, and shall have sufficient rigidity to maintain specified tolerances.
2. Formwork shall conform to ACI 347.
3. Earth cuts may be used to form footings, trench footings, and mass footings provided that the cut is clean, reasonably straight, and meets the tolerances of this Section. Review by the ENGINEER is required in order to use earthcuts. If the earth cannot hold the shapes required by the Drawings these items shall be formed.

B. Design and Installation of Formwork

1. The design and engineering of the formwork, as well as its construction, shall be the responsibility of the CONTRACTOR.
2. The formwork shall be designed for the loads, lateral pressure, and allowable stresses outlined in ACI 347, Design of "Recommended Practice for Concrete Formwork" as well as for the design considerations, wind loads, allowable stresses, and other applicable requirements of the controlling local building code.
3. Requirements for facing materials are given in following items of this Section of the Specifications. The maximum deflection of facing materials reflected in concrete surfaces exposed to view shall be 1/240 of the span between structural members.
4. Forms shall be sufficiently tight to prevent loss of mortar from the concrete. Chamfer strips (1" x 1" x 1-1/2") shall be placed in the corners of forms to produce beveled edges on permanently exposed surfaces unless detailed otherwise. Interior corners on such surfaces and the edges of formed joints will not require beveling. Exposed surfaces include surfaces exposed to view or water in the finished construction.
5. Positive means of adjustment (wedge or jacks) of shores and struts shall be provided and all settlement shall be taken up during concrete placing operation. Forms shall be securely braced against lateral deflections. Formwork shall be cambered to compensate for anticipated deflections in the formwork prior to hardening of the concrete.
6. Temporary openings shall be provided at the base of column forms and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed.
7. Form accessories to be partially or wholly embedded in the concrete, such as ties and hangers, shall be of a commercially manufactured type. Non-fabricated wire shall not be used.
8. Form ties shall be constructed so that the end or end fasteners can be removed without causing appreciable spalling at the faces of the concrete. Form ties shall have cones on each end.
 - a. Non-Exposed Concrete Work: After the ends or end fasteners of form ties have been removed, the embedded portion of the ties shall terminate not less than 2 diameters or twice the minimum dimension of the tie from the

formed faces of concrete and in no case shall this distance be less than 3/4 inch.

- b. Exposed Concrete Work (this shall apply to areas where one or both faces of the work is exposed to view; i.e., retaining wall): Form, ties, assemblies for concrete exposed to water, influent, effluent, weather, freeze/thaw and similar exposures shall permit tightening of the forms and shall leave no metal or other material within 1-1/2 inch of the surface. The assembly should provide cone-shaped depressions at the form/concrete surface interface of at least one inch diameter and 1-1/2 inch deep to permit filling and patching. Tie shall be tight fitting or tie holes shall be sealed to prevent leakage. Single rod ties shall be equipped with a tightly fitted washer at midpoint when part of the tie is to remain in concrete exposed to liquids.
 - c. Tie systems shall provide positive pressure at all joints to preclude mortar/grout leakage.
- 9. At construction joints, contact surface of the form sheathing for flush surfaces shall overlap the hardened concrete in the previous placement by not more than 1 inch. The forms shall be held against the hardened concrete to prevent offsets or loss of mortar at the construction joint and to maintain a true surface.
 - 10. Wood forms for wall openings shall be constructed to facilitate loosening, if necessary, to counteract swelling of the forms.
 - 11. Wedges used for final adjustment of the forms prior to concrete placement shall be fastened in position after the final check.
 - 12. Formwork shall be so anchored to shores or other supporting surfaces or members that upward or lateral movement of any part of the formwork system during concrete placement will be prevented.
 - 13. Runways for moving equipment shall be provided with struts or legs and shall be supported directly on the formwork or structural member without resting on the reinforcing steel.
 - 14. Provide temporary openings at base of wall and column forms and other interior areas of formwork where it is inaccessible for cleanout, for observation before concrete placement, and for placement of concrete. Securely brace temporary openings and set tightly to forms to prevent loss of concrete mortar. Locate temporary openings on forms at inconspicuous locations.
 - 15. Provisions for other trades: Provide openings in concrete formwork to accommodate work of other trades. Determine size and location of openings, recesses, and chases from trades providing these items. Accurately place and securely support items built into forms.

C. Tolerances

- 1. The formwork shall be constructed so that the concrete surfaces will conform to the tolerance limits listed in Table 2.08.C.1.

Table 2.08.C.1
Tolerances for Formed Surfaces

- (1) Variation from plumb:
- a. In the lines and surfaces of columns, piers, walls, and in arises:

in any 10 ft of length	¼ - inch
maximum for entire length	1 inch
 - b. For exposed corner columns, control joint grooves and other conspicuous lines:

in any 20'- 0" length	¼ - inch
maximum for the entire length	½ - inch
- (2) Variation from the level or from the grades specified in the Contract Documents:
- a. In slab soffits, ceilings, beam soffits and in arises, measured before removal of supporting shores

in any 10 ft of length	¼ - inch
in any bay or any 20 ft length	⅜ - inch
maximum for entire length	¾ - inch
 - b. In exposed lintels, sills, parapets, horizontal grooves, and other conspicuous lines:

in any bay or in 20 ft length	¼ - inch
maximum for entire length	½ - inch
- (3) Variation of the linear building lines from established position in plan and related position of columns, walls, & partitions:
- | | |
|---------------------------|----------|
| in any bay | ½ - inch |
| in any 20 ft of length | ½ - inch |
| maximum for entire length | 1 inch |
- (4) Variation in the sizes and location of sleeves, floor openings, & wall openings
- ± ¼ - inch
- (5) Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls
- | | |
|-------|----------|
| minus | ¼ - inch |
| plus | ½ - inch |
- (6) Footings
- a. Variations in dimensions in plan:

minus	½ - inch
plus	2 inches

b. Misplacement of eccentricity:

2% of footing width in direction of misplacement but no more than 2 inches

c. Thickness:

decrease in specified thickness	0 inch
increase in specified thickness	1 inch

(7) Variation in steps:

a. In a flight of stairs:

Rise	$\pm \frac{1}{8}$ - inch
Tread	$\pm \frac{1}{8}$ - inch

b. In consecutive steps:

Rise	$\pm \frac{1}{16}$ - inch
Tread	$\pm \frac{1}{8}$ - inch

2. The CONTRACTOR shall establish and maintain in an undisturbed condition and until final completion and acceptance of the project sufficient control points and bench marks to be used for reference purposes to check tolerances.
3. Regardless of the tolerances listed in Table 208.C.1, no portion of the building shall extend beyond the legal boundary of the project.

D. Preparation of Form Surfaces

1. All surfaces of forms and embedded materials shall be cleaned of any accumulated mortar or grout from previous concreting and of all other foreign material before concrete is placed in them. Local defects such as chipped plywood or kinks in steel forms will not be permitted.
2. Unless otherwise specified or approved, surfaces of forms shall be treated as follows:
 - a. Before placing of either the reinforcing steel or the concrete, the surfaces of the forms shall be covered with an approved coating material that will effectively prevent absorption of moisture and prevent bond with the concrete, and will not stain the concrete surfaces. A field applied form release agent or sealer of approved type or a factory applied non-absorptive liner may be used.
 - b. Excess form coating material shall not be allowed to stand in puddles in the forms nor shall such coating be allowed to come in contact with reinforcing steel or with hardened concrete against which fresh concrete is to be placed.
3. The CONTRACTOR shall submit the name of the form coating agent material proposed to be used with sufficient supportive documentation to the ENGINEER for review.

E. Removal of Forms

1. Forms shall be removed as soon as the concrete has hardened sufficiently to resist damage from removal operations after review by the ENGINEER.
2. Top forms on sloping surfaces of concrete shall be removed as soon as the concrete has attained sufficient stiffness to prevent sagging. Any needed repairs or treatment required on such sloping surfaces shall be performed at once and be followed by specified curves.
3. Wood forms for wall openings shall be loosened as soon as this can be accomplished without damage to the concrete.
4. Formwork for columns, walls, sides of beams, and other parts not supporting the weight of the concrete may be removed as soon as the concrete has hardened sufficiently to resist damage from removal operations.
5. Forms and shoring in the formwork used to support the weight of concrete in beams, slabs, arches and other structural members shall remain in place until the concrete has reached 28-day compressive strength.
6. When shores and other vertical supports are so arranged that the non-load-carrying form facing material may be removed without loosening or disturbing the shores and supports, the facing material may be removed at an earlier age as permitted by the ENGINEER.

F. Removal Strength

1. When removal of formwork is based on the concrete reaching a specified strength, the concrete shall be presumed to have reached this strength when the following conditions have been met:
 - a. When the concrete has been cured in accordance with the provisions of Article 3.06 for the same length of time as the age at test of laboratory-cured cylinders which reached the specified strength for form removal. The length of time the concrete has been cured in the structure shall be determined by the cumulative number of days or fractions thereof, not necessarily consecutive, during which the temperature of the air in contact with the concrete is above 50°F and the concrete has been damp or thoroughly sealed from evaporation and loss of moisture.

2.9 REINFORCEMENT

A. General

1. Shop Drawings, showing all fabrication dimensions and locations for placing of the reinforcing steel and accessories shall be submitted for review in accordance with provisions in Article 1.04. Review shall be obtained before fabrication.
2. Details of concrete reinforcement and accessories not covered herein shall be in accordance with ACI 315.

B. Reinforcing Steel

1. All reinforcement shall be Grade 60 ($f_y = 60,000$ psi) and shall conform to the appropriate Specification listed below, except as follows:

- a. Yield strength shall be determined by testing of full size bars.
 - b. For bars, wire, or wire fabric with a specified yield strength f_y exceeding 60,000 psi, f_y shall be the stress corresponding to a strain of 0.35 percent.
2. Reinforcing bars shall conform to ASTM A615 Grade 60 and the supplementary requirement S1 shall apply.
 3. All cutting, bending, fabrication, and erection of reinforcing steel shall conform to the "Manual for Concrete Structures". (ACI 315 latest edition).
 4. All splicing of reinforcing steel shall conform to "Reinforcing Bar Splices" latest edition by the Concrete Reinforcing Steel Institute and the "Building Code Requirements for Reinforced Concrete" (ACI 318-99).
 5. Mats: Bar and rod mats for concrete reinforcement shall be of the clipped type conforming to "Specification for Fabricated Steel Bar or Rod Mats for Concrete Reinforcement" (ASTM A 184).
 6. The use of plain bars is not permitted.
 7. Supports for reinforcement: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Use wire bar supports complying with CRSI specifications.
 8. For slabs-on-grade, use supports with sand plates or horizontal runners where base material does not support chair legs.
 9. For exposed-to-view concrete surfaces, where support legs are in contact with forms, use supports with legs which are plastic protected (CRSI, Class I) or stainless steel-protected (CRSI, Class 2).
- C. Welding
1. When required or permitted, all welding of reinforcing bars shall conform to AWS D14. Unless otherwise accepted, welding of cross bars (tack welding) for assembly of reinforcement is prohibited. Reinforcing to be welded must be certified as weldable.
 2. Welding of wire to wire, and of wire or welded wire fabric to reinforcing bars or structural steels, shall conform to applicable provisions of AWS D14 and supplementary requirements specified by the Architect/ENGINEER.
- D. Fabricating and Placing Tolerances
1. Bars shall be fabricated in accordance with the tolerances given in ACI 315.
 2. Reinforcement shall be placed to the following tolerances:

	<u>Tolerances, In.</u>
Clear distance	
To formed soffits	- ¼
To other formed surfaces	¼
Minimum spacing between bars	- ¼
Clear distances from unformed surface to top reinforcement	
Members 8 in. deep or less	¼
Members more than 8 in. deep but less than 24 in. deep	- ¼, + ½
Members 24 in. deep or greater	- ¼, + 1
Uniform spacing of bars, but the required number of bars shall not be reduced	2
Uniform spacing of stirrups and ties, but the required number of stirrups and ties shall not be reduced	1
Longitudinal locations of bends and ends of reinforcement	
General	2
Discontinuous ends of members	½ - 1½
Length of bar laps	- 1½
Embedded length	
For bar sizes No. 3 through 11	- 1
For bar sizes No. 14 and 18	- 2

3. Bars may be moved as necessary to avoid interference with other reinforcing steel, or embedded items. If bars are moved more than one bar diameter, or enough to exceed the above tolerances, additional reinforcing as directed by the ENGINEER may be required.

E. Placing

1. Minimum concrete cover for reinforcement, except for extremely corrosive atmosphere, other severe exposures, or fire protection, shall be as follows unless shown otherwise on the Drawings:

	<u>Minimum cover, in.</u>
Concrete deposited against the ground	3
Formed surfaces exposed to weather or in contact with the ground	
For bar sizes No. 6 or larger	2
For bar sizes No. 5 and smaller, and W31 or D31 wire and smaller	1½
Formed surfaces not exposed to weather or not in contact with the ground	
Beams, girders, and columns	1½
Slabs, walls, and joists	
For bar sizes No. 11 or smaller	¾
For bar sizes No. 14 and 18	1½

2. All reinforcement, at the time concrete is placed, shall be free of mud, oil or other materials that may adversely affect or reduce the bond. Reinforcement with rust, mill scale or a combination of both will be accepted as being satisfactory without cleaning or brushing provided the dimensions and weights, including heights of deformations, of a cleaned sample are not less than required by the applicable ASTM specification.
3. All reinforcement shall be supported and fastened together to prevent displacement by construction loads or the placing of concrete beyond the tolerances of paragraph

2.08.D. On ground, where necessary, supporting concrete blocks may be used. Over formwork, metal, plastic or other approved bar chairs and spacers shall be used. All accessories within ½ inch of the formed concrete surface shall be plastic coated.

4. Vertical bars in columns shall be offset at least one bar diameter at lapped splices. To insure proper placement, templates shall be furnished for all column dowels.
5. All splices not shown in the Contract Documents shall be subject to review by the ENGINEER.

Splicing shall be a minimum of 48 bar diameters (typ uno)

6. Reinforcement shall not be bent after being embedded in hardened concrete..

2.10 JOINTS AND EMBEDDED ITEMS

A. Construction Joints

1. Joints not shown in the Contract Documents shall receive prior review by the ENGINEER and shall be so made and located at least to impair the strength of the structure. In general, they shall be located near the middle of the spans of slabs, beams, and girders unless a beam intersects a girder at this point, in which case the joint in the girder shall be offset a distance equal to twice the width of the beam. Joints in walls and columns shall be at the underside of floors, slabs, beams, or girders and at the tops of footings or floor slabs. Beams, girders, brackets, column capitals, haunches, and drop panels shall be placed at the same time as slabs. Joints shall be perpendicular to the main reinforcement.
2. All reinforcement shall be continued across joints. Keys and inclined dowels shall be provided as directed by the ENGINEER. Longitudinal keys at least 1-1/2 in. deep shall be provided in all joints in walls and between walls and slabs or footings.
3. The surface of the concrete at all joints shall be thoroughly cleaned and all laitance removed prior to placing adjoining concrete.
4. Bond shall be obtained by roughening the surface of concrete in an approved manner which will expose the aggregate uniformly and will not leave laitance, loosened particles of aggregate or damaged concrete at the surface.
5. Construction joints shall be located as shown on the Contract Documents. In general, slab and wall pours shall not exceed 1200 sq ft surface area in one concrete placement between construction joints, the longer edge shall not be greater than twice the shorter edge for any one concrete pour between construction joints, and pour sequences shall be scheduled and located so that shrinkage and creep effects are minimized.

B. Expansion Joints

1. Reinforcement or other embedded metal items bonded to the concrete (except dowels in floors bonded on only one side of joints) shall not be permitted to extend continuously through any expansion joint.
2. Premolded expansion and isolation joint filler shall be of the type required and located by the Contract Documents and shall conform to the following specifications.

- a. "Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type)" (ASTM D 994), at intersections of walls and pavements unless otherwise shown.
 - b. "Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Non-extruding and Resilient Bituminous Types)" (ASTM D 1751), at pavements where pavement to pavement is jointed.
 - c. "Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction" (ASTM D1752 Type 1) at all expansion and isolation joints in structural concrete.
3. Expansion and Isolation Joint Sealant, one part polyurethane: Concrete gray color unless otherwise required by ENGINEER. Before applying, wipe surface clean with solvent supplied by manufacturer.
- C. Other Embedded Items
- 1. All sleeves, inserts, anchors, and embedded items required for adjoining work or for its support shall be placed prior to concreting.
- D. Placing Embedded Items
- 1. Expansion joint material and other embedded items shall be positioned accurately and supported against displacement. Voids in sleeves, inserts, and anchor slots shall be filled temporarily with readily removable material to prevent the entry of concrete into the voids.
 - 2. Set and build into Work anchorage devices and other embedded items required for other work that are attached to, or supported by, cast-in-place concrete. Use setting Drawings, diagrams, instructions and directions provided by suppliers of attachment items.
 - 3. Conduits and pipes of aluminum shall not be embedded in structural concrete unless they are effectively coated or covered to prevent aluminum-concrete reaction or electrolytic action between aluminum and steel.

PART 3 - EXECUTION

3.1 PRODUCTION OF CONCRETE

- A. Ready-Mixed Concrete
- 1. Except as otherwise provided in this Section, ready-mixed concrete shall be batched, mixed and transported in accordance with "Specification for Ready-Mixed Concrete" (ASTM C 94) and ACI 304. Plant equipment and facilities shall conform to the "Check List for Certification of Ready Mixed Concrete Production Facilities" of the National Ready Mixed Concrete Association.
 - 2. Concrete produced by on-site volumetric batching and continuous mixing shall be batched and mixed in accordance with and shall conform to all requirements of ASTM C685.

B. Control of Admixtures

1. Air-entraining admixtures, and other chemical admixtures shall be measured by means of an approved mechanical dispensing device. The liquid shall be considered a part of the mixing water. Admixtures that cannot be added in solution may be weighed or may be measured by volume if so recommended by the manufacturer.
2. If two or more admixtures are used in the concrete, they shall be added separately to avoid possible interaction that might interfere with the efficiency of either admixture or adversely affect the concrete.
3. Addition of retarding admixtures shall be completed within 1 minute after addition of water to the cement has been completed, or prior to the beginning of the last three-quarters of the required mixing, whichever occurs first.

C. Tempering and Control of Mixing Water

1. Concrete shall be mixed only in quantities for immediate use. Concrete which has set shall not be retempered, but shall be discarded.
2. The addition of water at the construction site will not be permitted.

D. Weather Conditions

1. Cold Weather - Ambient Temperature 45°F or below
 - a. In cold weather, the temperature of the concrete when delivered at the site of the work shall conform to the following temperature limitations:

<u>Minimum Temperature °F</u>	<u>Minimum Concrete Temperature °F</u>
30 to 45	60
15 to 30	65
below 15	no concreting permitted

- b. If water or aggregate is heated above 100°F, the water shall be combined with the aggregate in the mixer before cement is added. Cement shall not be mixed with water or with mixtures of water and aggregate having a temperature greater than 100°F.
 - c. When the temperature of the surrounding air is expected to be below 40°F during placing or within 24 hours thereafter, special precautions for concrete, placing, and protection shall be followed as required by "Recommended Practice for Cold Weather Concreting" ACI 306 and modifications herein, see Article 3.06.
 - d. The CONTRACTOR shall provide all labor, equipment, and materials to meet the above cold weather requirements.
2. Hot Weather Ambient Temperature 90°F or Above
 - a. The ingredients shall be cooled before mixing, or flake ice or well-crushed ice of a size that will melt completely during mixing may be substituted for all

or part of the mixing water if, due to high temperature, low slump, flash set or cold joints are encountered.

- b. Concreting under hot weather conditions shall conform to "Recommended Practice for Hot Weather Concreting" ACI 305 and modifications herein. See Article 3.06. The use of an approved set retarder will be permitted under hot weather conditions.

3.2 PLACING

A. Preparation Before Placing

1. Hardened concrete and foreign materials shall be removed from the inner surfaces of the conveying equipment.
2. Formwork shall have been completed; snow, ice and water shall have been removed; reinforcement shall have been secured in place; expansion joint material, anchors, and other embedded items shall have been positioned.
3. Semi-porous subgrades shall be sprinkled sufficiently to eliminate suction and porous subgrades shall be sealed in an approved manner. See paragraph 3.05.B.4.
4. Concrete shall not be placed on frozen ground.

B. Conveying

1. Concrete shall be handled from the mixer to the place of final deposit as rapidly as practicable by methods which will prevent segregation or loss of ingredients and in a manner which will assure that the required quality of the concrete is maintained.
2. Conveying equipment shall be approved and shall be of a size and design such that detectable setting of concrete shall not occur before adjacent concrete is placed. Conveying equipment shall be cleaned at the end of each operation or workday. Conveying equipment and operations shall conform to the following additional requirements:
 - a. Truck mixers, agitators, and non-agitating units and their manner of operation shall conform to the applicable requirements of "Specification for Ready-Mixed Concrete" (ASTM C 94).
 - b. Belt conveyors shall be horizontal or at a slope which will not cause excessive segregation or loss of ingredients. Concrete shall be protected against undue drying or rise in temperature. An approved arrangement shall be used at the discharge end to prevent apparent segregation. Mortar shall not be allowed to adhere to the return length of the belt. Long runs shall be discharged into a hopper or through a baffle.
 - c. Chutes shall be metal or metal-lined and shall have a slope not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal. Chutes more than 20 feet long and chutes not meeting the slope requirements may not be used.
 - d. Pumping or pneumatic conveying equipment shall be of suitable kind with adequate pumping capacity and shall conform to ACI committee report 304. Pneumatic placement shall be controlled so that segregation is not apparent in the discharged concrete. The loss of slump in pumping or

pneumatic conveying equipment shall not exceed 1-1/2 inches. Concrete shall not be conveyed through pipe made of aluminum or aluminum alloy.

C. Depositing

1. General: Concrete shall be deposited continuously, or in layers of such thickness that no concrete will be deposited on concrete which has hardened sufficiently to cause the formation of seams or planes of weakness within the section. If a section cannot be placed continuously, construction joints shall be located as shown in the Contract Documents or as approved. Placing shall be carried on at such a rate that the concrete which is being integrated with fresh concrete is still plastic. Concrete which has partially hardened or has been contaminated by foreign materials shall not be deposited. Temporary spreaders in forms shall be removed when the concrete placing has reached an elevation rendering their service unnecessary. They may remain embedded in the concrete only if made of metal or concrete and if prior approval has been obtained. Communication between the batching plant and the point of delivery shall be such that concrete placement can proceed without interruption and without trucks waiting more than 15 minutes to make delivery.
2. Placing: Placing of concrete in supported elements shall not be started until the concrete previously placed in columns and walls is no longer plastic and has been in place at least two hours. Wall and column placement and consolidation shall be in approximately horizontal layers not exceeding 2 feet in height. Concrete shall not be allowed to drop freely more than 4 ft or through a reinforcing steel cage. Sections of walls between joints shall be placed continuously to produce a monolithic unit. At least 48 hrs shall elapse between casting of adjoining wall units.
3. Segregation: Concrete shall be deposited as nearly as practicable in its final position to avoid segregation due to rehandling or flowing. Concrete shall not be subjected to any procedure which will cause segregation. Horizontal flow shall not exceed five feet. Where concrete placing operations involve dropping concrete freely more than 4 feet vertically, spouts or pipes shall be used. Such pipes or spouts shall be of suitable diameter for the large aggregate being used, shall be kept within 3 feet of the concrete, and shall have suitable hoppers on their upper ends. Temporary openings or portholes in wall or column forms may be used to limit concrete free-fall to less than 4 ft. The ports should be spaced no more than 6 to 8 ft apart to limit horizontal concrete flow.
4. Placement Time: Concrete shall be placed no more than 90 minutes after the cement is first introduced into the drum. The batch will be rejected and removed from the site if this limit is exceeded.
5. Consolidation: All concrete shall be consolidated by vibration, spading, rodding or forking so that the concrete is thoroughly worked around the reinforcement, around embedded items, and into corners of forms, eliminating all air or stone pockets which may cause honeycombing, pitting, or planes of weakness. Internal vibrators shall have a minimum frequency of 8000 vibrations per min., and sufficient amplitude to consolidate the concrete effectively. They shall be operated by competent workmen. Use of vibrators to transport concrete within forms shall not be allowed. Vibrators shall be inserted and withdrawn at points approximately 18 inches apart. At each insertion, the duration shall be sufficient to consolidate the concrete but not sufficient to cause segregation. A spare vibrator shall be kept on the job site during all concrete placing operations. Where the concrete is to have an as-cast finish, a full surface of mortar shall be brought against the form by the vibration process, supplemented if necessary by spading to work the coarse aggregate back from the formed surface. Consolidation shall conform to "Recommended Practice for Consolidation of Concrete" (ACI 309).

D. Protection

1. Adhere to the requirements of:
 - b. ACI 305 Hot Weather Concreting
 - c. ACI 306 cold Weather Concreting
2. Unless adequate protection is provided concrete shall not be placed during rain, sleet, or snow.
3. Rainwater shall not be allowed to increase the mixing water nor to damage the surface finish.
4. Placing Temperature: When the temperature of the surrounding air is expected to be below 40°F during placing or within 24 hours thereafter, the temperature of the plastic concrete, as placed, shall be no lower than 55°F. The temperature of the concrete as placed shall not be so high as to cause difficulty from loss of slump, flash set, or cold joints and shall not exceed 90°F.

E. Bonding

1. When specified, the surface of joints shall be prepared in accordance with one of the methods specified in paragraph 2.10.
2. The hardened concrete of wall construction joints and of construction joints between floor slabs shall be dampened (but not saturated) immediately prior to placing of fresh concrete.
3. The hardened concrete of joints in exposed work; joints in the middle of beams, girders, and joists; and horizontal joints in work designed to contain liquids shall be dampened (but not saturated) and then thoroughly covered with a coat of cement grout of similar proportions to the mortar in the concrete. The grout shall be as thick as possible on vertical surfaces and at least one inch (1") thick on horizontal surfaces. The fresh concrete shall be placed before the grout has attained its initial set.

3.3 REPAIR OF SURFACE DEFECTS

A. General

1. Surface defects, including tie holes, shall be repaired immediately after form removal.

B. Repair of Defective Areas

1. All honeycombed and other defective concrete shall be chipped down to sound concrete. The edges shall be perpendicular to the surface or slightly undercut. No feather edges will be permitted. The area to be patched and an area at least 6 inches wide surrounding it shall be dampened to prevent absorption of water from the patching mortar. A bonding grout shall be prepared using a mix of approximately 1 part cement to 1 part fine sand passing a No. 30 mesh sieve, mixed to the consistency of thick cream, and then well brushed into the surface.

2. The patching mixture shall be made of the same materials and of approximately the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of not more than 1 part cement to 2-1/2 parts sand by damp loose volume. The quantity of mixing water shall be no more than necessary for handling and placing. The patching mortar shall be mixed in advance and allowed to stand with frequent manipulation with a trowel, without addition of water, until it has reached the stiffest consistency that will permit placing. Use of latex bonding agent is required.
 3. After surface water has evaporated from the area to be patched, the bond coat shall be well brushed into the surface. When the bond coat begins to lose the water sheen, the premixed patching mortar shall be applied. The mortar shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface. To permit initial shrinkage, it shall be left undisturbed for at least 1 hour before being finally finished. The patched area shall be kept damp for 7 days. Metal tools shall not be used in finishing a patch in a formed wall which will be exposed.
- C. Tie Holes
1. After being cleaned and thoroughly dampened, the tie holes shall be filled solid with a non-metallic non-shrink patching mortar. The layout of tie holes and exterior finish of the tie holes on surfaces permanently exposed to view on the outside shall be submitted to the ENGINEER for review.
- D. Proprietary compounds for adhesion or as patching ingredients may be used in lieu of or in addition to the foregoing patching procedures providing that prior review is done by the ENGINEER. The ENGINEER may require such compounds in certain patching locations.

3.4 FINISHING OF FORMED SURFACES

- A. Finish on all surfaces shall be as cast finish as follows:
1. Smooth Form Finish: The form facing material shall produce a smooth, hard, uniform texture on the concrete. It may be plywood, tempered concrete-form-grade hardboard, metal, plastic, paper, or other approved material capable of producing the desired finish. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to the practical minimum. It shall be supported by studs or other backing capable of preventing excessive deflection. Material with raised grain, torn surfaces, worn edges, patches, dents, or other defects which will impair the texture of the concrete surface shall not be used. Tie holes and defects shall be patched. All fins, projections, and seams shall be completely removed.
- B. Related Unformed Surfaces
1. Tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces shall be struck smooth after concrete is placed and shall be floated to a texture reasonably consistent with that of the formed surfaces. Final treatment on formed surfaces shall continue uniformly across the unformed surfaces.

3.5 SLABS

A. General

1. Concrete work for slab construction shall conform to "Recommended Practice for Concrete Floor and Slab Construction (ACI-302).

B. Preparation of Subgrade for Slabs on Ground

1. The subgrade shall be well drained and of adequate and uniform load bearing nature. The in-place density of the subgrade soils shall be at least the minimum required in the Specifications.
2. The subgrade shall be free of frost before concrete placing begins. If the temperature inside a structure where concrete is to be placed is below freezing it shall be raised and maintained above 50°F long enough to remove all frost from the subgrade.
3. The subgrade shall be moist at the time of concreting. If necessary, it shall be dampened with water in advance of concreting, but there shall be no free water standing on the subgrade nor any muddy or soft spots when the concrete is placed.
4. Floor slabs on granular fill shall be placed over a 6 mil polyethylene vapor barrier. Lap all joints of vapor barrier 12 inches minimum.
5. Soil Testing
 - a. The CONTRACTOR shall obtain and pay for, the services of a soils testing firm (acceptable to the ENGINEER) for the following:
 - 1) Certify that materials proposed by CONTRACTOR meet specifications Certification test reports will be submitted by the CONTRACTOR.
 - 2) Conduct compaction testing of engineered fill below footings and slabs and backfilling for utility trenches. The testing frequency shall be one test per lift per 400 square feet of fill.
 - 3) Copies of test reports shall be furnished to the OWNER and distributed to parties designated by the OWNER, including the ENGINEER.
 - 4) Any area failing compaction test shall be compacted and re-tested at the CONTRACTOR's expense.

C. Edge Forms and Screeds

1. Edge forms and intermediate screed strips shall be set accurately to produce the designated elevations and contours of the finished surface and shall be sufficiently strong to support vibration. The concrete surface shall be aligned to the contours of screed strips by the use of strike-off templates.
2. When formwork is cambered, screeds shall be set to a like camber to maintain the proper concrete thicknesses.
3. Screeds shall be removed before initial concrete set and depressions immediately filled to form a smooth monolithic surface.

D. Placement

1. Mixing and placing shall be carefully coordinated with finishing. Concrete shall not be placed on the subgrade or forms more rapidly than it can be spread, straightedged, and darbied or bullfloated. These operations must be performed before bleeding water has an opportunity to collect on the surface.
2. To obtain good surfaces and avoid cold joints, the size of finishing crews shall be planned with due regard for the effects of concrete temperature and atmospheric conditions on the rate of hardening of the concrete. If construction joints become necessary, they shall be constructed as required in subparagraph 2.10.A of this Section.

E. Jointing

1. Joints in slabs on grade shall be located and detailed as indicated in the Contract Documents. If saw-cut joints are required or permitted, cutting shall be timed properly with the set of the concrete: cutting shall be started as soon as the concrete has hardened sufficiently to prevent aggregates being dislodged by the saw, and shall be completed before shrinkage stresses become sufficient to produce cracking.

F. Consolidation

1. Concrete in slabs shall be thoroughly consolidated. Internal vibration shall be used in beams and girders of framed slabs and along the bulkheads of slabs on grade. Consolidation of slabs shall be obtained with internal vibrators.

G. Finishes (See paragraph 3.05.H for Finishing Tolerance)

1. All concrete flatwork such as slabs on grade inside and outside of the building and supported slabs shall at first receive a "floated finish". After the concrete has been placed, consolidated, struck off, and leveled, the concrete shall not be worked further until ready for floating. Floating shall begin when the water sheen has disappeared and when the surface has stiffened sufficiently to permit the operation. During or after the first floating, planeness of surface shall be checked by the CONTRACTOR with a 10-ft. straightedge applied at not less than two different angles. All high spots shall be cut down and all low spots filled during this procedure to produce a surface within Class B tolerance throughout. The slab shall then be refloated immediately to a uniform sandy texture. Additional finishing shall be required. See G.2 or G.3.
2. Outside sidewalk, ramp slabs, loading dock and walkway top slabs shall receive a broom or belt finish. Immediately after concrete has received the "float finish" as specified in 3.05.G.1 above, it shall be given a coarse transverse scored texture by drawing a broom or burlap belt across the surface.
3. A "troweled finish" shall be used for all concrete flatwork which does not receive a broom finish or which does not receive a grout finish. The surface shall first be float-finished as specified in item 3.05.G.1 above. It shall next be power troweled, and finally hand troweled. The first trowelling after power floating shall produce a smooth surface which is relatively free of defects but which may still show some trowel marks. Additional trowellings shall be done by hand after the surface has hardened sufficiently. The final trowelling shall be done when a ringing sound is produced as the trowel is moved over the surface. The surface shall be thoroughly consolidated by the hand trowelling operations. The finished surface shall be essentially free of trowel marks, uniform in texture and appearance and shall be plane to a Class A tolerance, except tolerance for concrete on metal deck shall be Class B. On

surfaces intended to support floor coverings, any defects of sufficient magnitude to show through the floor covering shall be removed by grinding.

H. Finishing Tolerances

1. Finishes with Class A tolerances shall be true planes within 1/8 inch in 10 ft as determined by a 10-foot straightedge placed anywhere on the slab in any direction.
2. Finishes with Class B tolerances shall be true planes within 1/4-inch on 10 ft as determined by a 10-foot straightedge placed anywhere on the slab in any direction.
3. Finishes with Class C tolerances shall be true planes within 1/4 inch in 2 ft as determined by a 2-ft straightedge placed anywhere on the slab in any direction.

3.6 CURING AND PROTECTION

A. General

1. Beginning immediately after placement, concrete shall be protected from premature drying, excessively hot or cold temperatures, and mechanical injury, and shall be maintained with minimal moisture loss at a relatively constant temperature for the period necessary for hydration of the cement and hardening of the concrete. The materials and methods of curing shall be in accordance with ACI 308 and subject to review by the ENGINEER.

B. Preservation of Moisture

1. For concrete surfaces not in contact with forms, ponding or continuous sprinkling shall be applied immediately after completion of placement and finishing and be continued for a minimum of three (3) days. After the initial 3-day period, one of the following procedures shall be applied:
 - a. Ponding or continuous sprinkling;
 - b. Application of absorptive mats or fabric kept continuously wet;
 - c. Continuous application of mist spray;
 - e. Application of other moisture-retaining covering as approved.
 - f. The use of curing compounds shall not be permitted.
2. Moisture loss from surfaces placed against wooden forms or metal forms exposed to heating by the sun shall be minimized by keeping the forms wet until they can be safely removed. After form removal, the concrete shall be cured until the end of the time prescribed in 3.06.B.3 below by one of the methods of 3.06.B.1 above.
3. Curing in accordance with 3.06.B.1 and 2 above shall be continued for at least 14 days in the case of all concrete.

C. Temperature, Wind, and Humidity

1. Adhere to the requirements of:
 - a. ACI 305 Hot Weather Concreting
 - b. ACI 306 Cold Weather Concreting

2. Cold Weather: When the mean daily outdoor temperature is less than 40°F, the temperature of the concrete shall be maintained between 50°F and 70°F for 14 days. Arrangements for heating, covering, insulating, and housing the concrete work shall be made in advance of placement and shall be adequate to maintain the required temperature without injury due to concentration of heat. Combustion heaters shall not be used during the first 24 hours unless precautions are taken to prevent exposure of the concrete to exhaust gases.
 3. Hot Weather: When necessary, provision for windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light colored material shall be made in advance of placement, and such protective measures shall be taken as quickly as concrete hardening and finishing operations will allow.
 4. Rate of Temperature Change: Changes in temperature of the air immediately adjacent to the concrete during and immediately following the curing period shall be kept as uniform as possible and shall not exceed 5°F in any one hour or 50°F in any 24-hour period.
- D. Protection from Mechanical Injury
1. During the curing period, the concrete shall be protected from damaging mechanical disturbances, such as load stresses, heavy shock, and excessive vibration. All finished concrete surfaces shall be protected from damage by construction equipment, materials, or methods, by application of curing procedures, and by rain or running water. Structures shall not be loaded in such a way as to overstress the concrete.

3.7 TESTING

A. General

1. Concrete materials and operations will be tested and inspected as the work progresses. Failure to detect any defective work or material shall not in any way prevent later rejection when such defect is discovered nor shall it obligate the ENGINEER for final review.

B. Testing Agencies

1. All testing agencies shall meet the requirements of "Inspection and Testing Agencies for Concrete and Steel as Used in Construction," (ASTM E329).

C. Testing Services

The following testing services shall be performed by the designated agency:

1. Review and test the CONTRACTOR's proposed materials for compliance with the Specifications.
2. Review and test the CONTRACTOR's proposed mix design as required by the ENGINEER.
3. Secure production samples of materials at plants or stock-piles during the course of the work and test for compliance with the Specifications.
4. Conduct strength tests of the concrete during construction in accordance with the following procedures:

- a. Secure composite samples in accordance with "Method of Sampling Fresh Concrete" (ASTM C 172). Each sample shall be obtained from a different batch of concrete on a random basis, avoiding any selection of the test batch other than by a number selected at random before commencement of concrete placement.
 - b. Mold and cure four specimens from each sample in accordance with "Method of Making and Curing Concrete Test Specimens in the Field" (ASTM C 31). Any deviations from the requirements of this standard shall be recorded in the test report.
 - c. Test specimens in accordance with "Method of Test for Compressive Strength of Cylindrical Concrete Specimens" (ASTM C 39). Two specimens shall be tested at 28 days for acceptance and one shall be tested at 7 days for information. The fourth cylinder shall be held as a spare specimen to be tested as directed by the ENGINEER. The acceptance "strength test" result shall be the average of the strengths of the two specimens tested at 28 days. If one specimen in a test manifests evidence of improper sampling, molding or testing, it shall be discarded and the strength of the remaining cylinder shall be considered the "strength test" result. Should both specimens in a test show any of the above defects, the entire test shall be discarded. When high early strength concrete is used, the specimens shall be tested with two specimens at 14 days and one specimen at 3 days. The acceptance will be based on the 14-day test.
 - d. Make at least one "strength test" (mold four cylinders) for each 50 cubic yards, or fraction thereof, of each mix design of concrete placed in any 1 day.
5. Determine slump of the concrete sample for each strength test and whenever consistency of concrete appears to vary, using "Method of Test for Slump of Portland Cement Concrete: (ASTM C 143).
 6. Determine air content of normal weight concrete sample for each strength test in accordance with the "Method of Test for Air Content of Freshly Mixed Concrete by the Pressure Method" (ASTM C 231), "Method of Test for Air Content of Freshly Mixed Concrete by the Volumetric Method" (ASTM C 173) or "Method of Test for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete" (ASTM C 138).
 7. Determine temperature of concrete sample for each strength test.
- D. Additional Services When Required

The following services shall be performed by the designated agency when required by the ENGINEER:

1. Inspect concrete batching, mixing and delivery operations to the extent deemed necessary by the ENGINEER.
2. Sample concrete at point of placement and perform required tests.
3. Other testing or inspection services as required by the ENGINEER.

E. Other Services as Needed

The following services shall be performed by the designated agency when necessary and costs of said services shall be borne by the CONTRACTOR:

1. Additional testing and inspection required because of changes in materials or proportions requested by the CONTRACTOR.
2. Additional testing of materials or concrete occasioned by their failure by test or inspection to meet specification requirements. (See Article 3.08)
3. Testing to determine strength for early form removal. (See paragraph 2.08.E and F.)

F. Duties and Authorities of Designated Testing Agency

1. Representatives of the agency shall inspect, sample and test the materials and the production of concrete as specified herein. When it appears that any material furnished or work performed by the CONTRACTOR fails to fulfill specification requirements, the testing agency shall report such deficiency to the ENGINEER and the CONTRACTOR promptly.
2. The agency shall report all test and inspection results to the ENGINEER and CONTRACTOR immediately after they are performed. All test reports shall include the exact location in the work at which the batch represented by a test was deposited. Reports of strength tests shall include detailed information on storage and curing of specimens prior to testing.
3. The testing agency or its representatives are not authorized to modify any requirement of the Contract Documents, nor to approve, accept, disapprove or reject any portion of the work.

G. Responsibilities and Duties of CONTRACTOR

1. The use of testing services shall in no way relieve the CONTRACTOR of the responsibility to furnish materials and construction in full compliance with the Contract Documents.
2. The CONTRACTOR shall submit to the ENGINEER the concrete materials and the concrete mix designs proposed for use with a written request for review. This submittal shall include the results of all testing performed to qualify the materials and to establish the mix designs. No concrete shall be placed in the work until the CONTRACTOR has received such approval in writing.
3. To facilitate testing and inspection, the CONTRACTOR shall provide and maintain for the use of the testing agency and ENGINEER adequate facilities for safe storage and proper curing of concrete test specimens on the project site for the first 24 hours as required by "Method of Making and Curing Concrete Test Specimens in the Field" (ASTM C 31). The CONTRACTOR shall provide labor, tools, and equipment to assist in the sampling and testing of concrete on the job. The CONTRACTOR shall advise the designated testing agency sufficiently in advance of operations to allow for completion of quality tests and assignment of personnel.

3.8 EVALUATION AND ACCEPTANCE OF CONCRETE

A. Evaluation of Test Results

1. Test results for standard molded and standard cured test cylinders shall be evaluated separately for each specified concrete mix design. Such evaluation shall be valid only if tests have been conducted in accordance with procedures specified in Article 3.07.

B. Acceptance of Concrete

1. The following conditions must be met:
 - a. The strength level of the concrete will be considered satisfactory and acceptable so long as the average of all sets of three consecutive "strength test" results equals or exceeds the specified 28 day strength f'c and no individual "strength test" result falls below the specified 28 day strength f'c by more than 500 psi. The strength level of the concrete shall be measured at 14 days for high-early strength concrete. High-early strength concrete shall achieve the specified 28-day f'c at the age of 14 days.
 - b. The requirements described by paragraphs 3.09 Acceptance of Structure, A, B, C and D.

C. Testing of Concrete in Place

1. This Work shall be at the CONTRACTOR's expense.
2. Testing by impact hammer, sonoscope, or other non-destructive device may be permitted or required by the ENGINEER to determine relative strengths at various locations in the structure as an aid in evaluating concrete strength in place and for selecting areas to be cored, if the strength level of the concrete is not satisfactory. Such tests shall not be used as a basis for acceptance or rejection.
3. Core Tests: Required when paragraph 3.08.B specifications are not met.
 - a. Cores at least 2 inches in diameter shall be obtained and tested in accordance with "Methods of Obtaining and Testing Drilled Cores and Sawed Beams of Concrete" (ASTM C 42). Cores shall be taken as soon as practicable after determining that the concrete strength level is unsatisfactory in accordance with paragraph 3.08.B. If the concrete in the structure will be dry under service conditions, other cores shall be air dried (temperature 60 to 80 F, relative humidity less than 60 percent) for 7 days before test and shall be tested dry. If the concrete in the structure will be more than superficially wet under service conditions, the cores shall be tested after moisture conditioning in accordance with ASTM C 42.
 - b. At least three representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient. The location and number of cores shall be determined by the ENGINEER so as least to impair the strength of the structure and best represent the condition of the potentially deficient concrete. If, before testing, one or more of the cores shows evidence of having been damaged subsequent to or during removal from the structure, they shall be replaced.

- c. Concrete in the area represented by the core test will be considered adequate and acceptable if the average strength of the cores is equal to at least 85 percent of, and if no single core is less than 75 percent of, the specified 28 day strength f'c. If the above strengths are not met, the CONTRACTOR shall remove the deficient concrete.
- d. Core holes shall be filled by the CONTRACTOR with low slump concrete or mortar. See Article 3.03, Repair of Surface Defects.

3.9 ACCEPTANCE OF STRUCTURE

A. General

- 1. Completed concrete work which meets all applicable specification requirements will be accepted without qualification.
- 2. Completed concrete work which fails to meet one or more of the specified requirements but which has been repaired to bring it into compliance will be accepted without qualifications.
- 3. If any concrete does not meet the specified strength levels in paragraph 03.08.B, Acceptance of Concrete, the ENGINEER will require additional material and other tests to determine the probable cause of the low strength levels. This may result in remedial actions or modifications being required in the methods or materials being employed. Such actions or modifications shall be at the CONTRACTOR's expense.
- 4. Completed concrete work which fails to meet the requirements of paragraph 03.08.C.2.c. will be rejected and the CONTRACTOR will be required to remove and replace the defective concrete. In this event, modifications will be required to assure that remaining work complies with the requirements.

B. Dimensional Tolerances

- 1. Formed surfaces resulting in concrete outlines smaller than permitted by the tolerances of paragraph 2.08.C shall be considered potentially deficient in strength and subject to the provisions of paragraph 3.09.D.
- 2. Formed surfaces resulting in concrete outlines larger than permitted by the tolerances of paragraph 2.08.C may be rejected and the excess material shall be subject to removal. If removal of the excess material is required, it shall be accomplished in such a manner as to maintain the strength of the section and to meet all other applicable requirements of function and appearance.
- 3. Concrete members cast in the wrong location will be rejected.
- 4. Inaccurately formed concrete surfaces exceeding the limits of paragraph 02.08.C may be rejected and shall be repaired or removed and replaced as required by the ENGINEER.
- 5. Finished slabs exceeding the tolerances of paragraphs 03.05.H may be required to be repaired provided that strength or appearance is not adversely affected. High spots may be removed with a terrazzo grinder, low spots filled with a patching compound, or other remedial measures performed as reviewed by the ENGINEER.

C. Appearance

1. All concrete with defects which adversely affect the appearance or function of the specified finish may be repaired only by approved methods.

D. Strength of Structure

1. The strength of the structure in place will be considered deficient if it fails to comply with any requirements, which control the strength of the structure, including but not necessarily limited to the following conditions:
 - a. Low concrete strength as designated in Article 03.08.
 - b. Reinforcing steel size, quantity, strength, position, or arrangement at variance with the requirements of Article 02.09, Reinforcement, or the Contract Documents.
 - c. Concrete which differs from the required dimensions or location in such a manner as to reduce the strength.
 - d. Curing less than that specified.
 - e. Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.
 - f. Mechanical injury as defined in paragraph 03.06.D, construction fires, accidents or premature removal of formwork likely to result in deficient strength.
2. Additional testing will be required when the strength of the structure is considered potentially deficient. Cost of this testing will be borne by the CONTRACTOR.
3. Core tests in accordance with paragraph 03.08.C.2 will be required when ENGINEER determines that the strength of the concrete in place is considered potentially deficient. Cost of coring and testing will be borne by the CONTRACTOR.
4. Concrete work judged inadequate by failure to meet the requirements of paragraphs 03.08B and 03.08.C.2 shall be removed and replaced at the CONTRACTOR's expense.
5. The CONTRACTOR shall pay all costs incurred in providing the additional testing and/or analysis required by these Specifications, or the Contract Documents.
6. The OWNER will pay all costs of additional testing and/or analyses which are made at its request and which are not required by these Specifications, or the Contract Documents.

3.10 CLEANING UP

- A. At the completion of the concrete work to the satisfaction of and review by the ENGINEER, all extraneous concrete debris, materials and equipment shall be removed from the job site and the concrete shall be left clean and in first class condition.

MIX DESIGN SCHEDULE

Concrete Class	A
Locations	Interior Slabs & Housekeeping Pads
28-day Compressive Strength (psi)	4,000
Cement Content (per CYD of concrete)	594 (6 sack equivalent)
Coarse Aggregate	6AA (¾")
Water/Cement Ratio by Weight (maximum)	0.43
Air Content (% by volume)	2% ±
Slump at point of placement (inches)	4" – 6" (will vary based on location)
Fiber Reinforcement	Yes
Fly Ash (% of cement content; maximum)	15 – 20%
Silica Fume	No

Note: Provide hardener for storage building interior floor.

Concrete Class	B
Locations	Foundation
28-day Compressive Strength (psi)	4,000
Cement Content (per CYD of concrete)	594 (6 sack)
Coarse Aggregate	6AA (¾")
Water/Cement Ratio by Weight (maximum)	0.43
Air Content (% by volume)	6.0 +/- 1.0
Slump at point of placement (inches)	4" – 6" (will vary based on location)
Fiber Reinforcement	No
Fly Ash (% of cement content; maximum)	15 – 20%
Silica Fume	No

Concrete Class	C
Locations	Underground Duct Bank
28-day Compressive Strength (psi)	4,000
Cement Content (per CYD of concrete)	594 (6 sack equivalent)
Coarse Aggregate	6AA (¾")
Water/Cement Ratio by Weight (maximum)	0.43
Air Content (% by volume)	6.0 +/- 1.0
Slump at point of placement (inches)	4" – 6" (will vary based on location)
Fiber Reinforcement	Yes
Fly Ash (% of cement content; maximum)	15 – 20%
Silica Fume	No

Concrete Class	D
Locations	Sidewalk, Pavements and Exterior Slabs
28-day Compressive Strength (psi)	4,000
Cement Content (per CYD of concrete)	594 (6 sack equivalent)
Coarse Aggregate	½ "
Water/Cement Ratio by Weight (maximum)	0.43
Air Content (% by volume)	6.0 +/- 1.0
Slump at point of placement (inches)	4" – 6" (will vary based on location)
Fiber Reinforcement	Yes
Fly Ash (% of cement content; maximum)	15 – 20%
Silica Fume	No

END OF SECTION

SECTION 03600

GROUTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install grout.
- B. Grout all materials and equipment as noted in the plans and specifications and pursuant to all manufacturer recommendations for installation.

1.2 RELATED SECTIONS

- A. Section 03300 – Cast-in-Place Concrete.

1.3 REFERENCES

- A. ACI 211.1, Practice for Selecting Proportions for Normal, Heavy-Weight and Mass Concrete.
- B. ACI 301, Specification for Structural Concrete (Includes ASTM Standards referred to herein).
- C. ASTM C33, Specification for Concrete Aggregates.
- D. ASTM C109, Test Method for Compressive Strength of Hydraulic Cement Mortars (using 2-in. or 50 mm. Cube Specimens).
- E. ASTM C230, Specification for Flow Table for use in Tests of Hydraulic Cement.
- F. ASTM C531, Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing.
- G. ASTM C579, Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing and Polymer Concretes.
- H. ASTM C827, Test Method for Early Volume Change of Cementitious Mixtures.
- I. ASTM C882, Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete.
- J. ASTM C937, Specification for Grout Fluidifier for Preplaced-Aggregate Concrete.
- K. ASTM C939, Text Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
- L. ASTM C1107, Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
- M. ASTM C1181, Test Method for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts.

1.4 PERFORMANCE REQUIREMENTS

- A. Application: The following is a listing of typical applications and the corresponding type of grout which is to be used. Unless otherwise indicated, grouts shall be provided as listed below whether called for on the Drawings or not.

Beam and column (1 or 2 story) base plates and precast concrete bearing less than 16 inches in the least dimension.	Non-Shrink Grout
Column base plates and precast concrete bearing (greater than 2 story or larger than 16 inches in the least dimension).	Non-Shrink Grout
Base plates for storage tanks and other non-motorized equipment and machinery less than 50 horsepower.	Epoxy Grout
Machinery over 50 horsepower and equipment under 50 horsepower but subject to severe shock loads and high vibration.	Epoxy Base Plate Grout
Filling blockout spaces for embedded items such as railing posts, gate guide frames, etc.	Non-Shrink Grout
Toppings and concrete fill greater than 4-inches thick.	Concrete in accordance with Section 03300, Cast-In-Place Concrete.
Applications not listed above, where grout is called for on the Drawings.	Non-Shrink Grout, unless noted otherwise.

1.4 SUBMITTALS

- A. Submit the following in accordance with Section 01330 for approval:
1. Submit copies of manufacturer's certification of compliance with the specified properties for Class I, II, and III grouts.
 2. Submit certified testing lab reports for ASTM C 1107, Grade B and Grade C (as revised herein) requirements for Class I and II grouts tested at a fluid consistency for temperatures of 45, 73.4, 90°F with a pot life of 30 minutes at fluid consistency.
 3. Submit certification that materials conform to the Specifications requirements for nonproprietary materials.
 4. Submit certifications that all grouts used on the project are free of chlorides or other chemicals causing corrosion.

5. Manufacturer's specifications and installation instructions for all proprietary materials.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Grout materials from manufacturers shall be delivered in unopened containers and shall bear intact manufacturer's labels.
- B. Store grout materials in a dry shelter and protect from moisture.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cement Grout

1. Cement grout shall be composed of Portland Cement and sand in the proportion specified in the Contract Documents and the minimum amount of water necessary to obtain the desired consistency. If no proportion is indicated, cement grout shall consist of one part Portland Cement to three parts sand. Water amount shall be as required to achieve desired consistency without compromising strength requirements. White portland cement shall be mixed with the Portland Cement as required to match color of adjacent concrete.
2. The minimum compressive strength at 28 days shall be 4000 psi.
3. For beds thicker than 1-1/2 inch and/or where free passage of grout will not be obstructed by coarse aggregate, 1-1/2 parts of coarse aggregate having a top size of 3/8 inch should be added. This stipulation does not apply for grout being swept in by a mechanism. These applications shall use a plain cement grout without coarse aggregate regardless of bed thickness.
4. Sand shall conform to the requirements of ASTM C144.

B. Non-Shrink Grout

1. Non-shrink grout shall conform to CRD-C 621 and ASTM C 1107, Grade B or C when tested at a max. fluid consistency of 30 seconds per CDC 611/ASTM C939 at temperature extremes of 45°F and 90°F and an extended working time of 15 minutes. Grout shall have a min. 28-day strength of 7,000 psi. Non-shrink grout shall be, "Euco N-S" by the Euclid Chemical Company, "SikagROUT 212" by Sika Corporation, Conspec 100 Non-Shrink Non-Metallic Grout by Conspec.

C. Epoxy Grout

1. Epoxy grout shall be "Sikadur 32 Hi-Mod" by Sika Corporation, "Duralcrete LV" by Tamms Industries, or "Euco #452" by Euclid Chemical.
2. Epoxy grout shall be modified as required for each particular application with aggregate per manufacturer's instructions.

- D. Epoxy Base Plate Grout
 - 1. Epoxy base plate grout shall be Sikadur 42, Grout-Pak by Sika Corporation.

2.2 MIXES

- A. Proportion mixes by either laboratory trial batch or field experience methods, using materials to be employed on the Project for grout required. Comply with ACI 211.1 and report to ENGINEER the following data:
 - 1. Complete identification of aggregate source of supply.
 - 2. Tests of aggregates for compliance with specified requirements.
 - 3. Scale weight of each aggregate.
 - 4. Absorbed water in each aggregate.
 - 5. Brand, type and composition of cement.
 - 6. Brand, type and amount of each admixture.
 - 7. Amounts of water used in trial mixes.
 - 8. Proportions of each material per cubic yard.
 - 9. Gross weight and yield per cubic yard of trial mixtures.
 - 10. Measured slump.
 - 11. Measured air content.
 - 12. Compressive strength developed at seven days and 28 days, from not less than three test specimens cast for each seven-day and 28-day test, and for each design mix.
- B. Submit written reports to ENGINEER of proposed mix of grout at least 30 days prior to start of the Work. Do not begin grout production until mixes have been approved by ENGINEER.
- C. Laboratory Trial Batches: When laboratory trial batches are used to select grout proportions, prepare test specimens and conduct strength tests as specified in ACI 301, Section 4 -Proportioning. However, mixes need not be designed for greater than 125 percent of specified strength, regardless of standard deviation of production facility.
- D. Field Experience Method: When field experience methods are used to select grout proportions, establish proportions as specified in ACI 301, Section 4.
- E. Admixtures: Use air-entraining admixture in all grout. Use amounts of admixtures as recommended by grout manufacturer for climate conditions prevailing at time of placing. Adjust quantities and types of admixtures as required to maintain quality. Do not use admixtures that have not been incorporated and tested in accepted design mix unless otherwise authorized in writing by ENGINEER..

2.2 CURING MATERIALS

- A. Curing materials shall conform to Section 03300, Cast-in-Place Concrete, and as recommended by manufacturer of prepackaged grouts.

2.3 CONSISTENCY

- A. Consistency of grouts shall be that necessary to completely fill the space to be grouted for the particular application. Dry pack consistency is such that grout is plastic and moldable, but will not flow. Where "dry pack" is required per the Contract Documents, it shall mean a grout of that consistency; type of grout to be used shall be as specified in this Section for the application.
- B. Slump for topping grout and grout fill shall be adjusted to match placement and finishing conditions, but shall not exceed four inches.
- C. Slump for construction joint grout shall be seven inches (plus or minus 1 inch).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. CONTRACTOR shall examine substrate and conditions under which grout is to be placed and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

3.2 INSTALLATION

- A. Place grout as shown and in accordance with manufacturer's instructions. If manufacturer's instructions conflict with the Contract Documents, request clarification from ENGINEER and do not proceed until ENGINEER provides clarification.
- B. Placing grout shall conform to temperature and weather limitations in Section 03300, Cast-In-Place Concrete.
- C. Cure grout per manufacturer's instructions for prepackaged grout and the requirements of Section 03300, Cast-In-Place Concrete, for grout fill and topping grout.
- D. Columns, Beams and Equipment Bases:
 - 1. Epoxy Grout: After shimming equipment to proper grade, securely tighten anchorages. Properly form around base plates, allowing sufficient room around edges for placing grout. Provide adequate depth between bottom of base plate and top of concrete base to assure that void is completely filled with epoxy grout.
 - 2. Non-shrink Grout: After shimming columns, beams and equipment to proper grade, securely tighten anchorages. Properly form around base plates allowing sufficient room around edges for placing grout. Provide adequate depth between bottom of base plate and top of concrete base to assure that void is completely filled with non-shrink grout.

- E. Handrails and Railings:
 - 1. After posts have been properly inserted into holes or sleeves, fill annular space between posts and sleeve with non-shrink grout. Bevel grout at juncture with post so that moisture flows away from post.

3.3 FIELD QUALITY CONTROL

- A. Compression test specimens shall be taken during construction from the first placement of each type of grout, and at intervals thereafter as selected by the ENGINEER to ensure continued compliance with these Specifications.
- B. Compression tests and fabrication of specimens for non-shrink grout will be performed as specified in ASTM C109 at intervals during construction as selected by the ENGINEER. A set of three specimens will be made for testing at seven days, 28 days, and each additional time period as appropriate.
- C. Compression tests and fabrication of specimens for epoxy grout will be performed as specified in ASTM C579, Method B, at intervals during construction as selected by the ENGINEER. A set of three specimens will be made for testing at seven days, and each earlier time period as appropriate.
- D. The cost of all laboratory tests on grout will be borne by the CONTRACTOR. CONTRACTOR shall pay for the cost of any additional tests and investigation on Work performed which does not conform to the requirements of the Specifications. CONTRACTOR shall supply all materials necessary for fabricating the test specimens.

END OF SECTION

SECTION 04200

UNIT MASONRY

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Concrete masonry units (CMU's).
- B. Building (common) brick.
- C. Mortar and masonry grout
- D. Accessories for masonry construction.

1.2 RELATED SECTIONS

- A. Section 05500 – Metal Fabrications.
- B. Section 07150 - Dampproofing
- C. Section 07210 - Building Insulation
- D. Section 07600 - Flashing and Sheet Metal

1.3 REFERENCES

- A. ACI 530.1/ASCE 6/TMS 602 Specifications for Masonry Structures
 - 1. ACI 530.1/ASCE 6/TMS 602, jointly published by the American Concrete Institute and the American Society of Civil Engineers, hereafter referred to as ACI 530.1 shall be considered minimum specifications for all materials, workmanship, methods and techniques for all masonry work.
- B. ASTM C62 Standard Specification for Building Brick
- C. ASTM C90 Standard Specification for Load-Bearing Concrete Masonry Units
- D. ASTM C140 Standard Methods for Sampling and Testing Concrete Masonry Units
- E. ASTM C216 Standard Specification for Facing Brick
- F. ASTM C744 Standard Specification for Prefaced Concrete and Calcium Silicate Masonry Units
- G. ANSI A41.1 R70 Code Requirements for Masonry

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For reinforcing steel. Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.

- C. Samples for Verification: For each type and color of exposed masonry unit.
- D. Material Certificates: For each type and size of product indicated. For masonry units include data on material properties material test reports substantiating compliance with requirements.
- E. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.
 - 1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C109 M for compressive strength, ASTM C1506 for water retention, and ASTM C91 for air content.
 - 2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

1.6 QUALITY ASSURANCE

- A. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.

1.7 MOCK-UPS

- A. Build mock ups at the site, where directed, indicating the proposed color range, texture and workmanship for each type of masonry. Obtain Owner's acceptance of visual qualities of the mock up before start of masonry work. Do not alter, move or destroy mock ups until Work is completed and removal is directed by the Owner.
- B. Construct a sample 4'-0" x 8'-0" mock up vertical wall assembly using all materials and components specified including accent trim brick, flashing, insulation, reinforcement and accessories.

1.8 PROJECT CONDITIONS

- A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
- B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide special shape, type or size indicated or for application requiring a form, size or finish which cannot be produced from standard masonry units by sawing. Provide solid units where masonry unit is exposed.
- B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.

- C. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

2.2 CONCRETE MASONRY UNITS

- A. Shapes: Provide shapes indicated and for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
- B. Integral Water Repellent: Provide units made with liquid polymeric, integral water repellent admixture that does not reduce flexural bond strength for exposed units and where indicated.
- C. CMUs: ASTM C90.
 - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2150 psi (14.8 MPa).
 - 2. Density Classification: Normal weight unless otherwise indicated.
- D. Concrete Building Brick: ASTM C55.
 - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2800 psi (19.31 MPa).
 - 2. Density Classification: Normal weight.

2.3 MASONRY LINTELS

- A. General: Provide one of the following:
- B. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout.

2.4 BRICK

- A. General: Provide shapes indicated and as follows:
 - 1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
 - 2. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
- B. Face Brick: Facing brick complying with ASTM C216.
 - 1. Products: Subject to compliance with the requirements of this Section, face brick shall match the brick on the existing building. Contractor is responsible for providing products considered to match the existing brick. Brick shall be manufactured by the companies listed below or equal as approved by Engineer and Owner. Final color selections shall be subject to approval of the mock-up by the Owner.

- a. Belden Brick Company.
 - b. Sioux City Brick & Tile Company.
2. Grade: SW.
 3. Type: FBX.
 4. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of min. 3200 psi.
 5. Initial Rate of Absorption: Less than 30 g/30 sq. in. per minute when tested per ASTM C67.
 6. Efflorescence: Provide brick that has been tested according to ASTM C67 and is rated "not effloresced."
 7. Surface Coating: Brick with colors or textures produced by application of coatings shall withstand 50 cycles of freezing and thawing per ASTM C67 with no observable difference in the applied finish when viewed from 10 feet.
 8. Size: Utility size; match existing.

2.5 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of Portland cement and hydrated lime containing no other ingredients.
- D. Aggregate for Mortar: ASTM C144.
 1. For joints less than 1/4 inch (6 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.
 2. White-Mortar Aggregates: Natural white sand or crushed white stone.
 3. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- E. Aggregate for Grout: ASTM C404.
- F. Epoxy Pointing Mortar: ASTM C395, epoxy-resin-based material formulated for use as pointing mortar for structural-clay tile facing units (and approved for such use by manufacturer of units); in color indicated or, if not otherwise indicated, as selected by Architect from manufacturer's colors.
- G. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.

1. Products: Subject to compliance with requirements,
 - a. Euclid Chemical Company (The); Accelguard 80.
 - b. Grace Construction Products, W. R. Grace & Co. - Conn.; Morset.
 - c. Sonneborn Products, BASF Aktiengesellschaft; Trimix-NCA.
- H. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent by same manufacturer.
 1. Products: Subject to compliance with requirements,
 - a. ACM Chemistries; RainBloc for Mortar.
 - b. BASF Aktiengesellschaft; Rheopel Mortar Admixture.
 - c. Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block Mortar Admixture.
- I. Water: Potable.

2.6 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A615 or ASTM A996, Grade 60 (Grade 420).
- B. Masonry Joint Reinforcement, General: ASTM A951.
 1. Interior Walls: Hot-dip galvanized, carbon steel.
 2. Exterior Walls: Hot-dip galvanized, carbon steel.
 3. Wire Size for Side Rods: 0.148-inch (3.77-mm) diameter.
 4. Wire Size for Cross Rods: 0.148-inch (3.77-mm) diameter.
 5. Wire Size for Veneer Ties: 0.148-inch (3.77-mm) diameter.
 6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
 7. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.
- C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.

2.7 TIES AND ANCHORS

- A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.
 1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A82; with ASTM A153, Class B-2 coating.
 2. Steel Sheet, Galvanized after Fabrication: ASTM A1008, Commercial Steel, with ASTM A153, Class B coating.

3. Steel Plates, Shapes, and Bars: ASTM A36.
- B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.
- C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches wide.
 1. Wire: Fabricate from 3/16-inch diameter, hot-dip galvanized steel wire.
- D. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
 1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch-diameter, hot-dip galvanized steel wire.
 2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.187-inch-diameter, hot-dip galvanized steel wire.
- E. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
 1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.060-inch-thick, steel sheet, galvanized after fabrication.
 2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.187-inch-diameter, hot-dip galvanized steel wire.
 3. Corrugated Metal Ties: Metal strips not less than 7/8 inch wide with corrugations having a wavelength of 0.3 to 0.5 inch and an amplitude of made from 0.060-inch-thick, steel sheet, galvanized after fabrication with dovetail tabs for inserting into dovetail slots in concrete and sized to extend to within 1 inch of masonry face.
- F. Partition Top anchors: 0.105-inch-thick metal plate with 3/8-inch-diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.
- G. Rigid Anchors: Fabricate from steel bars 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins unless otherwise indicated.
 1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A153 thick.
- H. Adjustable Masonry-Veneer Anchors:
 1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:
 - a. Structural Performance Characteristics: Capable of withstanding a 100-lbf (445-N) load in both tension and compression without deforming or developing play in excess of 0.05 inch.

2. Fabricate sheet metal anchor sections and other sheet metal parts from 0.075-inch-thick steel sheet, galvanized after fabrication.
3. Wire Ties: Triangular-, rectangular-, or T-shaped wire ties fabricated from 0.187-inch-diameter, hot-dip galvanized steel wire.
4. Screw-Attached, Masonry-Veneer Anchors: Units consisting of a wire tie and a metal anchor section.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Dayton Superior Corporation, Dur-O-Wal Division; D/A 213 or D/A 210 with D/A 700-708.
 - 2) Heckmann Building Products Inc.; 315-D with 316.
 - 3) Hohmann & Barnard, Inc.; DW-10HS or DW-10-X.
 - 4) Wire-Bond; 1004, Type III or RJ-711.
 - b. Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, having slotted holes for inserting wire tie.
- I. Anchor Bolts: Headed steel bolts complying with ASTM A307, Grade A; with ASTM A563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A153, Class C; of dimensions indicated.

2.8 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:
 1. Metal Drip Edge: Fabricate from stainless steel. Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
 2. Metal Sealant Stop: Fabricate from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 1/4 inch to form a stop for retaining sealant backer rod.
 3. Metal Expansion-Joint Strips: Fabricate from copper to shapes indicated.
- B. Flexible Flashing: Use the following unless otherwise indicated:
 1. Copper-Laminated Flashing: 7-oz./sq. ft. copper sheet bonded between 2 layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.
 - a. Products: Subject to compliance with requirements,
 - 1) Advanced Building Products Inc.;
 - 2) Dayton Superior Corporation, Dur-O-Wal Division; Copper Fabric Thru-Wall Flashing.

- 3) Hohmann & Barnard, Inc.; H & B C-Fab Flashing.
 - 4) Phoenix Building Products; Type FCC-Fabric Covered Copper.
 - 5) Sandell Manufacturing Co., Inc.; Copper Fabric Flashing.
 - 6) York Manufacturing, Inc.; Multi-Flash 500.
- C. Solder and Sealants for Sheet Metal Flashings: As recommended.
 - D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.9 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; formulated from neoprene.
- B. Preformed Control-Joint Gaskets: Made from [styrene-butadiene-rubber compound, complying with ASTM D2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D226, Type I (No. 15 asphalt felt).
- D. Weep/Vent Products: Match type used on adjacent building.
- E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
 - 1. Products: Subject to compliance with requirements.
 - a. Advanced Building Products Inc.; Mortar Break
 - b. Archovations, Inc.; CavClear Masonry Mat.
 - c. Dayton Superior Corporation, Dur-O-Wal Division; Polytite MortarStop.
 - d. Mortar Net USA, Ltd.; Mortar Net.
 - 2. Provide one of the following configurations:
 - a. Strips, full-depth of cavity and 10 inches high, with dovetail shaped notches 7 inches deep.

2.10 CAVITY-WALL INSULATION

- A. Extruded-Polystyrene Board Insulation: ASTM C578, closed-cell product extruded with an integral skin.
- B. Adhesive: Type recommended by insulation board manufacturer for application indicated.

2.11 MASONRY CLEANERS

- A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
1. Manufacturers: Subject to compliance with requirements,
 - a. Diedrich Technologies, Inc.
 - b. EaCo Chem, Inc.
 - c. ProSoCo, Inc.

2.12 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
1. Do not use calcium chloride in mortar or grout.
 2. Use portland cement-lime or masonry cement mortar unless otherwise indicated.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with ASTM C270, Specification. Provide the following types of mortar for applications stated unless another type is indicated.
1. For masonry below grade or in contact with earth, use Type M.
 2. For reinforced masonry, use Type S.
 3. For mortar parge coats, use Type S
 4. 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.
 5. For interior non-load-bearing partitions, Type O may be used instead of Type N.
- D. Grout for Unit Masonry: Comply with ASTM C476.
1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
- E. Epoxy Pointing Mortar: Mix epoxy pointing mortar to comply with mortar manufacturer's written instructions.
1. Application: Use epoxy pointing mortar for exposed mortar joints with the following units:

- a. Pre-faced CMUs.
- b. Glazed structural-clay facing tile.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
- C. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C67. Allow units to absorb water so they are damp but not wet at time of laying.

3.2 TOLERANCES

- A. Dimensions and Locations of Elements:
 - 1. For dimensions in cross section or elevation do not vary by more than plus 1/2 inch or minus 1/4 inch.
 - 2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2 inch.
 - 3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.
- B. Lines and Levels:
 - 1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
 - 2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
 - 3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
 - 4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
 - 5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.

- C. Joints:
1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
 2. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
 3. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.

3.3 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.
- C. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- D. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- E. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

3.4 MORTAR BEDDING AND JOINTING

- A. Lay hollow CMUs as follows:
1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
 2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
 3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
 4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
- B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Lay structural-clay tile as follows:
1. Lay vertical-cell units with full head joints unless otherwise indicated. Provide bed joints with full mortar coverage on face shells and webs.

2. Lay horizontal-cell units with full bed joints unless otherwise indicated. Keep drainage channels, if any, free of mortar. Form head joints with sufficient mortar so excess will be squeezed out as units are placed in position. Butter both sides of units to be placed, or butter one side of unit already in place and one side of unit to be placed.
 3. Maintain joint thicknesses indicated except for minor variations required to maintain bond alignment. If not indicated, lay walls with 1/4- to 3/8-inch- thick joints.
 4. Where epoxy-mortar pointed joints are indicated, rake out setting mortar to a uniform depth of 1/4 inch and point with epoxy mortar to comply with epoxy-mortar manufacturer's written instructions.
- D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
- E. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.

3.5 COMPOSITE MASONRY

- A. Bond wythes of composite masonry together using one of the following methods:
1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 4.5 sq. ft. of wall area spaced not to exceed 16 inches o.c. horizontally and 16 inches o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than 36 inches apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches o.c. vertically.
 2. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
- B. Collar Joints: Solidly fill collar joints by parging face of first wythe that is laid and shoving units of other wythe into place.
- C. Collar Joints in Clay Tile Masonry: After each course is laid, fill the vertical, longitudinal joint between wythes solidly with mortar at exterior walls, and interior walls and partitions.
- D. Corners: Provide interlocking masonry unit bond in each wythe and course at corners unless otherwise indicated.
- E. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, bond walls together as follows:
1. Provide individual metal ties not more than 16 inches o.c.
 2. Provide continuity with masonry joint reinforcement by using prefabricated T-shaped units.
 3. Provide rigid metal anchors not more than 24 inches o.c. If used with hollow masonry units, embed ends in mortar-filled cores.

3.6 CAVITY WALLS

- A. Bond wythes of cavity walls together using one of the following methods:

1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 4.5 sq. ft of wall area spaced not to exceed 16 inches o.c. horizontally and 16 inches o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than 36 inches apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches o.c. vertically.
 2. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
 - a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes.
 - b. Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement.
 - c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement to allow for differential movement regardless of whether bed joints align.
- B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.
- C. Parge cavity face of backup wythe in a single coat approximately 3/8 inch thick. Trowel face of parge coat smooth.
- D. Coat cavity face of backup wythe to comply with Section 07150 Dampproofing.
- E. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.

3.7 MASONRY JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
1. Space reinforcement not more than 16 inches o.c.
 2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
 3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.
- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.

3.8 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

- A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:
 - 1. Provide an open space not less than 1/2 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
 - 2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
 - 3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

3.9 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.
- B. Install flashing as follows unless otherwise indicated:
 - 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
 - 2. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
 - 3. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal drip edge.
 - 4. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall and adhere flexible flashing to top of metal flashing termination.
- C. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
 - 1. Use specified weep/vent products to form weep holes.
 - 2. Space weep holes 24 inches o.c. unless otherwise indicated.
 - 3. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
- D. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

- E. Install vents in head joints in exterior wythes at spacing indicated.
 - 1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

3.10 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
 - 1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 - 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
 - 1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
 - 2. Limit height of vertical grout pours to not more than 60 inches.

3.11 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
- B. Testing Prior to Construction: One set of tests.
- C. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.
- D. Clay Masonry Unit Test: For each type of unit provided, according to ASTM C67 for compressive strength.
- E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C140 for compressive strength.
- F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C780.
- G. Mortar Test (Property Specification): For each mix provided, according to ASTM C780. Test mortar for mortar air content and compressive strength.
- H. Grout Test (Compressive Strength): For each mix provided, according to ASTM C1019.

3.12 PARGING

- A. Parge exterior faces of below-grade masonry walls, where indicated, in 2 uniform coats to a total thickness of 3/4 inch.
- B. Use a steel-trowel finish to produce a smooth, flat, dense surface. Form a wash at top of parging and a cove at bottom.
- C. Damp-cure parging for at least 24 hours and protect parging until cured.

3.13 REPAIRING, POINTING, AND CLEANING

- A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
 - 2. Protect surfaces from contact with cleaner.
 - 3. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
 - 4. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
 - 5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
 - 6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.14 MASONRY WASTE DISPOSAL

- A. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soil-contaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
 - 1. Do not dispose of masonry waste as fill within 18 inches of finished grade.
- B. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION

SECTION 04400

LIMESTONE

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. Furnish labor, materials and equipment required for complete execution of Work shown on the Drawings and Specifications herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 04200 – Unit Masonry
- B. Section 07900 – Joint Sealants

1.3 REFERENCED SPECIFICATIONS, CODES AND STANDARDS

- A. ASTM C568, Standard Specification for Limestone Building Stone
- B. ASTM C97, Test Methods for Absorption and Bulk Specific Gravity of Building Stones
- C. ASTM C99, Test Method for Modulus of Rupture of Building Stone
- D. ASTM C170, Test Method for Compressive Strength of Building Stone
- E. Indiana Limestone Handbook, latest edition
- F. Contractors Handbook on Indiana Limestone, latest edition
- G. ILI Technote on Safety Factors
- H. Repairing damage to Indiana Limestone, latest edition

1.4 SUMMARY

- A. Extent of limestone work is indicated on the Drawings.
- B. General: Provide Indiana Limestone cladding in accordance with the Contract Documents. The work shall include the following:
 - 1. Limestone wall capstone.
 - 2. Steel support and retention connections for stonework, including necessary shims.
 - 3. Installation of stonework.
- C. Installation of preset masonry inserts.

1.5 SYSTEM DESCRIPTION

- A. General: Design, fabricate, and install stonework to withstand normal loads from wind, gravity, movement of structure, and thermally induced movement, as well as to resist deterioration under conditions of normal use including exposure to weather, without failure.
- B. Performance Requirements – General: The cladding requirements shown by the general stone details are intended to establish basic dimensions of units or modules, plus profiles and sight lines for the stonework. Within these limitations, the Contractor shall be responsible for the design of the stonework, and shall request approval of, and make whatever modifications and additions to the details as may be required to fulfill the performance requirements. The visual concept shall be maintained as shown, including profiles and alignment of components.

The requirements for the stone support and anchorage as shown by the details are intended to establish the basic intent of the stone anchorage system. The Contractor shall be responsible for the design of the support and anchorage system and shall request approval of, and make whatever modifications and additions to the details, as may be required to fulfill the performance requirements.

- C. Performance Requirements – Stone
1. Physical Properties: The Indiana Limestone physical properties shall meet or exceed the values listed in the Indiana Limestone Institute of America, Inc. Handbook (ILIA), latest edition.
 2. Safety Factors - Stone: Safety factors for Indiana Limestone shall be not less than as listed in the Technote on Safety Factors, as published by ILIA.
 3. Connections and Attachments for Limestone: Support and Retention Steel: All steel shapes, plates and straps shall be designed to carry the design loads with safety factors and allowable stresses in accordance with the American Institute of Steel Construction, Inc. (AISC) except that steel supports carrying gravity loads shall be stressed not more than 50% of the yield stress in bending.
 4. Connections into the Stone: Expansion bolts, straps, hooks, anchors, and other devices shall be designed to carry the design loads with safety factors not less than listed in ILIA Technote on Safety Factors.
 5. Attachments to the Structure: Connections and attachments to the structure or secondary framing shall be designed to carry the design loads with safety factors or allowable stresses in accordance with the following:
 - a. Welds: Structural Welding Code (AWS D1.1 and AISC).
 - b. Expansion Bolts: Per ICBO evaluation report for the specific bolt to be used. If an ICBO report is not available, use not less than the following:

Safety Factors:

Into 4,000 psi concrete - 4 to 1

Into grouted CMU - 6 to 1

- c. The combined load factor for combined tension and shear shall satisfy the ILIA Technote Safety Factors.
 - d. Bolts: AISC.
 - e. Concrete Embedded (Cast-In) Items: PCI or manufacturer's recommendations, whichever is more conservative. The safety factor shall not be less than 4 to 1 based on concrete failure.
6. Provisions for Fabrication and Erection Tolerances: Design, detail and fabricate connections to provide allowance for fabrication tolerances, erection tolerances, and structural deflections.
- a. Concrete structural fabrication and erection tolerances are specified in Division 3 - section "Structural Steel".
 - b. Structural steel fabrication and erection tolerances are specified in Division 5 - section "Structural Steel".
8. Control of Corrosion: Prevent galvanic and other forms of corrosion by insulating metals and other materials from direct contact with non-compatible materials, or by suitable coating.

1.6 SUBMITTALS

- A. Product Data: Submit manufacturer's technical data for all stone, stonework accessories, and other manufactured products required.
- B. Shop Drawings: Submit cutting and setting drawings indicating sizes, dimensions, sections and profiles of stones; arrangement and provisions for jointing, supporting, anchoring, and bonding stonework; and details showing relationship with, attachment to, and reception of, related work. The Drawings shall include the details as developed by the cladding engineer as defined in the performance requirements section.
- C. Submit the following samples:
 - 1. Limestone samples in form of sets of three, consisting of stones not less than 12" square. Sample sets will show a range of variations in color and grain to be expected in completed work.
 - 2. Sealant samples for each type and color of joint sealant required.

1.7 QUALITY ASSURANCE

- A. Single Source Responsibility for Stone: Obtain limestone from a single quarry source with resources to provide materials of specified consistent quality. The fabricator and the quarry shall have sufficient capacity to quarry, cut, and deliver the stonework on schedule. Both fabricator and quarry must be members in good standing of Indiana Limestone Institute.
- B. Installer Qualifications: Engage an installer with not less than 10 years experience and who has successfully completed stonework similar in material, design and extent to that indicated for this project.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Delivery masonry materials to project in undamaged condition.
- B. Store and handle stone and related materials to prevent their deterioration or damage:
 - 1. Do not use pinch or wrecking bars on stonework.
 - 2. Lift with wide-belt type swings where possible; do not use wire rope or ropes containing tar or other substances which might cause staining.
 - 3. Store stone on non-staining wood skids or pallets, covered with non-staining, waterproof membrane. Place and stack skids and stone to distribute weight evenly and to prevent breakage or cracking of stones.
 - 4. Store cementitious materials off the ground, under cover and in dry location.

1.9 PROJECT CONDITIONS

- A. Protect stonework during erection as follows:
 - 1. Cover top of walls with non-staining waterproof sheeting at tend of each day's work. Cover partially completed structures when work is not in progress. Extend cover a minimum of 24" down both sides and hold securely in place.
 - 2. Prevent staining of stone from mortar, grout, sealants, and other sources. Immediately remove such materials from stone without damage to the stonework.
 - 3. Protect base of walls from rain-splashed mud and mortar splatter by means of coverings spread on ground and over wall surface.
 - 4. Protect sills, ledges and projections from droppings of mortar and sealants.
- B. Cold Weather Protection: Comply with the following requirements:
 - 1. Remove ice or snow formed on stonework beds by carefully applying heat until top surface is dry to the touch.
 - 2. Remove stonework damaged by freezing conditions.
 - 3. Perform the following construction procedures while stonework is progressing:
 - a. Temperature ranges indicated apply to air temperatures existing at time of installations.
 - b. In heating mortar materials, maintain mixing temperatures selected within 10 degrees F (6 degrees C); do not heat water for mortar to above 160 degrees F (71 degrees C).
 - c. Mortar: At 40 degrees F (4.4 degrees C) and below, produce mortar temperatures between 40 degrees F (4.4 degrees C) and 120 degrees F (49 degrees C) by heating mixing water and, at temperatures of 32 degrees F (0 degrees C) and below, sand as well. Always maintain temperature of mortar on boards above freezing.

- d. At 25 degrees F (-4 degrees C) to 20 degrees F (-7 degrees C), heat both sides of walls under construction using salamanders or other heat sources and use windbreaks or enclosures when wind is in excess of 15 mph.
- e. At 20 degrees F (-7 degrees C) and below, provide enclosure and auxiliary heat to maintain an air temperature of at least 40 degrees F (4.4 degrees C) for 24 hours after setting stonework and heat stones so that they are above 20 degrees F (-7 degrees C) at time of installation.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Comply with referenced standards and other requirements indicated applicable to each type of material required.
- B. Provide stone from a single quarry for each grade, color, and finish of stone required.

2.2 LIMESTONE

- A. Limestone Building Stone Standard: ASTM C 568
 - 1. Classification: Category II (Medium Density).
 - 2. Variety: Indiana Limestone.
 - 3. Finish of Exterior Limestone Cladding: As follows:
 - a. Finish Indiana Limestone to match approved samples and/or mockups of Indiana Limestone. New limestone to match existing buildings.

2.3 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, Type I except Type III may be used for cold weather construction. Provide gray or white cement as needed to produce mortar color required.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Aggregate: ASTM C 144; and as indicated below:
 - 1. For joints narrower than ¼" use aggregate graded with 100 percent passing the No. 8 sieve and 95 percent the No. 16 sieve.
- D. Water: Clean, non-alkaline and potable.

2.4 STONE ANCHORS AND ATTACHMENTS

- A. Provide anchors and attachments of type and size required to support the stonework fabricated from the following metals for conditions included below:
 - 1. Stainless Steel, ANSI Type 304 or 316, for anchors and expansion bolts embedded within the stone.

2. Hot-Dip Galvanized Steel as follows:
 - a. Galvanized malleable iron for adjustable inserts embedded in the concrete structure.
 3. For anchor bolts, nuts and washers not in direct contact with stone; comply with ASTM A 307, Grade A, for material and ASTM C 153, Class C, for galvanizing.
 4. For steel plates, shapes and bars not in direct contact with stone; comply with ASTM A 36 for materials and ASTM A 123 for galvanizing.
 5. For expansion bolts not in direct contact with stone use zinc plated or cadmium plated bolts with stainless steel expansion clips.
 6. For steel angle supporting limestone; comply with ASTM A 36 for materials and ASTM A 123 for galvanizing. Supports protected with one shop coat of zinc-rich or other rust-inhibiting paint, and one job coat of similar, compatible paint, may be used at the discretion of the Engineer.
- B. Dovetail Slots: Where required, furnish dovetail slots, with filler strips, of slot size required to receive anchors provided, fabricated from 0.0336 (22-gage) galvanized sheet steel complying with ASTM A 446, G90.

2.5 STONE ACCESSORIES

- A. Setting Shims: Lead, stainless steel, or plastic shims, non-staining to stone, sized to suit joint thicknesses and bed depths of stonework involved without intruding into required depths of joint sealants.
- B. Concealed Sheet Metal Flashing: Fabricate from stainless steel or other material complying with requirements specified in Division 7 Section "Flashing and Sheet Metal", in thicknesses indicated but not less than 0.015" thick.
- C. Plastic Tubing Weeps: Medium density polyethylene, outside diameter of ¼" and of length required to extend between exterior face of stone and cavity behind.

2.6 ELASTOMERIC SEALANTS

- A. Refer to Section 07900.

2.7 MORTAR AND GROUT MIXES

- A. General: Do not add mixtures including coloring pigments, air-entraining agents, accelerators, retarders, water repellent agents, anti-freeze compounds, or calcium chloride, unless otherwise indicated.
- B. Mixing: Combine and thoroughly mix cementitious materials, water and aggregates in a mechanical batch mixer; comply with referenced ASTM standard for mixing time and water content, unless otherwise indicated.
- C. Setting Mortar: Comply with ASTM C 270, Proportion Specification, for types of mortars and applications required below, unless otherwise indicated.
 1. Set Indiana Limestone with Type N mortar.

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2.8 STONE FABRICATION

- A. General: Fabricate stonework in sizes and shapes required to comply with the requirements as shown on approved Shop Drawings.
- B. Comply with recommendations of the Indiana Limestone Institute of America, Inc. (ILI) as published in the Indiana Limestone Handbook (latest edition).
- C. Cut and drill sinkages and holes in stones for anchors, fasteners, supports and lifting devices as indicated or needed to set stonework securely in place; shape beds to fit supports.
- D. Cut stones to produce pieces of thickness, size and shape indicated or required and within fabrication tolerances recommended by ILI.
- F. Control depth of stones and back-checks to maintain a clearance between backs of stones and surfaces or projections of structural members, fire-proofing (if any), backup walls and other work behind stones.
- G. Cut joints (bed and vertical) straight and at 90 degree angle to face, unless otherwise indicated.
- H. Quirk-miter corners, unless otherwise indicated; shall provide for cramp anchorage in top and bottom bed joints of corner pieces.
- I. Cut stones to produce joints of uniform width and in locations indicated.
 - 1. Joint Width: 3/8"
- J. Contiguous Work: Provide chases, reveals, reglets, openings and similar features as required to accommodate contiguous work.
- K. Fabricate molded work, including washes and drips, to produce stone shapes having a uniform profile throughout their entire length and with precisely formed arises slightly eased to prevent snipping, and matched at joints between units.
- L. Finish exposed faces and edges of stones to comply with requirements indicated for finish under each type and application of stone required and to match approved samples and field-constructed mockups.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Require installer to examine surfaces to receive stonework and conditions under which stonework will be installed and to report in writing any conditions which are not in compliance with requirements. Do not proceed with installation until surfaces and conditions comply with requirements indicated until surfaces and conditions comply with requirements indicated in specifications or elsewhere for execution of other work which affects stonework.

3.2 PREPARATION

- A. Advise installers of other work about specific requirements relating to placement of inserts, flashing reglets and similar items which will be used by stonework installer for anchoring, supporting and flashing of stonework. Furnish installers of other work with drawings or templates showing locations of these items. General contractor or concrete contractor will provide drawings to locate weld-plates and embeds for connection of stone skin or its system.
- B. Clean stone surfaces which have become dirty or stained prior to setting to remove soil, stains and foreign materials. Clean stones by thoroughly scrubbing stones with fiber brushes followed by a thorough drenching with clear water. Use only mild cleaning compounds that contain no acid, caustic or abrasives.

3.3 SETTING STONE, GENERAL

- A. Execute stonework by skilled mechanics, and employ skilled stone fitters at the site to do necessary field cutting as stones are set. Use power saws to cut stones; for exposed edges, produce edges which are cut straight and true. Mallet and chisel cutting will be permitted provided craftsmen are skilled in their use.
- B. Contiguous Work: Provide chases, reveals, reglets, openings and other spaces as indicated for accommodating contiguous work. Close up openings in stonework after other work is in place with stonework which matches that already set.
- C. Set stones to comply with requirements indicated on drawings and final shop drawings. Install anchors, supports, fasteners and other attachments indicated or necessary to secure stonework in place. Shim and adjust anchors, supports and accessories to set stones accurately in locations indicated with uniform joints of widths indicated and with edges and faces aligned according to established relationships and indicated tolerances.
- D. Construction Tolerances: Set stones to comply with the following tolerances:
 - 1. Variation from Plumb: For lines and surfaces of columns, walls and arises, do not exceed $\frac{1}{4}$ " in 10', $\frac{3}{8}$ " in a story height or 20' maximum, nor $\frac{1}{2}$ " in 40' or more. For external corners, expansion joints and other conspicuous lines, do not exceed $\frac{1}{4}$ " in any story or 20' maximum, nor $\frac{1}{2}$ " in 40' or more.
 - 2. Variation from Level: For grades indicated for exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, do not exceed $\frac{1}{2}$ " in any bay or 20' maximum, nor $\frac{3}{4}$ " in 40' or more.
 - 3. Variation of Linear Building Line: For position shown in plan and related portion of columns, walls and partitions, do not exceed $\frac{1}{2}$ " in any bay or 20' maximum, nor $\frac{3}{4}$ " in 40' or more.
 - 4. Variation in Cross-Sectional Dimensions: For columns and thickness of walls from dimensions indicated, do not exceed minus $\frac{1}{4}$ ", nor plus $\frac{1}{2}$ ".
- E. Provide expansion joints, control joints and pressure-relieving joints of widths and at locations indicated or required.
 - 1. Sealants, expansion, and other joints are specified in Section 07900.
 - 2. Use no mortar or shims in expansion joints.

3.4 SETTING STONWORK WITH SEALANT JOINTS

- A. Support stonework on gravity supports, and insert anchors for lateral loads, of type and number indicated on final shop drawings, and complying with requirements indicated for material and performance.
- B. Attach anchors securely to stones and to backup surfaces.
- C. Attach framing for stone support system to structural frame of building at connection points indicated by welded or bolted field connections complying with the following requirements:
 - 1. Install high strength threaded fasteners to comply with AISC Specifications for Structural Joints using ASTM A 325 or A 490 bolts approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation (RCRBSJ).
 - 2. Weld connections to comply with AWS D1.1 Structural Welding Code Steel.
 - 3. Provide joints to exclude water or permit its escape to exterior of building. Provide weeps at locations where water could accumulate due to condensation or other causes.
 - 4. For galvanized surfaces of assembled framing, comply with ASTM A 780 for cleaning field welds, bolted connections and abraded areas and application of galvanizing repair paint.
 - 5. For shop-painted surfaces, clean field welds, bolted connections, and abraded areas, immediately after erection. Apply paint to exposed areas using same material as used for shop painting.
- D. Fill anchor holes with non-staining mortar or sealant. Where dowel holes occur at pressure-relieving joints, provide compressive material above and below dowels.
- E. For stones supported on clip or continuous angles, set stones, on non-corrosive and non-staining shim material in sufficient area to support the load. Mortar may be used in lieu of shims provided that setting pads are provided to maintain joint sizes if stone weight squeezes out mortar.
 - 1. Place setting buttons of adequate size in sufficient quantity, and of same thickness as indicated joint width, to prevent mortar from squeezing out and to maintain uniform joint widths. Hold buttons back from face of stone to provide space for backer rope and sealant.
 - 2. The joint between bottom of relieving angles and top surface of stones below angles shall be free of mortar or shims to avoid load transfer.
- F. Install concealed flashing at continuous shelf angles, lintels, ledges and similar obstructions to the downward flow of water so as to divert such water to the exterior.
- G. Keep cavities open where unfilled space is indicated between back of stone veneer and backup wall; do not fill cavities with mortar or grout.

- H. Place weepholes/vents in joints where moisture may accumulate including base of cavity walls, above shelf angles and flashing. Locate weepholes/vents at intervals not exceeding 2' and those serving as vents only, at intervals not exceeding 5' horizontally and 20' vertically.
- I. Where mortar is used in setting stones on anchors or elsewhere, rake out mortar from joints to depths adequate to receive sealants and sealant backings.
- J. Embed ends of lugged sills on shims or mortar; leave balance of joint open until final sealing.
- K. Set the stonework with open vertical joints for installation of joint sealants. Use no shims or spacers in vertical joints.

3.5 INSTALLATION OF JOINT SEALANTS

- A. Specified in Section 07900.

3.6 ADJUSTING AND CLEANING

- A. **Repairing Damaged Stone:** Repair of stone is an accepted practice and will be permitted. Some chipping is expected; repair of small chips is not required if it does not detract from the overall appearance of the work, is not visible from a distance of not less than 20 feet, or impair the effectiveness of the mortar or sealant. The criteria for acceptance of chips and repairs will be as follows:
 - 1. Chips shall not be larger than ¼ inch any dimension.
 - 2. Cracks shall not be wider than 0.02 inches (0.5 mm) and not longer than 25% of the height of the stone unit. Repair of damaged stone shall follow the procedures outlined in the document "Repairing Damage to Indiana Limestone", by the Indiana Limestone Institute.
- B. Remove and replace stonework of the following description:
 - 1. Stones so damaged that repair is impossible, either structurally or aesthetically.
 - 2. Defective joints.
 - 3. Stones and joints not in conformance with approved samples and field-constructed mockups.
 - 4. Stonework not complying with other requirements indicated.
- C. Replace in manner which results in stonework conforming to approved standards, complying with other requirements and showing no evidence of replacement.
- D. Clean stonework using clean water and stiff bristle fiber brushes. Do not use wire brushes, acid type cleaning agents, or other materials or methods which could damage stone. Mechanical or pressure cleaning methods may be used if approved by architect. Protect limestone when adjacent brick is being acid-washed.

3.7 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to fabricator and installer, which ensures stonework being without damage or deterioration at time of substantial completion.

END OF SECTION

SECTION 05010

METAL MATERIALS

PART 1 – GENERAL

1.1 THE REQUIREMENT

- A. Metal materials not otherwise specified shall conform to the requirements of this Section.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Materials for fasteners are included in Section 05050, Metal Fastening.
- B. Requirements for specific products made from the materials specified herein are included in other sections of the Specifications. See the section for the specific item in question.

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. ASTM A36 Standard Specification for Structural Steel
- B. ASTM A47 Standard Specification for Malleable Iron Castings
- C. ASTM A48 Standard Specification for Gray Iron Castings
- D. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
- E. ASTM A167 Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
- F. ASTM A276 Standard Specification for Stainless and Heat-Resisting Steel Bars and Shapes
- G. ASTM A307 Standard Specification for Carbon Steel Externally Threaded Standard Fasteners
- H. ASTM A446 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Structural (Physical) quality
- I. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
- J. ASTM A501 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
- K. ASTM A529 Standard Specification for Structural Steel with 42 000 psi (290 Mpa) Minimum Yield Point (1/2 in. (12.7 mm) Maximum Thickness)
- L. ASTM A536 Standard Specification for Ductile Iron Castings
- M. ASTM A570 Standard Specification for Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality
- N. ASTM A992 Standard Specification for Structural Steel Shapes

- O. ASTM A666 Standard Specification for Austenitic Stainless Steel, Sheet, Strip, Plate, and Flat Bar for Structural Applications
- P. ASTM B26 Standard Specification for Aluminum-Alloy Sand Castings
- Q. ASTM B85 Standard Specification for Aluminum-Alloy Die Castings
- R. ASTM B108 Standard Specification for Aluminum-Alloy Permanent Mold Castings
- S. ASTM B138 Standard Specification for Manganese Bronze Rod, Bar, and Shapes
- T. ASTM B209 Standard Specification for Aluminum-Alloy Sheet and Plate
- U. ASTM B221 Standard Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes
- V. ASTM B308 Standard Specification for Aluminum-Alloy Standard Structural Shapes, Rolled or Extruded
- W. ASTM B574 Standard Specification for Nickel-Molybdenum-Chromium Alloy Rod
- X. ASTM F468 Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use
- Y. ASTM F593 Standard Specification for Stainless Steel Fasteners

1.4 SUBMITTALS

- A. Material certifications shall be submitted along with any shop drawings for metal products and fabrications required by other sections of the Specifications.

1.5 QUALITY ASSURANCE

- A. Owner may engage the services of a testing agency to test any metal materials for conformance with the material requirements herein. If the material is found to be in conformance with Specifications the cost of testing will be borne by the Owner. If the material does not conform to the Specifications, the cost of testing shall be paid by the Contractor and all materials not in conformance as determined by the Engineer shall be replaced by the Contractor at no additional cost to the Owner. In lieu of replacing materials the Contractor may request further testing to determine conformance, but any such testing shall be paid for by the Contractor regardless of outcome of such testing.

PART 2 – PRODUCTS

2.1 CARBON AND LOW ALLOY STEEL

- A. Material types and ASTM designations shall be as listed below:
 - 1. Structural Fabrications A992
 - 2. Sheet Steel A 570 Grade C
 - 3. Steel Angles and Plates A36
 - 4. Bars and Rods A 36 or A307 Grade A
 - 5. Pipe - Structural Use A53 Type E or S, Grade B
 - 6. Tubes A500 Grade B or A501

2.2 STAINLESS STEEL

- A. All stainless steel fabrications exposed to underwater service shall be Type 316. All other stainless steel fabrications shall be Type 304, unless noted otherwise.
- B. Material types and ASTM designations are listed below:
 - 1. Plates and Sheets ASTM A167 or A666 Grade A
 - 2. Structural Shapes ASTM A276
 - 3. Fasteners (Bolts, etc.) ASTM F593

2.3 ALUMINUM

- A. All aluminum shall be alloy 6061-T6, unless otherwise noted or specified herein.
- B. Material types and ASTM designations are listed below:
 - 1. Structural Shapes ASTM B308
 - 2. Castings ASTM B26, B85, or B108
 - 3. Extruded Bars ASTM B221 - Alloy 6061
 - 4. Extruded Rods, Shapes and Tubes ASTM B221 - Alloy 6063
 - 5. Plates ASTM B209 - Alloy 6061
 - 6. Sheets ASTM B221 - Alloy 3003
- C. All aluminum shall be provided with mill finish unless otherwise noted.
- D. Where bolted connections are indicated, aluminum shall be fastened with stainless steel bolts.
- E. Aluminum in contact with dissimilar materials and all concrete surfaces shall be insulated with an approved dielectric.

2.4 CAST IRON

- A. Material types and ASTM designations are listed below:
 - 1. Gray ASTM A48 Class 30B
 - 2. Malleable ASTM A47
 - 3. Ductile ASTM A536 Grade 60-40-18

2.5 BRONZE

- A. Material types and ASTM designations are listed below:
 - 1. Rods, Bars and Sheets ASTM B138 - Alloy B Soft

2.6 HASTELLOY

- A. All Hastelloy shall be Alloy C-276.

PART 3 – EXECUTION

(NOT USED)

END OF SECTION

SECTION 05035

GALVANIZING

PART 1 – GENERAL

1.1 THE REQUIREMENT

- A. Where galvanizing is called for in the Contract Documents, the galvanizing shall be performed in accordance with the provisions of this Section unless otherwise noted.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Further requirements for galvanizing specific items may be included in other Sections of the Specifications. See section for the specific item in question.

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.

1. Michigan Building Code
2. ASTM A123 - Standard Specification for Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars, and Strip
3. ASTM A153 - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
4. ASTM A386 - Standard Specification for Zinc Coating (Hot-Dip) on Assembled Steel Products
5. ASTM A924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
6. ASTM A780 - Standard Practice of Repair of Damaged Hot-Dip Galvanized Coatings

1.4 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
1. Certification that the item(s) are galvanized in accordance with the applicable ASTM standards specified herein. This certification may be included as part of any material certification that may be required by other Sections of the Specifications.

PART 2 – PRODUCTS

2.1 GALVANIC COATING

- A. Material composition of the galvanic coating shall be in accordance with the applicable ASTM standards specified herein.

PART 3 -- EXECUTION

3.1 FABRICATED PRODUCTS

- A. Products fabricated from rolled, pressed, and forged steel shapes, plates, bars, and strips, 1/8 inch thick and heavier which are to be galvanized shall be galvanized in accordance with ASTM A123. Products shall be fabricated into the largest unit which is practicable to galvanize before the galvanizing is done. Fabrication shall include all operations necessary to complete the unit such as shearing, cutting, punching, forming, drilling, milling, bending, and welding. Components of bolted or riveted assemblies shall be galvanized separately before assembly. When it is necessary to straighten any sections after galvanizing, such work shall be performed without damage to the zinc coating. The galvanizer shall be a member of American Galvanizers Association.
- B. Components with partial surface finishes shall be commercial blast cleaned prior to pickling.
- C. Sampling and testing of each lot shall be performed prior to shipment from the galvanizer's facility per ASTM A123.

3.2 HARDWARE

- A. Iron and steel hardware which is to be galvanized shall be galvanized in accordance with ASTM A153.

3.3 ASSEMBLED PRODUCTS

- A. Assembled steel products which are to be galvanized shall be galvanized in accordance with ASTM A123 or ASTM A386. All edges of tightly contacting surfaces shall be completely sealed by welding before galvanizing.

3.4 SHEETS

- A. Iron or steel sheets which are to be galvanized shall be galvanized in accordance with ASTM A924.

3.5 REPAIR OF GALVANIZING

- A. Galvanized surfaces that are abraded or damaged at any time after the application of zinc coating shall be repaired by thoroughly wire brushing the damaged areas and removing all loose and cracked coating, after which the cleaned areas shall be painted with 2 coats of zinc rich paint meeting the requirements of Federal Specification DOD-P-21035A and shall be thoroughly mixed prior to application. Zinc rich paint shall not be tinted. The total thickness of the 2 coats shall not be less than 6 mils. In lieu of repairing by painting with zinc rich paint, other methods of repairing galvanized surfaces in accordance with ASTM A780 may be used provided the proposed method is acceptable to the Engineer.

END OF SECTION

SECTION 05050

METAL FASTENING

PART 1 – GENERAL

1.1 THE REQUIREMENT

- A. Furnish all materials, labor, and equipment required to provide all metal welds and fasteners not otherwise specified, in accordance with the Contract Documents.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05010 - Metal Materials
B. Section 05035 - Galvanizing
C. Section 05120 - Structural Steel

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the other requirements of the specifications, all work herein shall conform to the applicable requirements of the following documents. All referenced specifications, codes, and standards refer to the most current issue available at the time of Bid.
1. Michigan Building Code
 2. AISC Specification for Structural Joints Using ASTM A325 or A490 Bolts.
 3. AISC Code of Standard Practice
 4. AWS D1.1 Structural Welding Code - Steel
 5. AWS D1.2 Structural Welding Code - Aluminum
 6. AWS D1.6 Structural Welding Code – Stainless Steel
 7. Aluminum Association Specifications for Aluminum Structures
 8. ASTM A572/A572M-94C Standard Specification for High Strength Low-Alloy Columbium-Vanadium Structural Steel Grade 50
 9. ASTM A307 Standard Specification for Carbon Steel Externally Threaded Standard Fasteners
 10. ASTM A325 Standard Specification for High-Strength Bolts for Structural Steel Joints
 11. ASTM A489 Standard Specification for Eyebolts

12.	ASTM A490	Standard Specification for Quenched and Tempered Alloy Steel Bolts for Structural Steel Joints
13.	ASTM A563	Standard Specifications for Carbon and Alloy Steel Nuts
14.	ASTM F593	Standard Specification for Stainless Steel Bolts; Hex Cap Screws, and Studs
15.	ASTM F594	Standard Specification for Stainless Steel Nuts
16.	ASTM D1785	Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe
17.	ASTM F467	Standard Specification for Nonferrous Nuts for General Use

1.4 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
 - 1. Shop Drawings providing the fastener's manufacturer and type and certification of the fastener's material and capacity.
 - 2. Copy of valid certification for each person who is to perform field welding.
 - 3. Certified weld inspection reports, when required.
 - 4. Welding procedures.

1.5 QUALITY ASSURANCE

- A. Fasteners not manufactured in the United States shall be tested and certification provided with respect to specified quality and strength standards. Certifications of origin shall be submitted for all U.S. fasteners supplied on the project.
- B. All steel welding shall be performed by welders certified in accordance with AWS D1.1. All aluminum welding shall be performed by welders certified in accordance with AWS D1.2. All stainless steel welding shall be performed by welders certified in accordance with AWS D1.6. Certifications of field welders shall be submitted prior to performing any field welds.
- C. Welds and high strength bolts used in connections of structural steel will be visually inspected in accordance with Article 3.04.
- D. The Owner may engage an independent testing agency to perform testing of welded connections and to prepare test reports in accordance with AWS. Inadequate welds shall be corrected or redone and retested to the satisfaction of the Engineer, Owner, and/or an acceptable independent testing laboratory, at no additional cost to the Owner.
- E. Provide a welding procedure for each type and thickness of weld. For welds that are not prequalified, include a Performance Qualification Report. The welding procedure shall be given to each welder performing the weld. The welding procedure shall follow the format in Annex E of AWS D1.1 with relevant information presented.

PART 2 – PRODUCTS

2.1 ANCHOR BOLTS

- A. Anchor bolts shall conform to ASTM A36 or ASTM A307 Grade A except where stainless steel or other approved anchor bolts are shown on the Drawings. Anchor bolts shall have hexagonal heads and shall be supplied with hexagonal nuts meeting the requirements of ASTM A563 Grade A.
- B. Where pipe sleeves around anchor bolts are shown on the Drawings, pipe sleeves shall be cut from Schedule 40 PVC plastic piping meeting the requirements of ASTM D1785.

2.2 HIGH STRENGTH BOLTS

- A. High strength bolts and associated nuts and washers shall be in accordance with ASTM A325 or ASTM A490. Bolts, nuts and washers shall meet the requirements of AISC "Specification for Structural Joints Using ASTM A325 or A490 Bolts".
- B. Where high strength bolts are used to connect galvanized steel or are otherwise specified to be galvanized, bolts, nuts, and washers shall be hot-dip galvanized in accordance with ASTM A325.

2.3 STAINLESS STEEL BOLTS

- A. Stainless steel bolts shall conform to ASTM F-593. All underwater fasteners, fasteners in confined areas containing fluid, and fasteners in corrosive environments shall be Type 316 stainless steel unless noted otherwise. Fasteners for aluminum and stainless steel members not subject to the above conditions shall be Type 304 stainless steel unless otherwise noted.
- B. Stainless steel bolts shall have hexagonal heads with a raised letter or symbol on the bolts indicating the manufacturer, and shall be supplied with hexagonal nuts meeting the requirements of ASTM F594. Nuts shall be of the same alloy as the bolts.

2.4 CONCRETE ANCHORS

- A. All concrete anchors shall be adhesive anchors.
 - 1. Adhesive anchors shall be two part injection type.
- B. Adhesive anchors shall consist of stainless steel threaded rods or bolts anchored with an adhesive system into hardened concrete or grout-filled masonry. The adhesive system shall use a two-component adhesive mix and shall be injected with a static mixing nozzle following manufacturer's instructions. Thoroughly clean drill holes of all debris and drill dust with wire brush prior to installation of adhesive and threaded rod/bolt. Wipe rod free from oil that may be present from shipping or handling. The embedment depth of the rod/bolt shall provide a minimum allowable bond strength that is equal to the allowable tensile capacity of the rod/bolt (see Table 1) unless noted otherwise on the Drawings. The adhesive system shall be "Epcon System A7, C6, or G5" as manufactured by ITW Ramset/Redhead, "HIT HY-150 or RE-500 Injection Adhesive Anchor System" as manufactured by Hilti, Inc.

- C. Concrete anchors used to anchor aluminum, FRP, or stainless steel shall be Type 304 stainless steel unless noted otherwise. All underwater concrete anchors shall be Type 316 stainless steel.

TABLE 1
ALLOWABLE TENSILE CAPACITY (KIPS)

Size	A36 Threaded Rod/Bolt	SST Threaded Rod/Bolt
3/8"	2.1	1.9
1/2"	3.8	3.5
5/8"	5.9	5.6
3/4"	8.4	8.2
7/8"	11.5	11.4
1"	15.0	15.0

2.5 MASONRY ANCHORS

- A. Anchors for fastening to solid or grout-filled masonry shall be stainless steel adhesive anchors as specified above for concrete anchors.
- B. Anchors for fastening to hollow masonry or brick shall be adhesive anchors consisting of threaded rods or bolts anchored with an adhesive system dispensed into a screen tube inserted into the masonry. The adhesive system shall use a two-component adhesive mix and shall inject into the screen tube with a static mixing nozzle. Thoroughly clean drill holes of all debris and drill dust with nylon (not wire) brush prior to installation of adhesive and anchor. Contractor shall follow manufacturer's installation instructions. The adhesive system shall be "Epcon System A7, C6, or G5" as manufactured by ITW Ramset/Redhead, "HIT HY-20 System" as manufactured by Hilti, Inc., or "SET/ET Epoxy-Tie" or "AT Acrylic-Tie" as manufactured by Simpson Strong-Tie Co.
- C. Masonry anchors used to anchor aluminum, FRP, or stainless steel shall be Type 304 stainless steel unless noted otherwise. All underwater anchors shall be Type 316 stainless steel.

2.6 WELDS

- A. Electrodes for welding structural steel and all ferrous steel shall comply with AWS Code, using E70 series electrodes for shielded metal arc welding (SMAW), or F7 series electrodes for submerged arc welding (SAW).
- B. Electrodes for welding aluminum shall comply with the Aluminum Association Specifications and AWS D1.2.
- C. Electrodes for welding stainless steel and other metals shall comply with AWS D1.6.

2.7 WELDED STUD CONNECTORS

- A. Welded stud connectors shall conform to the requirements of AWS D1.1 Type C.

2.8 EYEBOLTS

- A. Eyebolts shall conform to ASTM A489 unless noted otherwise.

2.9 HASTELLOY FASTENERS

- A. Hastelloy fasteners and nuts shall be constructed of Hastelloy C-276.

2.10 ANTISEIZE LUBRICANT

- A. Antiseize lubricant shall be Graphite 50 Anti-Seize by Loctite Corporation, 1000 Anti-Seize Paste by Dow Corning, 3M Lube and Anti-Seize by 3M, or equal as approved by Engineer and Owner.

PART 3 – EXECUTION

3.1 MEASUREMENTS

- A. The Contractor shall verify all dimensions and review the Drawings and shall report any discrepancies to the Engineer for clarification prior to starting fabrication.

3.2 BOLT INSTALLATION

- A. Anchor Bolts, Concrete Anchors, and Masonry Anchors
 1. Anchor bolts shall be installed in accordance with AISC "Code of Standard Practice" by setting in concrete while it is being placed and positioned by means of a rigidly held template.
 2. The Contractor shall verify that all concrete and masonry anchors have been installed in accordance with the manufacturer's recommendations and that the capacity of the installed anchor meets or exceeds the specified safe holding capacity.
 3. Concrete anchors shall not be used in place of anchor bolts without Engineer's approval.
 4. All stainless steel threads shall be coated with antiseize lubricant.
- B. High Strength Bolts
 1. All bolted connections for structural steel shall use high strength bolts. High strength bolts shall be installed in accordance with AISC "Specification for Structural Joints, using A325 or A490 Bolts." All bolted joints shall be Type N, snug-tight, bearing connections in accordance with AISC Specifications unless noted otherwise on the Drawings.
- C. Other Bolts
 1. All dissimilar metal shall be connected with appropriate fasteners and shall be insulated with a dielectric or approved equal.
 2. All stainless steel bolts shall be coated with antiseize lubricant.

3.3 WELDING

- A. All welding shall comply with AWS Code for procedures, appearance, quality of welds, qualifications of welders and methods used in correcting welded work.

- B. Welded stud connectors shall be installed in accordance with AWS D1.1.

3.4 INSPECTION

- A. High strength bolting will be visually inspected in accordance with AISC "Specification for Structural Joints Using A325 or A490 Bolts". Rejected bolts shall be either replaced or retightened as required.
- B. Field welds will be visually inspected in accordance with AWS Codes. Inadequate welds shall be corrected or redone as required in accordance with AWS Codes.

END OF SECTION

SECTION 05120

STRUCTURAL STEEL

PART 1 – GENERAL

1.1 THE REQUIREMENT

- A. Furnish all equipment, labor, materials, and services required to provide all structural steel work in accordance with the Contract Documents. The term "structural steel" shall include items as defined in the AISC "Code of Standard Practice".

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 05010 - Metal Materials
- B. Section 05035 - Galvanizing
- C. Section 05050 - Metal Fastening

1.3 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of the Specifications, all work specified herein shall conform to the applicable requirements of the following documents.
 - 1. Michigan Building Code
 - 2. AISC - "Code of Standard Practice".
 - 3. AISC - "Specification for Structural Steel Buildings".
 - 4. AISC - "Specifications for Structural Joints Using ASTM A325 or A490 Bolts".
 - 5. AWS - "Structural Welding Code".

1.4 SUBMITTALS

- A. Submit the following in accordance with Section 01300, Submittals.
 - 1. Certified Mill Test Reports
 - 2. Affidavit of Compliance with grade specified
 - 3. Shop Drawings which include the following:
 - a. Layout drawings indicating all structural shapes, sizes, and dimensions.
 - b. Beam and column schedules.
 - c. Detailed drawings indicating jointing, anchoring and connection details.

1.5 QUALITY ASSURANCE

- A. Shop inspection may be required by the Owner at his own expense. The Contractor shall give ample notice to the Engineer and Owner prior to the beginning of any fabrication work so

that inspection may be provided. The Contractor shall furnish all facilities for the inspection of materials and workmanship in the shop, and the inspectors shall be allowed free access to the necessary parts of the work. Inspectors shall have the authority to reject any materials or work which do not meet the requirements of these Specifications. Inspection at the shop is intended as a means of facilitating the work and avoiding errors, but is expressly understood that it will in no way relieve the Contractor from his responsibility for furnishing proper materials or workmanship under this Specification.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Structural Steel

1. Structural steel for W shapes shall conform to ASTM A992 unless otherwise indicated.
2. Structural steel for S, M, and HP shapes and channels shall conform to ASTM A572 Grade 50 unless otherwise indicated.
3. Structural steel for angles and plates shall conform to ASTM A36 unless otherwise indicated.
4. Steel pipe shall be ASTM A53, Grade B.
5. HSS shall be ASTM A500, Grade B. All members shall be furnished full length without splices unless otherwise noted or accepted by the Engineer.
6. All unidentified steel will be rejected and shall be removed from the site and replaced by the Contractor, all at the expense of the Contractor.
7. Fasteners for structural steel shall be in accordance with Section 05050, Metal Fastening.
8. All structural steel shall be free from mill scale.

B. Welds

1. Electrodes for welding shall be in accordance with Section 05050, Metal Fastening.

PART 3 – EXECUTION

3.1 MEASUREMENT

- #### **A.**
- The Contractor shall verify all dimensions and shall make any field measurements necessary and shall be fully responsible for accuracy and layout of work. The Contractor shall review the Drawings and any discrepancies shall be reported to the Engineer for clarification prior to starting fabrication.

3.2 FABRICATION

- #### **A.**
- Fabrication shall be in accordance with the AISC "Specification for Structural Steel Buildings and AISC "Code of Standard Practice". Fabrication shall begin only after Shop Drawing approval.

- B. Except where otherwise noted on the Drawings or in this Specification, all shop connections shall be welded.
- C. All holes in structural steel members required for anchors, anchor bolts, bolt holes, sag rods or other members or for attachment of other work shall be provided by the fabricator and detailed on the Shop Drawings.
- D. All materials shall be properly worked and match-marked for field assembly.
- E. Where galvanizing of structural steel is required, it shall be done in accordance with Section 05035, Galvanizing.

3.3 DELIVERY, STORAGE AND HANDLING

- A. Structural members shall be loaded in such a manner that they may be transported and unloaded without being over-stressed, deformed or otherwise damaged.
- B. Structural steel members and packaged materials shall be protected from corrosion and deterioration. Material shall be stored in a dry area and shall not be placed in direct contact with the ground. Materials shall not be placed on the structure in a manner that might cause distortion or damage to the members or the supporting structures. The Contractor shall repair or replace damaged materials or structures as directed.

3.4 ERECTION

- A. The erection of all structural steel shall conform to the applicable requirements of the AISC "Specification for Structural Steel Buildings" and AISC "Code of Standard Practice". All temporary bracing, guys and bolts as may be necessary to ensure the safety of the structure until the permanent connections have been made shall be provided by the Contractor.
- B. Structural members shall be set accurately to the lines and elevations indicated. The various members shall be aligned and adjusted to form a part of a complete frame or structure before permanently fastened.
- C. No cutting of structural steel members in the field will be allowed except by the written approval of the Engineer.
- D. Bearing surfaces and other surfaces which will be in permanent contact shall be cleaned before assembly.
- E. Field welding shall not be permitted unless specifically indicated in the Drawings or approved in writing by the Engineer. All field welding shall comply with Section 05050, Metal Fastening.
- F. All bolted connections shall use high strength bolts in accordance with Section 05050, Metal Fastening. Bolts shall be fully pretensioned according to the AISC "Specification for Structural Joints Using ASTM A325 or A490 Bolts".
- G. All field connections shall be accurately fitted up before being bolted. Drifting shall be only such as will bring the parts into position and shall not be sufficient to enlarge the holes or to distort the metal. All unfair holes shall be drilled or reamed.
- H. Misfits at Bolted Connections
 - 1. Where misfits in erection bolting are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misfit for review by the

Engineer. The Engineer will determine whether the remedy is acceptable or if the member must be refabricated.

2. Incorrectly sized or misaligned holes in members shall not be enlarged by burning or by the use of drift pins. The Contractor shall notify the Engineer immediately and shall submit a proposed method of remedy for review by the Engineer.
3. Where misalignment between anchor bolts and bolt holes in steel members are encountered, the Engineer shall be immediately notified. The Contractor shall submit a method to remedy the misalignment for review by the Engineer.

I. Grouting of Base Plates and Bearing Plates

1. The bottom surface of the plates shall be cleaned of all foreign materials, and concrete or masonry bearing surface shall be cleaned of all foreign materials and roughened to improve bonding.
2. Accurately set all base and bearing plates to designated levels with steel wedges or leveling plates.
3. Baseplates shall be grouted with non-shrink grout to assure full uniform bearing. Grouting shall be done prior to placing loads on the structure.
4. Anchor bolts shall be tightened after the supported members have been positioned and plumbed and the non-shrink grout has attained its specified strength.

J. Where finishing is required, assembly shall be completed including bolting and welding of units before start of finishing operations.

3.5 PAINTING

A. Painting shall be performed according to Section 09900, Painting and the following additional requirements.

1. Concrete Encased Steel: Steel members which will be encased in concrete shall be cleaned but not painted prior to encasement.
2. Contact Surfaces: Contact surfaces such as at field connections, shall be cleaned and primed but not painted.
3. Finished Surfaces: Machine finished surfaces shall be protected against corrosion by a rust-inhibiting coating which is easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.
4. Surfaces Adjacent to Field Welds: Surfaces within 2 inches of any field weld location shall be free of materials that would prevent proper welding or produce objectionable fumes while welding is being done.

END OF SECTION

SECTION 05500

METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Steel Lintels
 - 2. Steel Monorail Beams
 - 3. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

1.2 REFERENCES

- A. AISC - Specification for Structural Steel Buildings
- B. AISI - Specifications for the Design of Cold Formed Steel Structural Members
- C. Aluminum Association Specifications for Aluminum Structures

1.3 SUBMITTALS

- A. Shop Drawings: Show fabrication and installation details for metal fabrications.
 - 1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces without blemishes.
- B. When galvanizing is called for, provide hot galvanized coatings that conform to the requirements of ASTM A123 or ASTM A446.

2.2 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A36.
- B. Stainless-Steel Bars and Shapes: ASTM A276.
- C. Rolled-Steel Floor Plate: ASTM A786, rolled from plate complying with ASTM A36 or ASTM A283, Grade C or D.
- D. Steel Tubing: ASTM A500, cold-formed steel tubing.
- E. Steel Pipe: ASTM A53, standard weight (Schedule 40) unless otherwise indicated.
- F. Hot dipped Galvanization: ASTM A123.

- G. Hot dipped Galvanization: ASTM A153.

2.3 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and perimeter concrete and masonry walls.
 - 1. Provide stainless-steel fasteners for fastening galvanized metals.
- B. Cast-in-Place Anchors in Concrete: Threaded type unless otherwise indicated; stainless steel castings. Provide bolts, washers, and shims as needed, all stainless steel.
- C. Post-Installed Anchors: Chemical epoxy set anchors.
 - 1. Material for all Locations: Type 304 stainless steel, unless otherwise indicated.

2.4 MISCELLANEOUS MATERIALS

- A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.
- E. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- F. Concrete: Comply with requirements in Section 03300 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 4000 psi.

2.5 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Use connections that maintain structural value of joined pieces.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.
- C. Weld corners and seams continuously to comply 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. At exposed connections, finish exposed welds and surfaces smooth and blended.
- D. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Locate joints where least conspicuous.
- E. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- F. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors not less than 24 inches o.c.

2.6 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
- C. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill or punch baseplates and top plates for anchor and connection bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness unless otherwise indicated.

2.7 LOOSE STEEL LINTELS

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated.
- B. Galvanize loose steel lintels located in exterior walls.

2.8 STEEL MONORAIL BEAMS

- A. Supply and install monorail beam system at location indicated on the drawings.
- B. Provide shop drawings showing mounting and spacing details to Engineer for review.
- C. Paint monorail beams to Section 09900 requirements.
- D. Refer to Section 14600 Hoisting Devices.
- E. Refer to Section 13300 Pre-Engineered Building Systems.
- F. Shop drawings to be sealed and signed by a Professional Engineer in the State of Michigan experienced in structural design.

2.9 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.

BARTON AND SOUTH INDUSTRIAL PUMP STATIONS ELECTRICAL IMPROVEMENTS

2.10 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
- B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
- C. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 FABRICATION

- A. All measurements and dimensions shall be based on field conditions and shall be verified by the Contractor prior to fabrication. Such verification shall include coordination with adjoining work.
- B. All fabricated work shall be shop fitted together as much as practicable, and delivered to the field, complete and ready for erection. All miscellaneous items such as stiffeners, fillets, connections, brackets, and other details necessary for a complete installation shall be provided.
- C. All work shall be fabricated and installed in a manner that will provide for expansion and contraction, prevent shearing of bolts, screws, and other fastenings, ensure rigidity, and provide a close fit of sections.
- D. Finished members shall conform to the lines, angles, and curves shown on the Drawings and shall be free from distortions of any kind.
- E. All shearings shall be neat and accurate, with parts exposed to view neatly finished. Flame cutting is allowed only when performed utilizing a machine.
- F. All shop connections shall be welded unless otherwise indicated on the Drawings or specified herein. Bolts and welds shall conform to Section 05050, Metal Fastening. All fastenings shall be concealed where practicable.
- G. Fabricated items shall be shop painted when specified in Section 09900, Painting.
 - 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. At exposed connections, finish exposed welds and surfaces smooth and blended.

3.2 INSTALLATION

- A. Assembly and installation of fabricated system components shall be performed in strict accordance with manufacturer's recommendations.
- B. All miscellaneous metalwork shall be erected square, plumb and true, accurately fitted, adequately anchored in place, and set at proper elevations and positions
- C. Metal work shall be field painted when as specified in accordance with Section 09900, Painting.

3.3 INSTALLING BEARING AND LEVELING PLATES

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
- C. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780.

END OF SECTION

SECTION 07190

VAPOR BARRIER

PART 1 – GENERAL

1.1 THE REQUIREMENT

- A. Furnish labor, material, equipment and appliances required for complete execution of Work shown on Drawings and specified herein.
- B. Principal items of work include:
 - 1. Vapor barrier below structural slabs on grade.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03300 - Cast-in-Place Concrete

1.3 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:
 - 1. Manufacturer's data and installation instructions.

PART 2 – PRODUCTS

2.1 VAPOR BARRIER

- A. Vapor Barrier: A reinforced laminate membrane with a minimum tensile strength of 75 lbs/in. in accordance with ASTM D-882, vapor transmission rating of 0.02 perms in accordance with E-96, and a puncture resistance of 25 lbs in accordance with ASTM D-4833.
- B. Adhesive/Tape: Type approved by the Manufacturer of the vapor material.

PART 3 – EXECUTION

3.1 VAPOR BARRIER

- A. Vapor barrier shall be placed on top of 4 inches minimum of compacted structural fill stone, free of debris and protrusions, as shown on the Drawings for structural slabs.
- B. Lap edges 12 inches and seal with adhesive tape. Lay with seams perpendicular to and lapped in the direction of placement. Do not penetrate vapor barrier.
- C. Protect from damage until concrete is placed. Punctures and tears in vapor barrier shall be repaired using patches of the material which overlaps puncture or tear a minimum of 12 inches; seal with tape or adhesive.

END OF SECTION

SECTION 07210

BUILDING INSULATION

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. Furnish labor, materials, equipment and appliances required for complete execution of Work as shown on Drawings and specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 03300 - Cast-in-Place Concrete
- B. Section 04200 Unit Masonry
- C. Pre-Engineered Building Insulation: Section 13300 – Pre-Engineered Building Systems

1.3 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of these specifications Work shall conform to applicable requirements of the following documents:
 - 1. HH-I-1972/1 Insulation Board, Thermal, Polyurethane or Polyisocyanurate, Faced with Aluminum Foil On one side.
 - 2. TT-S-001657 Sealing Compound Single Component, Butyl Rubber Based, Solvent Release Type (For Buildings and other Types of Construction).
 - 3. ASTM C 665 Specification for Mineral fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

1.4 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:
 - 1. Manufacturer's literature, specifications, installation instructions, technical data, and general recommendations.
 - 2. Samples of each type of insulation specified.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials in unopened, undamaged original packaging with bearing the manufacturer's name.
- B. Store materials in clean, dry, protected areas. Do not leave materials exposed to the weather or sunlight, except to the extent necessary to perform the work.
- C. Protect against ignition.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the requirements, provide products as manufactured by the following:
 - 1. Manufacturers of Extruded Polystyrene Board Insulation
 - a. Amoco Foam Products Company
 - b. Dow Chemical U.S.A.
 - c. UC Industries
 - 2. Manufacturers of Polyisocyanurate Foam Insulation
 - a. Apache Products Company
 - b. Atlas Energy Products
 - c. The Celotex Corporation

2.2 MATERIALS

- A. Under Slab and Foundation Wall Insulation: Extruded polystyrene extruded into 2 inch thick boards for under slabs and over foundation waterproofing, or as indicated on Drawings. Provide insulation conforming to the requirements of ASTM C 578, Type IV; with a 5 year aged R-value of 5 per inch.
- B. Cavity Wall Insulation: Extruded polystyrene insulation boards meeting or exceeding the requirements of ASTM C578, Type IV, and with a "K" factor of 0.20 or less when tested in accordance with ASTM C 518. Provide insulation 1-1/2 inches thick unless otherwise shown.
- C. Safing Insulation: Semi-rigid boards for use as fire stop. Materials shall conform to requirements of UL penetration systems. Safing material shall meet the requirements of ASTM E-136.
- D. Adhesive and Fasteners: Type compatible with insulation, masonry, concrete, or other substrate and as recommended or produced by the insulation manufacturer.
- E. Sealer and Tape: Type recommended by insulation manufacturer and having perm rating and fire resistance characteristics similar to that of the insulation.

PART 3 - EXECUTION

3.1 GENERAL

- A. Insulation shall be provided in walls, slabs where shown on Drawings.

3.2 INSTALLATION OF INSULATION

- A. Install in accordance with the manufacturer's printed installation instructions to provide

maximum sound and thermal benefits for material specified. Install to fill or cover voids. Cut neatly to snugly fit angles, corners and irregular areas and carefully wrapped around pipes, conduits, outlets, switches, beams, etc., to maintain continuity of insulation. Avoid gaps or bridges.

B. Foundation and Under-Slab Insulation

1. On vertical surfaces, set units in adhesive applied in accordance with manufacturer's instructions. Stagger vertical joints, except ends over line of expansion joints.
2. On horizontal surfaces, set units level, unless otherwise noted.

C. Cavity Wall Insulation

1. On vertical surfaces of masonry adhere to inner wythe of block.
2. Joints between insulation board units shall coincide with masonry joint reinforcing.

D. Safing Insulation: Install safing insulation in accordance with UL design requirements and in accordance with manufacturer's recommendations.

3.3 ADJUSTMENT AND CLEANING

- A. Adequately protect Work from damage resulting from subsequent construction operations. Replace damaged or soiled Work.

END OF SECTION

SECTION 07600

FLASHING AND SHEET METAL

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. Provide all flashing, trim and sheet metal Work as indicated on the Drawings, as required for the completed Work, and as specified herein. The Work shall include, but shall not be limited to, the following:
 - 1. Roof Flashings (various types).
 - 2. Wall Flashings (various types).
 - 3. Flashing at expansion joints.
 - 4. Flashing at roof mounted equipment and roof penetrations.

1.2 REFERENCES

- A. References and industry standards listed in this Section are applicable to the Work. Unless more restrictive criteria or differing requirements are explicitly stated in the Specifications, or mandated by governing codes or regulations, the recommendations, suggestions, and requirements described in the referenced standards shall be deemed mandatory and applicable to the Work.
- B. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
- C. Copper Development Association (CDA).
- D. American Society for Testing and Materials (ASTM).
- E. Federal Specifications (FS).

1.3 SUBMITTALS

- A. Shop Drawings
 - 1. Show the manner of forming, jointing, and securing the metal flashings and trim. Include expansion joint connections, and the method of forming waterproof connections to adjoining construction.
- B. Product Data
 - 1. Catalog sheets, specifications, installation instructions for each item specified except for shop or job formed items, solder, flux, and bituminous coating.
- C. Color samples: Color chart showing standard available color finishes for selected metal products.
- D. Guarantee
- E. Certificates of Qualifications

1.4 QUALITY ASSURANCE

- A. Except as otherwise shown or specified, comply with applicable recommendations, details, and standards of CDA, and SMACNA.
- B. All metal Work shall ink-stamped at intervals, identifying Manufacturer, type metal, and gage or thickness.
- C. Manufacturer's Recommendations
 - 1. For factory fabricated items, follow the manufacturer's recommendations and installation instructions unless specifically shown or specified otherwise.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle products of this Section in such manner to protect them from damage.

1.6 PROJECT CONDITIONS

- A. Make the roof and all uncompleted flashings watertight at the end of each work day.

PART 2 - PRODUCTS

2.01 MATERIALS FOR FLASHING FABRICATION

- A. Plain Copper Sheet
 - 1. Cold rolled copper, ASTM B 370, 16 ounce, mill finish.
- B. Lead Coated copper Sheet

Cold rolled copper, ASTM B 370. Lead coating; ASTM B101, Type 1 weighing 0.06 to 0.07 lbs per sq ft applied to each side.
- C. Stainless Steel Sheet: Counterflashings

Dead soft fully annealed stainless steel sheet, ASTM A167, Type 302/304, 2D dull finish, 26 gauge.
- D. Sheet Lead at drains and pipe flashings:

ASTM B29. Minimum Wgt. 4 lbs per sq ft.

2.02 MANUFACTURED MATERIALS

- A. Copper/fabric flashing: consisting of a full sheet of copper, weight of copper core not less than 5 ounces per square foot, permanently bonded to and between 2 layers of asphalt impregnated fiberglass fabric.
 - 1. Manufacturers
 - a. Afco Products, Inc.: Copper-fabric Flashing.
 - b. York Manufacturing, Inc.: Copper Fabric Flashing.

- c. Hohmann & Barnard, Inc.: Copper Fabric Flashing.

2.03 FASTENERS

A. Nails

- 1. "Stronghold" type large flat head roofing nail.
 - a. For Copper: Hardened copper.
 - b. For Stainless Steel: Stainless steel.

B. Screws, Bolts, and other Fastening Accessories

- 1. For Copper: Copper or brass.
- 2. For Stainless Steel: Stainless steel.

C. Anchors

- 1. Provide one of the following types:
 - a. Hammer driven anchors, consisting of a stainless steel drive pin and a corrosion resistant metal expansion shield inserted thru a stainless steel disc with an EPDM sealing washer.
 - b. Self-tapping, corrosion resistant, concrete and masonry screw inserted thru a stainless steel disc with an EPDM sealing washer.

A. Solder

Composition of block tin/pig lead of proportion recommended by the metal manufacturer, stamped either 50/50 or 60/40 "Warranted".

B. Flux

Paste or acid type as recommended by the metal manufacturer.

C. Bituminous Coating (for separating dissimilar metals):

FS TT-C494.

D. Type 2 Sealant (For concealed sealant joints of thru-wall cap receivers and other areas which require concealed sealant).

One part butyl rubber sealant; Tremco Reglet Joint Sealant, Pecora BC-158, PTI 707, or Woodmont chem-Calk 300.

E. Thru Wall Flashing Joint sealant:

Trowel grade asphalt flashing cement or gun-grade sealant, as recommended by the flashing manufacturer.

2.05 FABRICATION

- A. Where practicable, form and fabricate sheet metal Work in the factory or shop. Produce

bends and profiles accurately to the indicated shapes. Where not indicated or specified, follow the applicable requirements of the reference standards listed in PART 1.

B. Counterflashings:

1. Stainless Steel: 26 gauge (0.018") minimum.

C. Pitch Pans & Hoods:

1. Copper: 16 oz.

D. Cap Flashing: (one-piece)

1. Copper: 16 oz.
2. Lead Coated copper: 16 oz.
3. Stainless Steel: 26 ga (0.018").

E. Cap Flashing: (two-piece) With In-Wall or Thru-Wall cap Receiver: Thru-wall Coping Flashing. (Same metals as in B., above).

1. Cap Flashing: Three way mortar bond type receiver with snap fit cap flashing. Acceptable products: "Keystone Two-Piece cap Flashing" as manufactured by Keystone Flashing Co., 5119 N. Second Street, Philadelphia, PA 19120 and "Cheney Prefabricated Snap Lock Cap Flashing" as manufactured by Cheney Flashing Co., 623 Prospect St., Trenton, NJ 08605.
2. Thru-wall Coping Flashing: Three way mortar bond flashing. Acceptable Products: "Keystone Thru-wall Flashing" as manufactured by Keystone Flashing Co., 5119 North Second Street, Philadelphia, PA 19120 and "Cheney 3-way Sawtooth Thru-Wall Flashing" as manufactured by Cheney Flashing Co., 623 Prospect St., Trenton, NJ 08605.

F. Base Flashing:

Note: This base flashing is not to be used for roofs; refer to Roofing Sections for roof base flashing.

1. Copper: 20 oz.
2. Lead Coated copper: 20 oz.
3. Stainless Steel: 24 ga (0.025").

G. Formed Gravel Stops:

1. Copper: 20 oz.
2. Lead Coated Copper: 20 oz.
3. Stainless steel: 24 ga (0.025").

H. Extruded Aluminum Gravel Stop:

Complete system including gravel stop, extruded aluminum joint cover plates, concealed 0.025" aluminum joint flashing, fasteners and all other accessory components. Type F gravel stop as manufactured by Architectural Products Company, Covington, KY., or equivalent by W.P. Hickman Co., Asheville, NC.

1. Face Height: Closest manufacturer's standard dimension to face height shown on Drawings.
 2. Finish: Anodized; Color: As selected by the Project Architect.
- I. Shop-Formed Coping:
1. Copper: 20 oz.
 2. Lead Coated Copper: 20 oz.
 3. Stainless Steel: 24 ga (0.025").
- J. Factory Fabricated Formed Coping:
- Complete system including 0.063" aluminum coping, anchor plates, joint drainage system, concealed joint covers and all other accessory components. "Permasnap Coping" as manufactured by W.P. Hickman Company, Asheville, NC; or "Snap-Lok Coping" as manufactured by MM Systems Corp, Tucker, GA.
1. Finish: Anodized; color: as selected by Architect.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Coordinate the work of this Section with other Work for the correct sequencing of items which make up the entire system of weatherproofing or waterproofing.

3.2 PREPARATION

- A. Do not install the Work of this Section unless all necessary nailers, blocking and other supporting components have been provided.
- B. Do not install the Work of this Section unless all substrates are clean and dry.

3.3 INSTALLATION

- A. Isolation
- Separate dissimilar metals from each other with bituminous coating.
- B. Tinning and Soldering
1. Use soldering irons (heavy coppers) as Industry Standard. Torch soldering is not acceptable.
 2. Clean, flux and tin all surfaces to be soldered.
 3. Sweat solder thoroughly into seams, completely filling the seam for the full width.

4. Upon completion of soldering, remove all traces of flux residue, and if required, apply a neutralizing wash followed by a clean water wash.
- C. Installing In-Wall and Thru-Wall Cap Flashing Receivers
1. Set the receiver so there is mortar above and below the built-in portion.
 2. Do not mallet, bend or deform the exposed portion.
 3. Lap all end joints so they interlock at the first raised rib. Apply Type 3 sealant between the mating surfaces of the built-in portion of the receiver before interlocking end joints.
- D. Installing Cap Flashing Counterflashings
1. Form and install the cap counterflashings to provide a spring tight fit against the base flashing. Lap all end joints and base flashing a minimum of 3". Extend the cap continuously around corners or provide lock seams. Install waterstop flashing at expansion joints.
 2. Cap Flashing for Installation In Reglets:
 - a. Extend the built-in portion of the cap a min., of 3/4" into the reglet. Form the edge of the built in portion with a 1/4" hook dam.
 - b. Secure the cap with lead wedges 8" oc. Fill joint completely with Type 2 sealant and tool to a slightly concave surface.
 3. Surface Mounted Cap Flashing Counterflashing:
 - a. Form the top portion of the cap flashing which comes in contact with the wall surface with a 1" wide bearing surface. Form a 45 degree x 1/4" wide stiffener and calking flange along the top edge.
 - b. Apply Type 2 sealant on the back side of the bearing surface.
 - c. Secure the cap flashing to the wall with fasteners spaced 12" oc thru the bearing surface.
 - d. Apply Type 2 sealant along the calking flange.
 4. Pre-tin and solder with soldering irons (heavy coppers) all inside and outside corners.
 5. Where applicable, release existing soldered lap with soldering iron, install base flashing, dress down and re-solder existing lap.
- E. Dressing Down Existing Cap Flashing
1. Turn up all cap flashings as required to perform the Work. Upon completion of the Work, dress down all disturbed cap flashings so they lie flat against the base flashing.
 2. Secure the cap flashing to the wall surface with fasteners spaced 18" oc.

3. Install matching metal patches at corners of cap flashings which have been cut to perform the Work. Lap the patches a minimum of 1" on each side of the cap flashing.
 - a. Secure the patch by pop-riveting or by soldering.

F. Installing Base Flashings

1. Form the base flashing with locked and soldered joints into lengths not more than 24'-0" oc.
2. Provide expansion joints a maximum of 24'-0" oc on straight runs and a maximum of 4' from corners. Form expansion joints with a 3" loose locked seam filled with Type 2 Sealant.
 - a. Expansion Joint: slit the cross folded portion of the flashing where it is bent at a right angle. Solder a patch over the slit to avoid binding at the cross fold.
3. Extend the vertical portion of the base flashing a minimum of 3" up behind the cap flashing.
 - a. Where shown on the Drawings, lock the base flashing to the cap flashing with a minimum 3/4" loose lock joint.
4. Extend the horizontal portion of the base flashing onto the roof surface a minimum of 4" and terminate in a 1/2" folded edge. Secure with nails spaced 3" oc staggered.

G. Installing Formed Metal Gravel Stops

1. Form the gravel stop into lengths not exceeding 8'-0". Allow 1/4" between sections for expansion.
2. Install a continuous edge strip secured 8" oc.
3. Install a 12" wide concealed splice plate at all joints. Form the splice plate to the exact shape of the gravel stop. Center the splice plate beneath the joints of the gravel stop and secure to the roof deck.
4. For single ply membranes: Apply the membrane manufacturer's recommended sealant between the contact surface of the horizontal portion of the splice plate and the gravel stop.
5. Extend the horizontal portion of the gravel stop onto the roof surface a minimum of 4" and terminate in a 1/2" folded edge. Secure with nails spaced 3" oc staggered. Hook the drip edge of the gravel stop over a continuous metal edge strip.
6. Where gravel stop face height exceeds 8", provide a longitudinal break at the center line unless shown otherwise on the Drawings.
7. Provide a 6" long exposed matching cover at all joints, fabricated to conform to the shape of the gravel stop.

I. Installing Extruded Aluminum Gravel Stop

1. Install 12" wide, 0.025" concealed aluminum flashing beneath the gravel stop at all joints.
 2. For single ply Membranes: Apply the membrane manufacturer's recommended sealant between the contact surfaces of the horizontal portion of the splice plate and the gravel stop.
 3. Secure the gravel stop at the mid point, and at ends of each 10'-0" section. Allow a 1/2" space between each section for expansion.
 4. Provide a 6" long, exposed matching aluminum cover at all joints, fabricated to conform to the shape of the gravel stop.
- I. Installing Formed Metal Coping
1. Form the coping into lengths not exceeding 8'-0".
 2. Join coping sections with 1-1/2" loose locked seams filled with Type 3 sealant.
 3. Hook the front and back edges of the coping over continuous metal edge strips. Nail the edge strip 6" oc.
- J. Installing Factory Fabricated Formed Metal Coping
- Install in accordance with the manufacturer's written instructions unless shown or specified otherwise.
- K. Installing manufactured copper/fabric flashing.
1. Installation
 - a. All surfaces to receive the copper/fiberglass fiber flashing shall be reasonably smooth, free from irregularities.
 - b. On all horizontal surfaces lay flashing either in a fresh bed of mortar above and below or, when recommended by the manufacturer, a trowel coat of mastic. Spot vertical surfaces with asphalt mastic to hold flashing in place and secure as detailed.
 - c. Install the flashing in continuous lengths with the minimum number of joints. Door and window flashing shall be installed in one continuous length from side to side.
 - d. At corners, beams, columns, and at other junctures, fit flashing to the proper contour.
 - e. Terminate the flashing 1/16" back from the exposed face of masonry wall, except at masonry indicated to have deeply raked joints.
 2. Joints: Lap joints at least 4", cemented with asphalt mastic.
 3. Provide stainless steel sealant edge flashing as indicated on the Drawings, for proper sealant adhesion. Form flashing as required to suit lipped brick or other configuration. Adhere to relieving angle with mastic where necessary.

END OF SECTION

SECTION 07840

FIRESTOPPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Fireproof, firestopping and firesafing material, and accessories including sealants, intumescent caulks, mineral wool, collars, silicones, mortars and pillows and foam backers.
- B. Providing firestopping at penetrations of all rated assemblies as called for on the drawings or required by the building inspection authority.
- C. Providing firestopping at all penetrations into fire rated rooms pursuant to all local, state and national codes.

1.2 RELATED SECTIONS

- A. Section 04200 – Unit Masonry
- B. Section 07210 – Building Insulation.
- C. Section 07900 – Joint Sealants.

1.3 REFERENCES

- A. ASTM E84 - Test Method for Surface Burning Characteristics of Building Material.
- B. ASTM E119 - Method of Fire Test of Building Construction and Material.
- C. ASTM E814 - Test Method of Fire Tests of Through-Penetration Firestops.
- D. UL - Underwriters Laboratories; Building Materials Fire Resistance Director.

1.4 SUBMITTALS

- A. Product Data: Provide data on product characteristics, performance and limitation criteria, and other pertinent performance data.
- B. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
- C. Manufacturer's Certificate: Provide manufacturer's certificate certifying that products meet or exceed specified requirements.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in the section with minimum five years documented experience.
- B. Applicator: Company specializing in performing the work of this section with minimum three years documented experience on projects of similar scope..

1.07 REGULATORY REQUIREMENTS

- A. Conform to applicable codes for fire resistance ratings and surface burning characteristics.
- B. Provide certificate of compliance from code authorities having jurisdiction indicating approval of combustibility.
- C. All materials to bear the U.L. Label Classification.

1.08 ENVIRONMENTAL REQUIREMENTS.

- A. Do not apply materials when temperature of substrate material and ambient air is below 60 degrees F (15 degrees C).
- B. Maintain this minimum temperature before, during, and after for 3 days after installation of materials.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Grace Construction Products, W.R. Grace & Company.
- B. Hilti Firestop Systems.
- C. USG Fire Stop Systems.

2.2 MATERIALS

- A. Firestopping Material: Permanent, non toxic, multiple component silicon elastomeric foam or water-based intumescent sealant compound, used in conjunction with mineral fiber stuffing insulation, used in proportions and quantities necessary to maintain building element fire ratings as referenced on drawings.
- B. Primer: Type recommended by firestopping manufacturer for specific substrate surface.

2.3 ACCESSORIES

- A. Forming or Dam Material: U.L. classified mineral wool insulation minimum 4 pcf density in thicknesses required by application and U.L. test assembly.
- B. Intumescent firestop collars.
- C. Mortars: Vinyl type formulation compounds designed for mixing with water. Color: Red.

2.3 FINISHES

- A. Color: Dark gray or black.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that openings are ready to receive the work of this section.

3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter which may affect bond of firestopping material.
- B. Remove incompatible materials which affect bond.
- C. Install backing materials to arrest liquid material leakage.

3.3 APPLICATION

- A. Apply primer and materials in accordance with manufacturer's instructions and in accordance with UL systems tested assemblies.
- B. Apply firestopping material in sufficient thickness to achieve ratings, and to uniform density and texture.
- C. Install material at walls or partition openings which contain penetrating sleeves, piping, ductwork, conduit and other items requiring firestopping.
- D. Remove dam material after firestopping material has cured.

3.4 CLEANING

- A. Clean adjacent surfaces of firestopping materials.

END OF SECTION

SECTION 07900

JOINT SEALANTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Contractor shall provide all labor, materials, tools, equipment and incidentals as shown, specified and required to furnish and install calking and sealants.

1.2 RELATED SECTIONS

- A. Section 04200 – Unit Masonry
- B. Section 08800 – Glass and Glazing.
- C. Section 08110 – Hollow Metal Doors and Frames.

1.3 REFERENCES

- A. ASTM C510, Test Method for Staining and Color Change of Single-or Multicomponent Joint Sealants.
- B. ASTM C661, Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer.
- C. ASTM C793, Test Method for Effects of Accelerated Weathering on Elastomeric Joint Sealants.
- D. ASTM C794, Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
- E. ASTM C920, Standard Specification for Elastomeric Joint Sealants
- F. Federal Specification, FS TT-S-00227, Sealing Compound - Elastomeric Type, Multi-component for Calking, Sealing, and Glazing in Buildings and Other Structures.
- G. Federal Specification, FS TT-S-001657 Sealing Compound - Single Component, Butyl Rubber Based, Solvent Release Type.

1.4 PERFORMANCE REQUIREMENTS

- A. Extent of each type of calking and sealant includes the following:
 - 1. All joints between concrete members and masonry.
 - 2. All concrete to concrete joints.
 - 3. All metal to metal joints.
 - 4. All joints between masonry and metal.
 - 5. All expansion joints in masonry and concrete.
 - 6. All control joints.

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7. All sound-sealed and air-sealed joints.
8. As an exposed-to-view finish on the exposed face of all fire-rated sealants.
9. On both sides of all terminations of all construction systems, specified to receive calking and sealants, where construction system remains exposed to view in the finished Work.
10. All isolation joints between equipment and other items.
11. All joints where construction systems are discontinuous or inherently non-watertight.
12. All locations whether or not shown, required to render the building watertight, except where a construction system is specified or shown as not relying upon the use of sealants in order to achieve weather-and watertightness.

1.5 SUBMITTALS

A. Samples:

1. Each type of actual cured material samples of each calking and sealant specified, 3-inches long, in each of the manufacturer's standard colors.
2. Each size and type of sealant backer rod, 3-inches long, as recommended by the calking and sealant manufacturer.
3. Bond breaker tape as recommended by the manufacturer.
4. Samples will be reviewed by Engineer for color and texture only. Compliance with other requirements is the responsibility of Contractor.

B. Shop Drawings:

1. Copies of manufacturer's specifications, recommendations and installation instructions for each type of sealant, caulking compound and associated miscellaneous material required. Include manufacturer's published data, indicating that each material complies with the requirements and is intended for the applications shown.
2. Pre-Installation Meeting report, as specified.

C. Test Reports:

1. Compatibility tests for substrates, based on adhesion-in-peel standard test procedures and FS TT-S-0027.
2. Certified laboratory test reports indicating conformance with the requirements.

D. Guarantee:

1. Copies of written guarantee agreeing to repair or replace sealants which fail to perform as specified.

1.6 WARRANTY

- A. Provide a written guarantee agreeing to repair or replace sealants which fail to perform as air-tight and watertight joints; or fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability; or appear to deteriorate in any other manner not clearly specified by submitted manufacturer's data, as an inherent quality of the material for the exposure indicated. Provide guarantee signed by installer and Contractor. Provide guarantee period of two years from Final Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Type of product used shall be per the Sealant Schedule.
- B. Sealants:
1. Type 1: Multi-component, non-sag, low-modulus polyurethane rubber sealant meeting ASTM C920, Type M, Grade NS, Class 25, use NT, M, A, and O. Capable of withstanding 50% in extension or compression such as Sikaflex-2C NS/SL, Sika Corporation Lyndhurst, NY, or Sonolastic SL-1, Sonneborn, Minneapolis, MN, or DynaTrol II by Pecora Corporation.
 2. Type 2: Single component polyurethane sealant meeting ASTM C920, Type S, Grade NS, Class 25, Use NT, M, A, and O. Capable of withstanding 25% in extension or compression such as Magnum NS-100, Tamms Industries, or Sikaflex 1A, Sika Corporation, Lyndhurst, NY, DynaTrol 1-XL by Pecora Corporation.
 3. Type 3: Single component, low-modulus moisture curing silicone meeting ASTM C920, Type S, Grade NS, Class 25, Use NT, M, G, and A. Capable of withstanding 50% extension and compression. Pecora 890 by Pecora Corporation or equal as approved by Engineer and Owner.
 4. Type 4: Single component, mildew resistant, moisture-curing silicone meeting ASTM C920, Type S, Grade NS, Class 25, Use NT, M, G, and A. Pecora 898 by Pecora Corporation or equal as approved by Engineer and Owner.
 5. Type 5: Single component, acrylic latex meeting ASTM C834. AC-20+ Silicone by Pecora Corporation or equal as approved by Engineer and Owner.
 6. Type 6: High grade butyl sealant meeting Federal Specification TT-S-00-1657. BC-158 by Pecora Corporation or equal as approved by Engineer and Owner.
 7. Type 7: Multi-component chemical resistant polysulfide sealant conforming to ASTM C920, Type M, Grade NS, Class 25 such as Sonolastic Two-part, Sonneborn, Minneapolis, MN, Hornflex-L, Tamms, Beltsville, MD, or Cormax PSC, DuPont, Synthacalk GC2+ by Pecora Corporation.
 8. Type 8: Nonsag, multi component, traffic grate polyurethane sealant meeting ASTM C920, Type 19, Grade NS, Class 25, use T, M, A, and O. DynaTread by Pecora Corporation.

- B. Primer: Non-staining primer recommended by sealant manufacturer for the substrates on this project.
- C. Backer Rod: Closed cell foam, nonreactive with caulking materials, non-oily, and approved by the sealant manufacturer. Minimum density shall be 3.24 pounds per cubic foot. Use no asphalt or bitumen-impregnated fiber with sealants.
- D. Joint Cleaner: Recommended by sealant or caulking compound manufacturer.
- E. Bond breaker: Either polyethylene film or plastic tape as recommended by the sealant manufacturer.
- F. Color: Where manufacturer's standard colors do not closely match materials being sealed, provide a custom color.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Contractor and installer shall examine joint surfaces, substrates, backing, and anchorage of units forming sealant rabbet, and the conditions under which the calking and sealant Work is to be performed, and notify Engineer, in writing, of any conditions detrimental to the proper and timely completion of the Work and performance of the sealants. Do not proceed with the calking and sealant Work until unsatisfactory conditions have been corrected in a manner acceptable to Engineer.

3.2 PREPARATION

- A. Protect finished surfaces adjoining by using masking tape or other suitable materials.
- B. Clean joint surfaces immediately before installation of sealant compound. Remove dirt, weakly adhering coatings, moisture and other substances which would interfere with bonds of sealant compound as recommended by sealant manufacturer's written instructions as shown on approved Shop Drawings.
- C. Etch concrete and masonry joint surfaces to remove excess alkalinity, unless sealant manufacturer's written instructions, as shown on approved Shop Drawings, indicate that alkalinity does not interfere with sealant bond and performance.
 1. Etch with five percent solution of muriatic acid.
 2. Neutralize with dilute ammonia solution.
 3. Rinse thoroughly with water and allow to dry before sealant installation.
- D. If necessary, clean porous materials such as concrete and masonry by grinding, sand blasting or mechanical abrading. Blow out joints with oil-free compressed air, or by vacuuming joints prior to application of primer or sealant.
- E. Roughen joint surfaces on vitreous coated and similar non-porous materials, wherever sealant manufacturer's data indicates lower bond strength than for porous surfaces. Rub with fine abrasive cloth or steel wool to produce a dull sheen.

3.3 INSTALLATION

- A. Comply with sealant manufacturer's written instructions except where more stringent requirements are shown or specified and except where manufacturer's technical representative directs otherwise; but only as approved by Engineer.
- B. Prime or seal the joint surfaces as shown on approved Shop Drawings. Do not allow prime or sealer to spill or migrate onto adjoining surfaces. Allow primer to dry prior to application of sealants.
- C. Apply masking tape before installation of primer, in continuous strips in alignment with the joint edge to produce sharp, clean interface with adjoining materials. Remove tape immediately after joints have been sealed and tooled as directed.
- D. Do not install sealants without backer rods or bond breaker tape.
- E. Roll the back-up rod stock into the joint to avoid lengthwise stretching. Do not twist, braid, puncture or prime backer-rods.
- F. Employ only proven installation techniques, which will ensure that sealants will be deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of the joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and a vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.
- G. Install sealants to depths as recommended by the sealant manufacturer but within the following general limitations, measured at the center (thin) section of the bead.
 - 1. For horizontal joints in sidewalks, pavements and similar locations sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to a depth equal to 75 percent of joint width, but not more than 5/8-inch deep or less than 3/8-inch deep.
 - 2. For vertical joints subjected to normal movement and sealed with elastomeric sealants, but not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but not more than 1/2-inch deep or less than 1/4-inch deep.
- H. Remove excess and spillage of compounds promptly as the Work progresses.
- I. Cure caulking and sealant compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability.

3.4 FIELD QUALITY CONTROL

- A. Where questions of compatibility of sealants and substrate arise, the sealant manufacturer shall test the substrate in question for compatibility with the specified sealant and report his findings, along with recommendations, to Engineer.
- B. Do not proceed with installation of elastomeric sealants over joint surfaces which have been painted, lacquered, waterproofed or treated with water repellent or other treatment or coating unless a laboratory test for durability (adhesion), in compliance with FS TT-S-00227 has successfully demonstrated that sealant bond is not impaired by the coating or

treatment. If laboratory test has not been performed, or shows bond interference, remove coating or treatment from joint surfaces before installing sealant.

- C. After nominal cure of exterior joint sealants which are exposed to the weather, test for water leaks. Flood the joint exposure with water directed from a 3/4-inch diameter garden hose, without nozzle, held perpendicular to wall face, 2 feet -0 inch from joint and connected to a water system with 30 psi minimum normal water pressure. Move stream of water along joint at an approximate rate of 20 feet per minute.
- D. Test approximately five percent of total joint system, in locations which are typical of every joint condition, and which can be inspected easily for leakage on opposite face. Conduct test in the presence of Engineer, who will determine the actual percentage of joints to be tested and the actual period of exposure to water from the hose, based upon the extent of observed leakage, or lack thereof.
- E. Where nature of observed leakage indicates the possibility of inadequate joint bond strength, Engineer may direct that additional testing be performed at a time when joints are fully cured, and before Substantial Completion of the Work.
- F. Do not paint sealant, unless recommended by sealant and paint manufacturer.

3.5 ADJUSTING

- A. Allow sealants to cure and remove protective edging, of doors, louvers, saddles windows etc. as directed by the Owner.
- B. Repair sealant installation at leaks or, if leakage is excessive, replace sealant installation.

3.6 CLEANING

- A. Clean adjacent surfaces of sealant and soiling resulting from the Work. Use solvent or cleaning agent recommended by the sealant manufacturer. Leave all finish Work in a neat and clean condition.
- B. Remove misplaced sealant compounds promptly using methods and materials recommended by the manufacturer, as the work progresses.

Sealant Schedule

Application	Sealant	Color
Vertical and horizontal joints bordered on both sides by concrete, masonry, precast concrete, natural stone or other porous building material.	Type 2	To closely match adjacent surfaces or mortar and as selected by the Owner.
Vertical and horizontal joints bordered on both sides by painted metals, anodized aluminum, mill finished aluminum, PVC, glass or other non-porous building material.	Type 3	To closely match adjacent surfaces and as selected by the Owner.
Masonry expansion and control joints less than 1¼" wide.	Type 2	To closely match adjacent surfaces and as selected by the Owner.
Masonry expansion and control joints equal or greater than 1 ¼ inches wide.	Type 1	To closely match adjacent surfaces and as selected by the Owner.
Interior – wood trim and finish joints.	Type 5	Color to be selected by Owner
Sanitary areas, joints in ceramic tile, around plumbing fixtures, countertops, and back splashes. See Note 1.	Type 4	To closely match adjacent surfaces and as selected by the Owner.
Perimeter sealing of doors, windows, louvers, piping, ducts, and electrical conduit. See Note 2.	Type 2 or Type 3	To closely match adjacent surfaces and as selected by the Owner.
Below thresholds.	Type 6	Manufacturer's standard
Submerged in liquids. See Note 4.	Type 1	Manufacturer's standard
Submerged in liquids with high concentration of chlorine (> 2 ppm).	Type 7	Manufacturer's standard
Horizontal Joints exposed to vehicular or pedestrian traffic.	Type 8	To closely match adjacent surfaces.
Other joints indicated on the drawings or customarily sealed but not listed.	Type recommended by manufacturer	To closely match adjacent surfaces and as selected by the Owner.

Notes:

1. Provide UL approved sealants for penetrations thru fire-rated walls and as specified in Section 07840.
2. Sealants which will come in contact with potable water shall meet the requirements of NSF 61/AWWA.

BARTON AND SOUTH INDUSTRIAL PUMP STATIONS ELECTRICAL IMPROVEMENTS

3. Where sealant will be immersed in liquid chemicals verify compatibility prior to installation of sealant.

END OF SECTION

SECTION 08110

HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes hollow-metal doors and frames.
- B. Furnish labor, material, equipment and appliances required for complete execution of work shown on drawings and specified herein.

1.2 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 08710 – Finish Hardware

1.4 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. Without limiting the generality of these specifications, the work shall conform to the applicable requirements of the following documents:
 - 1. ANSI/DHI A115 Series Specifications for Steel Door and Frame Preparation for Hardware
 - 2. ANSI/SDI 100 Recommended Specifications: Standard Steel Doors and Frames
 - 3. ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
 - 4. ASTM A366/A 366M Standard Specification for Steel, Sheet, Carbon, Cold-Rolled Commercial Quality
 - 5. ASTM A525 Standard Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
 - 6. ASTM E152 Standard Methods of Fire Tests of Door Assemblies
 - 7. NFPA 80 Standard for Fire Doors and Windows

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Shop Drawings: Include elevations, door edge details, frame profiles, metal thicknesses, preparations for hardware, and other details.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: For each type of exposed finish required.
- E. Schedule: Prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings.

1.6 INFORMATIONAL SUBMITTALS

- A. Product test reports.

1.7 QUALITY ASSURANCE

- A. Comply with ANSI/SDI 100.
- B. Locations where fire-rated door and frame assemblies are required, provide assemblies which comply with NFPA 80 and have been tested and labeled in accordance with ASTM E152 by agency acceptable to governing authorities.
- C. Provide certificate or label for fire-rated doors which exceed sizes tested from a independent testing and inspection agency. Certificate or label shall indicate that door and frame assembly conforms to the requirements of the design.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Deliver products boxed or crated suitable for storage.
- B. Store products under cover, raised above ground level, and stacked to prevent warping and damage.
- C. Replace items damaged during delivery, storage, or handling.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Ceco Door Products
 - 2. Hollow Metal Inc.
 - 3. Republic Doors and Frames.
 - 4. Steelcraft

2.2 REGULATORY REQUIREMENTS

- A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
 - 1. Smoke- and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.
- B. Fire-Rated, Borrowed-Light Assemblies: Complying with NFPA 80 and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

2.3 INTERIOR DOORS AND FRAMES

- A. Heavy-Duty Doors and Frames: Interior Doors: SDI 100, Grade II, heavy-duty, Model 3, seamless, 16 gauge.
 - 1. Physical Performance: Level B according to SDI A250.4 (minimum).
 - 2. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.
 - b. Thickness: 1-3/4 inches.
 - c. Face: Commercial quality hot or cold rolled. Galvanize sheet steel in accordance with ASTM A525, commercial quality, A60 zinc coating, mill phosphatized.
 - d. Edge Construction: Seamless.
 - e. Core: Polyurethane
 - 3. Frames:
 - a. Materials: steel sheet, minimum thickness of 0.053 inch.
 - b. Construction: welded.
 - 4. Exposed Finish: Prime and Paint per Section 09900.

2.4 EXTERIOR HOLLOW-METAL DOORS AND FRAMES

- A. Heavy-Duty Doors and Frames: Exterior Doors: DSI-100, Grade III, extra heavy-duty, Model 4, seamless, 14 gauge.
 - 1. Physical Performance: Level B according to SDI A250.4 (minimum).
 - 2. Doors:
 - a. Type: As indicated in the Door and Frame Schedule.

- b. Thickness: 1-3/4 inches.
 - c. Face: Commercial quality hot or cold rolled. Galvanize sheet steel in accordance with ASTM A525, commercial quality, A60 zinc coating, mill phosphatized.
 - d. Edge Construction: Seamless.
 - e. Core: Polyurethane.
3. Frames:
- a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch with minimum A40 (ZF120) coating.
 - b. Construction: welded.
4. Exposed Finish: Prime.

2.5 FRAME ANCHORS

- A. Jamb Anchors:
- 1. Masonry Type: Existing masonry wall anchors to suit 3/8" diameter stud anchors. Minimum 16 Ga.
- B. Floor Anchors: Formed from same material as frames, minimum thickness of 0.042 inch and as follows:
- 1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
 - 2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at finish floor surface.

2.6 MATERIALS

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
- B. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- C. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- D. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B.
- E. Frame Anchors: ASTM A 879/A 879M, Stainless Steel.
- F. Inserts, Bolts, and Fasteners: Stainless Steel.
- G. Power-Actuated Fasteners in Concrete: Stainless steel.

- H. Grout: ASTM C 476, except with a maximum slump of 4 inches, as measured according to ASTM C 143/C 143M.
- I. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing).
- J. Glazing: Section 088000 "Glazing".
- K. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15-mil dry film thickness per coat.

2.7 FABRICATION

- A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Hollow-Metal Doors:
 - 1. Exterior Doors: Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
 - 2. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated.
- C. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
 - 1. Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
 - 2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
 - 4. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.
 - 5. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Masonry Type: Locate anchors not more than 16 inches from top and bottom of frame. Space anchors not more than 32 inches o.c., to match coursing, and as follows:
 - 1) Three anchors per jamb from 60 to 90 inches high.

- 2) Four anchors per jamb from 90 to 120 inches high.
 - 3) Four anchors per jamb plus one additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.
6. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers.
- a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
 - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
- D. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.
- 1. Refer to Specification Section 08710, Finish Hardware. Factory prepare hollow metal door to receive panic hardware with electronic trim, electronic power transfer, power supply, wiring and related devices.
 - 2. Reinforce doors and frames to receive non-templated, mortised, and surface-mounted door hardware.
 - 3. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.
- E. Stops and Moldings: Provide stops and moldings around glazed lites and louvers where indicated. Form corners of stops and moldings with mitered hairline joints.
- 1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow-metal work.
 - 2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
 - 3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
 - 4. Provide loose stops and moldings on inside of hollow-metal work.
 - 5. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.

2.8 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
 - 1. Shop Primer: SDI A250.10.
- B. Factory Finish: SDI A250.3.
 - 1. Color and Gloss: As selected by Owner from manufacturer's full range.

2.9 ACCESSORIES

- A. Mullions and Transom Bars: Provide removable, refer to drawings.
- B. Provide top and bottom closures on all doors, weather tight cap on all exterior doors.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Hollow-Metal Frames: Install hollow-metal frames of size and profile indicated. Comply with SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.
 - 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - a. At fire-rated openings, install frames according to NFPA 80.
 - b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
 - c. Install frames with removable stops located on secure side of opening.
 - d. Install door silencers in frames before grouting.
 - e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - f. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
 - g. Field apply bituminous coating to backs of frames that will be filled with grout containing antifreezing agents.
 - 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
 - 3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
 - 4. Concrete Walls: Solidly fill space between frames and concrete with mineral-fiber insulation.
 - 5. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

6. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.

- B. Hollow-Metal Doors: Fit hollow-metal doors accurately in frames, within clearances specified below. Shim as necessary.
 1. Non-Fire-Rated Steel Doors:
 - a. Between Door and Frame Jambs and Head: 1/8 inch plus or minus 1/32 inch.
 - b. Between Edges of Pairs of Doors: 1/8 inch to 1/4 inch plus or minus 1/32 inch.
 - c. At Bottom of Door: 5/8 inch plus or minus 1/32 inch
 - d. Between Door Face and Stop: 1/16 inch to 1/8 inch plus or minus.
 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
 3. Smoke-Control Doors: Install doors and gaskets according to NFPA 105.

- C. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.
 1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

3.2 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.
- B. Remove grout and other bonding material from hollow-metal work immediately after installation.
- C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

- D. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- E. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION

SECTION 08334

OVERHEAD ROLLING DOORS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Requirements for supply and installation of overhead rolling door and hardware.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Metal Fabrication Section 05500
- B. Painting Section 09900
- C. Pre-Engineered Building Systems Section 13300
- D. Electrical Division 16

1.3 SHOP DRAWINGS

- A. Submit shop drawings to the Engineer for approval.
- B. Shop drawings shall indicate the following:
 - 1. All details required for complete operation and installation.
 - 2. Hardware locations.
 - 3. Type of metal and finish for door sections.
 - 4. Finish for miscellaneous components and accessories.
- C. Product Data: Indicating manufacturer's product data and installation instructions.

1.4 REFERENCE STANDARDS

- A. ANSI/DASMA 203 American National Standards Institute Specifications for non-rated fire rolling doors published by Door & Access Systems Manufacturers Association International.
- B. ASTM A123 Zinc [hot-dipped galvanized] coatings on iron and steel products.
- C. ASTM A229 Steel wire, oil-tempered for mechanical springs.
- D. ASTM A-653-94 Steel sheet, zinc-coated [galvanized] by the hot-dipped process, commercial quality.
- E. ASTM E330 Structural performance of exterior windows, curtain walls, and doors by uniform static air pressure difference.

- F. ASTM E413-87 Sound transmission class acoustical performance value = 22.

1.5 QUALITY ASSURANCE

- A. Rolling doors and all accessories and components required for complete and secure installations shall be manufactured as a system from one manufacturer.

1.6 SYSTEM DESCRIPTION

- A. Rolling Door: Type: Thermotite Model 800C by Wayne Dalton or approved equal.
- B. Mounting: steel jambs
- C. Operation: motor with chain hoist
- D. Material: Aluminum with powder coated finish

1.7 DELIVERY, HANDLING AND STORAGE

- A. Deliver products in manufacturers original containers, dry, undamaged, seals and labels intact.
- B. Store and protect products in accordance with manufacturers recommendations.

1.8 WARRANTY

- A. Standard manufacturers one year warranty against defects in material and workmanship.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Curtain:
 - 1. Curtain will be composed of interlocking #14 flat slats 16 gauge B&S aluminium, 22 gauge B&S aluminium back slats, roll-formed per ASTM standards. The area between the #14 exterior slat and the back slat will be filled by polyurethane insulation, R-value of 7.7 (U = 0.15). Curtain designed to withstand a 20 PSF windload. Ends of alternate/continuous slats will be fitted with metal endlocks/windlocks.
 - 2. Bottom Bar will consist of two equal steel angles, .121" minimum thickness, to stiffen curtain, with astragal. For additional security, provide slide bolts on the bottom bar operable from coil side.
- B. Guides:
 - 1. Guides will be roll-formed steel channel bolted to angle or structural grade, three angle assembly of steel to form a slot of sufficient depth to retain curtains in guides to achieve 20 PSF windload standard. Guides to be provided with integral windlock bars and removable bottom bar stops.

- C. Brackets:
1. Brackets will be of 3/16 minimum thick steel plates, with permanently sealed ball bearings. Designed to enclose ends of coil and provide support for counterbalance pipe at each end.
- D. Counterbalance
1. Curtain to be coiled on a pipe of sufficient size to carry door load with deflection not to exceed .033" per foot of door span and to be correctly balanced by helical springs, oil tempered torsion type. Cast iron barrel plugs will be used to anchor springs to tension shaft and pipe.
- E. Hood
1. Hood will be minimum 24-gauge sheet metal, flanged at top for attachment to header and flanged at bottom to provide longitudinal stiffness. Hood will enclose curtain coil and counterbalance mechanism. A flexible hood baffle to be included.
- F. Motor Operator:
1. Provide operator complete with control and standards as outlined in Division 16 of Specifications.
 2. Motor operator to be Model GCL-MJ Medium-Duty door control system as manufactured by the Genie Company and suitable for the type and size of door specified and as shown on the Contract Drawings. Motor to be AC 1/2 HP, 115 volt, single phase, 60 Hz, vertical mount complete with Solenoid brake, emergency chain operator, safety interlock, limit switch, overload protection, standard photo electric eyes and 3 button pushbutton control station. Doors to be operable by remote control. Provide 8 remote controls per door.
 3. Floor level disconnect lever to have plastic coated handle and no sharp edges.
 4. Door to be equipped with Electro-Mechanical Safety bar.
- G. Finish
1. Shop coat of rust inhibitive primer on non-galvanized surfaces and operating mechanisms. Guides and bracket plates will be coated with a flat black prime paint. Powder coating colour finish. Color to be chosen by OWNER during construction.
- H. Operation
1. Door will be operated by means of motor operation. Electrical sensing edge to be attached to bottom bar to stop and reverse the door when it contacts an object during the closing cycle.
- I. Weatherstripping
1. Doors will include bottom astragal, surface guide weatherstrip, and internal hood baffle weatherstrip and lintel brush weatherstrip.

- J. Locking
 - 1. Electric-motor operation doors will lock through the operator gearing. Electric interlocks to be provided to prevent operation when lock bolts are engaged in the guides, thus preventing damage to the curtain and/or operator.
- K. Windload
 - 1. Windload minimum 20 psf per DASMA 102-2003 and as required by local codes.

PART 3 – EXECUTION

3.1 ERECTION

- A. General:
 - 1. Install doors in accordance with manufacturer's instructions and standards. Installation shall be by an authorized manufacturer's representative.
 - 2. Verify that existing conditions are ready to receive rolling door work.
 - 3. Beginning of rolling door work means acceptance of existing conditions. .
- B. Install door complete with necessary hardware, jamb and head mold strips, anchors, inserts, hangers, and equipment supports in accordance with final shop drawings, manufacturer's instructions, and as specified herein.
- C. Fit, align and adjust rolling door assemblies level and plumb for smooth operation.
- D. Upon completion of final installation, lubricate, test and adjust doors to operate easily, free from warp, twist or distortion and fitting for entire perimeter.
- E. Door to be set up complete including internal wiring and set up of limits, limit switches and safety bar. Power supply and external wiring by Division 16.

3.2 PAINTING

- A. Shop finish powder coating. Color to be selected at time of construction.

END OF SECTION

SECTION 08520

ALUMINUM WINDOWS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all aluminum windows.

1.2 RELATED SECTIONS

- A. Section 07920 – Caulking and Sealants.
- B. Section 08800 – Glass and Glazing.

1.3 REFERENCES

- A. AAMA 101, Voluntary Specifications for Aluminum Prime Windows and Sliding Glass Doors.
- B. AAMA 302.8, Specification for Aluminum Windows.
- C. AAMA 701-702, Voluntary Specification for Pile Weatherstrip and Replaceable Fenestration Weatherseals.
- D. AAMA GS-001, Guide Specifications for Aluminum Architectural Windows.
- E. ASTM B117, Practice for Operating Salt Spray (Fog) Apparatus.
- F. ASTM B221, Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- G. ASTM D522, Test Methods for Mandrel Bend Test of Attached Organic Coatings.
- H. ASTM D523, Test Method for Specular Gloss.
- I. ASTM D968, Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive.
- J. ASTM D1308, Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
- K. ASTM D 2244, Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
- L. ASTM D2247, Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
- M. ASTM D4214, Test Methods for Evaluating Degree of Chalking of Exterior Paint Films.
- N. ASTM E283, Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen.

- O. ASTM E330, Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
- P. ASTM E331, Test Method for Water Penetration of Exterior Windows, Skylights, Doors and Curtain Walls by Uniform Static Air Pressure Difference.
- Q. NAAMM Metal Finishes Manual for Architectural and Metal Products.

1.4 SUBMITTALS

- A. Samples
 - 1. Samples of each required aluminum color and finish, on 12-inch long sections of extrusion shapes as required for the aluminum window units.
 - 2. Samples will be reviewed by ENGINEER for color and texture only. Compliance with all other requirements is the exclusive responsibility of CONTRACTOR.
- B. Shop Drawings
 - 1. Copies of manufacturer's specifications, recommendations and standard details for aluminum window units, including fabrication, finishing, hardware and other components of the Work. Include certified test laboratory reports as necessary to show compliance with the requirements.
 - 2. Copies of manufacturers' specifications and installation instructions for required materials and components, which are not included in the other submittals, specified in other Sections of these Specifications. Coordinate the submittal of such other data with this submittal, and with the submittal of samples required by other Sections.
 - 3. Fabrication and installation of aluminum window units and associated components of the Work. Include wall elevations at 1/4-inch scale, typical unit elevations at 1-inch scale and full-size detail sections of every typical composite member. Show anchors, hardware, operators and other components not included in manufacturer's standard data, including glazing details. Indicate clearly on the Shop Drawings, all deviations from Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Provide products of one of the following:
 - 1. TR-9950 series by Traco Architectural Systems, Inc.
 - 2. 8100 Series by United States Aluminum.
 - 3. Or equal.

2.2 FRAMING MATERIALS AND ACCESSORIES

- A. Aluminum Extrusions: Alloy and temper, ASTM B 221, 6063-T5 and not less than 1/8-inch thickness at any location for main frame sash members and tube supports. Vertical mullions and support clips as recommended by the window manufacturer.

- B. Thermal Separator: Interior and exterior aluminum frame sections shall be thermally separated by a continuous urethane connector.
- C. Fasteners: Stainless steel, guaranteed by the manufacturer to be non-corrosive and compatible with the aluminum window members, trim, hardware, anchors and other components of the window units.
 - 1. Do not use exposed fasteners, except where unavoidable for the application of hardware. Match the finish of the metal surrounding the fastener, unless otherwise specified.
 - 2. Provide Phillips flat-head machine screws for exposed fasteners, unless otherwise specified.
- D. Glazing Gaskets: Neoprene or EPDM.
- E. Glass and Glazing Materials: Refer to Section 08800, Glass and Glazing.

2.3 FINISHES

- A. Application: on clean extrusions free from serious surface blemishes; on exposed surfaces visible after product is installed.
- B. Coating: PPG Duranar with resin containing 70% fluoropolymer; thermosetting; alternative finishes will not be acceptable.
- C. Quality standard: conforming to AAMA 2605-05, including 10 years Florida exposure and 4000 hours humidity tests.
- D. Pretreatment: five-stage; zinc chromate conversion coating.
- E. Application: electrostatic spray and oven bake by approved applicator.
- F. Coating quantity: minimum one primer coat and one color coat.
- G. Dry film thickness: minimum 1.2 mils on exposed surfaces, except inside corners and channels.
- H. Color: selected by OWNER from manufacturer's standard or custom colors.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Prepare openings to be in tolerance, plumb, level, provide for secure anchoring, and in accordance with approved shop drawings.

3.2 INSTALLATION

- A. Install windows in accordance with manufacturer's recommendations and approved shop drawings with skilled craftspeople.
- B. Provide required support and securely fasten and set windows plumb, square, and level without twist or bow.

- C. Apply sealant per sealant manufacturer's recommendations at joints, wipe off excess, and leave exposed sealant surfaces clean and smooth.
- D. Tolerances:
 - 1. Limit variations from plumb and level:
 - a. 1/8 inch in 10 feet vertically and horizontally.
 - b. 1/4 inch in 40 feet, all directions.
 - 2. Limit offsets in theoretical end-to-end and edge-to-edge alignment:
 - a. 1/16 inch (2 mm) where surfaces are flush or less than 1/2 inch (13 mm) out of flush and separated by not more than 2 inches (51 mm).
 - b. 1/8 inch (3 mm) for surfaces separated by more than 2 inches (51 mm).
 - 3. Step in face: 1/16 inch (2 mm) maximum.
 - 4. Jog in alignment: 1/16 inch (2 mm) maximum.
 - 5. Location: 1/4 inch (6 mm) maximum deviation of any member at any location.
 - 6. Tolerances are not accumulative.
- D. Provide attachments and shims to permanently fasten system to building structure.
- E. Anchor securely in place, allowing for required movement, including expansion and contraction.
- F. Separate aluminum and other corrodible metal surfaces from sources of corrosion or electrolytic action at points of contact with other materials. Apply a bituminous coating of approximately 30-mil dry film thickness, or other suitable permanent separator, on concealed contact surfaces of dissimilar materials before installation, wherever there is the possibility of corrosive or electrolytic action.
- G. Do not install component parts, which are observed to be defective in any way, including warped, bowed, dented, abraded and broken members, and including glass with edge damage.
- H. Do not cut, or trim, component parts during erection, in a manner, which would damage the finish, decrease the strength, or result in a visual imperfection or a failure in performance of the aluminum window wall. Return component parts, which require alteration to the shop for re-fabrication, if possible, or for replacement by new parts.
- I. Clean aluminum surfaces promptly after installation of windows, exercising care to avoid damage of the finish. Remove excess glazing and sealant compounds, dirt and other substances. Lubricate hardware and other moving parts.

3.3 FIELD QUALITY CONTROL

- A. Test installed units in conformance with AAMA 502-08 minimum requirements for air and water infiltration with the window manufacturer, Contractor, and Engineer present.

- B. Select test units as directed by the Engineer and use an AAMA-accredited laboratory provided by Contractor.

3.4 PROTECTION AND CLEANING

- A. Protect installed product's finish surfaces from damage during construction. Protect aluminum window system from damage from grinding and polishing compounds, plaster, lime, acid, cement or other harmful contaminants.
- B. Repair or replace damaged installed products.
- C. Clean installed products in accordance with Manufacturer's instructions prior to Owner's acceptance.

END OF SECTION

SECTION 08710

FINISH HARDWARE

PART 1 – GENERAL

1.01 THE REQUIREMENT

- A. Furnish all labor, materials, equipment and appliances required for the complete execution of Work as shown on Drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 08110 – Hollow Metal Doors and Frames

1.03 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of these specifications, the Work shall conform to the applicable requirements of the following documents:
 - 1. ANSI/BHMA 156

1.04 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300 - Submittals, submit the following:
 - 1. Manufacturers data for each item of hardware. Include installation and maintenance instructions.
 - 2. Furnish templates to fabricators of other work which is to receive hardware.
 - 3. Hardware schedule organized into "hardware sets," indicating complete designation of every item required for each door or opening. Furnish initial draft of schedule at the earliest possible date, in order to facilitate the fabrication of other work (such as hollow metal frames) which may be critical in the project construction schedule. Furnish final draft of schedule after samples, manufacturer's data sheets, coordination with shop drawings for other work, delivery schedules and similar information has been completed and accepted.

1.05 QUALITY ASSURANCE

- A. Provide materials, assemblies, equipment and services from a single source for each category except that locksets, latchsets and cylinders must originate from the same manufacturer.
- B. Replace any item of finish hardware which cannot be installed or will not function properly.
- C. Provide hardware complying with NFPA 80 and UL labeled for fire rated openings.
- D. Furnish templates or information to door and frame manufacturer. Coordinate between the manufacturers where two or more articles of hardware are to be mounted on the same door. Verify all dimensions, new and existing.

- E. Coordinate hardware with other work. Furnish hardware items of proper design for use on doors and frames of the thicknesses, profile, swing, security and similar requirements indicated, as necessary for proper installation and function.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Handle, store, distribute, protect and install hardware in accordance with manufacturer's instructions or recommendations. Deliver packaged materials in original containers with seals unbroken and labels intact.
- B. Properly mark or label, so each piece of hardware is readily identifiable with the approved hardware schedule. Tag each change key or otherwise identifying the door of which its cylinder is intended. Where double cylinder functions are used or where it is not obvious which is the key side of a door, appropriate instructions shall be included with the lock and hardware schedule.
- C. Provide secure storage area for hardware.

PART 2 – PRODUCTS

2.01 MATERIALS AND FABRICATION

- A. Hand of Door
 - 1. Drawings show swing or hand of each door leaf (left, right, reverse bevel, etc.). Furnish hardware for proper installation and operation of door.
- B. Manufacturer's Name Plate
 - 1. Do not use manufacturer's products which have name or trade name displayed in a visible location (omit removable nameplates), except in conjunction with required UL labels.
- C. Base Metals
 - 1. Produce hardware units of the basic metal and forming method indicated, using manufacturer's non-corrosive metal alloy, composition, temper and hardness but in no case of lesser quality material than specified.
- D. Fasteners
 - 1. Manufacture hardware to conform to published templates, generally prepared for machine screw installation. Do not provide hardware which has been prepared for self-tapping sheet metal screws, except as specifically indicated.
 - 2. Furnish stainless steel fasteners for installation with each hardware item. Exposed finish (under any condition) to match hardware finish or surfaces of adjacent work. Match the finish of adjacent work as closely as possible, including surfaces to receive painted finish.
 - 3. Provide fasteners which are compatible with unit fastened and the substrate, and which will not cause corrosion or deterioration of finish hardware, base material or fastener.

- E. Tools for Maintenance
 - 1. Furnish a complete set of specialized tools as needed for Owner's continued adjustment, maintenance, removal and replacement of builders' hardware.
- F. Hardware Finishes
 - 1. Stainless steel, US32D unless otherwise noted.
 - 2. Closers shall have a USP finish unless otherwise noted.
- G. Field Checks
 - 1. Make periodic checks during installation of finish hardware to ascertain the correctness of the installation. After completion of the work, certify in writing, that all items of finish hardware have been installed, adjusted and are functioning in accordance with Specification requirements.

2.02 DESCRIPTION OF PRODUCTS

- A. Hinges
 - 1. Stainless steel full mortise concealed oil impregnated ball bearing type, five knuckle with non-rising pins for interior doors, and non-removable and non-rising pins for exterior doors. Tips shall be flat.
 - 2. Sizes and weights of hinges:
 - a. Doors up to 40 inches - 5 inches regular weight.
 - b. Doors 40 inches to 48 inches - 5 inches heavy weight.
 - 3. Provide three hinges per door leaf up to and including 90 inches and one additional hinge for each 30 inches of additional height.
 - 4. Acceptable Manufacturers: Stanley Hardware, Hager Hardware
- B. Locksets and Latchsets
 - 1. Stainless steel, heavy-duty mortise type conforming to ANSI A156.13 Series 1000, Grade 1.
 - 2. Wrought steel box strikes.
 - 3. Stainless steel deadbolt with 1" throw approval.
 - 4. 2 3/4 inch back set, 3/4 inch throw, two-piece anti-friction latchbolt.
 - 5. Non-ferrous critical internal parts.
 - 6. Cylinders shall be manufactured to conform to grand master key program.
 - 7. Trim design shall match existing. Provide lever design throughout.

8. Acceptable Manufacturers: Best Access Systems. This is the site standard, and no substitutions will be allowed.
 9. Coordinate with Owner to match City standards.
- C. Keys and Keying
1. Provide construction keyed, removable core master key system as directed by the Owner.
 2. Acceptable Manufacturers: Best Access System. This is the site standard, and no substitutions will be allowed.
- D. Panic Hardware
1. Panic hardware shall be provided for the exit on all doors.
 2. Heavy duty push bar exit device, U.L. labeled, with corrosive resistant construction aluminum clear anodized.
 3. ANSI A156.3, Grade 1.
 4. Exterior trim to closely match locksets.
 5. Single/active doors: mortise type.
 6. Double doors: concealed vericle rod.
 7. ANSI Function 08.
- E. Closers
1. Cast iron case with seamless one-piece forged steel spring tub.
 2. Heavy duty forged steel arm.
 3. Non-sized fully adjustable from size 1-6.
 4. Backcheck intensity and location valves.
 5. Delayed action closing.
 6. Full metal cover.
 7. Mechanical hold open device, except at fire rated doors.
 8. ANSI 156.4, Grade 1.
 9. Conforms to ADA 5 lbf. maximum door opening force requirement for non-fire rated interior doors.
 10. Provide mounting brackets, and fasteners required for proper attachment.
 11. Acceptable manufacturers: Corbin/Russwin, LCN, Norton

F. Door Stops and Bumpers

1. Provide door stops and/or bumpers for all doors that come in contact with the surrounding walls upon opening.
2. Finish: Satin chrome plated.
3. Floor mounted door stops.
 - a. Acceptable manufacturers and products: H.B. Ives 444, Hager Hardware Model 267F, and Glynn-Johnson Model FB36.
4. Wall bumpers
 - a. Acceptable manufacturers and products: H.B. Ives Model 407, Hager Hardware Model 234W, and Glynn-Johnson Model 60C.

H Flush Bolts

1. U.L. listed.
2. Forged brass construction, 1/2" diameter flattened bolt tip, 12" long rod.
3. Fit standard ANSI door preparation.
4. Acceptable manufacturers: Glynn-Johnson, Hager Hardware, and H.B. Ives.

I. Kickplates

1. Provide kick plates on all doors.
2. Stainless steel, 0.050" thick, beveled 3 sides, 8" high, width 2 inches less than door width.
3. Acceptable manufacturers: H.B. Ives, Hager Hardware, and Builders Brass Works.

J. Silencers

1. Rubber silencers: 3 for each single door and 2 for each double doors.
2. Acceptable manufacturers and products: Glynn-Johnson Models 64 or 65, Hager Hardware Models 308D or 307D, H.B. Ives Models 20 or 21.

K. Thresholds

1. Extruded aluminum saddle type with stainless steel fasteners. Six inches wide or as shown on drawings.
2. Acceptable manufacturers: Pemko, National Guard Products, Incorporated, and Zero International.

L. Door Bottom Seal

1. Extruded aluminum with neoprene seal.

2. Acceptable manufacturers and products: Pemko Model 57, Zero International Model 328 and National Guard Products, Inc. Model 96.
- M. Weatherstripping
1. Extruded aluminum with neoprene seal.
 2. U.L. Labeled.
 3. Acceptable manufacturers and products: Pemko Model 294, National Guard Products, Inc. Model 190, and Zero International Model 328.
- N. Automatic Flush Bolts
1. U.L. listed.
 2. Forged brass or stainless steel construction, ½" diameter flattened bolt tip, 12" long rod.
 3. Fully automatic.
 4. Operation shall incorporate an override function.
 5. Tested for a minimum of 100,000 cycles.
 6. Provide dust proof strikes.
 7. Acceptable Manufacturers: Glynn-Johnson, Hager Hardware, and H.B. Ives.
- O. Coordinator
1. U.L. labeled and tested for 100,000 cycles.
 2. Stop mounted, provide filler strips to fully cover stop.
 3. Adjustable holding power and override feature.
 4. Acceptable Manufacturers: Glynn-Johnson, Hager Hardware, and H.B. Ives.

PART 3 – EXECUTION

3.01 GENERAL

- A. Templates
1. After the hardware schedule is approved furnish to the various manufacturers, required blueprint templates for fabrication purposes. Templates shall be made available not more than ten (10) days after receipt of the approved hardware schedule.

B. Packaging and Marking

1. Ship hardware with proper non-corrosive fastenings for secure application. Each package of hardware shall be legibly marked indicating the part of the work for which it is intended. Markings shall correspond with the item numbers shown on the approved hardware schedule. Keys shall be tagged within each package set and plainly marked on the face of the envelope with the key control number, door designation and all identification as necessary.

3.02 INSTALLATION

- A. Install hardware in a manner which will eliminate cracks on surfaces.
- B. Mount hardware units at heights recommended in "Recommended Locations for Builders Hardware" by BHMA, in accordance the Americans with Disabilities Act (ADA), except as otherwise indicated or required to comply with governing regulations.
- C. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Do not install surface-mounted items until finishes have been completed on the substrate.
- D. Set units level, plumb and true to line and location. Adjust and reinforce the attachment substrate as is necessary for proper installation and operation.
- E. Drill and countersink units which are not factory-prepared for anchorage fasteners. Space fasteners and anchors in accordance with factory standards.
- F. Cut and fit thresholds and floor covers to profile of door frames, with mitered corners and hair-line joints. Join units with concealed welds or concealed mechanical joints. Cut smooth openings for spindles, bolts and similar items, if any.
- G. Screw thresholds to substrate with No. 10 or larger screws, of the proper type for permanent anchorage and of bronze or stainless steel which will not corrode in contact with the threshold metal.
- H. Set thresholds in a bed of either butyl rubber sealant or polyisobutylene mastic sealant to completely fill concealed voids and exclude moisture. Do not plug drainage holes or block weeps. Remove excess sealant.

3.03 ADJUST AND CLEAN

- A. Adjust and check each operating item of hardware and each door to ensure proper operation or function. Lubricate moving parts as recommended by manufacturer. Replace units which cannot be adjusted to operate freely and smoothly as intended for the application.
- B. Final Adjustment
 1. One week prior to acceptance or occupancy make a final check and adjustment of all hardware items. Clean and relubricate operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices and compensate for final operation of heating and ventilating equipment.
- C. Instruct Owner personnel in proper adjustment and maintenance of hardware and hardware finishes, during the final adjustment of hardware.

3.04 HARDWARE SETS

- A. The door hardware sets on the Drawings indicates functional and general requirements. Items shall be quality and finish as specified. Hardware set identification refers to set numbers indicated on the Drawings. Consult Drawings for set number required.
- B. Hardware shall be as follows:

Hardware Sets

1. Each Leaf
Hinges
Door Closer
Automatic Flush Bolts
Kickplate
Weatherstripping
Threshold
Door Bottom Seal
Astragal w/Weatherstripping
Lockset
Rain Cap
Panic Hardware
Coordinator
Silencers
Note: Accessories as required for leafs
2. Hinges
Door Closer
Kick Plate
Door Bottom Seal
Lockset
Weatherstripping
Rain Cap
Panic Hardware
Coordinator

Automatic Flush Bolts

Threshold

Silencers

Astragal with Weatherstripping

Note: Accessories as required for leafs.

3. Hinges

Door Closer

Kick Plate

Latchset

Weatherstripping

Floor Stop (Door 103 only)

Panic Hardware

Silencers

Door Bottom Seal

END OF SECTION

SECTION 08800

GLAZING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
 - 1. Doors.
 - 2. Aluminum Windows.

1.2 RELATED SECTIONS

- A. Section 08110 – Hollow Metal Doors and Frames
- B. Section 8520 – Aluminum Windows

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design glass, including comprehensive engineering analysis according to ASTM E 1300 by a qualified professional engineer registered in the State of Michigan, using the following design criteria:
 - 1. Design Wind Pressures: Per Code.
 - 2. Design Snow Loads: Per Code.
 - 3. Vertical Glazing: For glass surfaces sloped 15 degrees or less from vertical, design glass to resist design wind pressure based on glass type factors for short-duration load.
 - 4. Thickness of Patterned Glass: Base design of patterned glass on thickness at thinnest part of the glass.
 - 5. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.
 - 6. Compatibility: Glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member shall be compatible with elastomeric glazing sealants.

1.4 SUBMITTALS

- A. Product Data: For each glass product and glazing material indicated.
- B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches square.
- C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.
- D. Preconstruction adhesion and compatibility test report.

1.5 QUALITY ASSURANCE

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. GANA Publications: GANA's "Glazing Manual".
 - 2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR-A7, "Sloped Glazing Guidelines".
 - 3. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use".
- B. Safety Glazing Labeling: Where safety glazing labeling is indicated or required by Code, permanently mark glazing with certification label of the manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- C. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, test standard, whether glazing is for use in fire doors or other openings, whether or not glazing passes hose-stream test, whether or not glazing has a temperature rise rating of 450 deg F and the fire-resistance rating in minutes.
- D. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

1.6 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form in which coated-glass manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
 - 1. Warranty Period: 10 years from date of Substantial Completion.
- B. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

2.1 GLASS PRODUCTS, GENERAL

- A. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.
- B. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.
- C. Windborne-Debris-Impact Resistance: Provide exterior glazing that passes protection testing requirements in ASTM E1996 for the appropriate wind zone when tested according to ASTM E1886. Test specimens shall be no smaller in width and length than glazing indicated for use on the Project and shall be installed in same manner as glazing indicated for use on the Project.
- D. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
 - 1. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
 - 2. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
 - 3. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.2 GLASS PRODUCTS

- A. Float Glass: ASTM C1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.
- B. Ultraclear Float Glass: ASTM C1036, Type I, Quality-Q3, Class I, complying with other requirements specified and with visible light transmission not less than 91 percent.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. AFG Industries, Inc.
 - b. Guardian Industries Corp.
 - c. Pilkington North America
 - d. PPG Industries, Inc.
- C. Heat-Treated Float Glass: ASTM C1048; Type I; Quality-Q3; Class I (clear) unless otherwise indicated; of kind and condition indicated.
- D. Pyrolytic-Coated, Self-Cleaning, Low-Maintenance Glass: Clear float glass with a coating on first surface having both photocatalytic and hydrophilic properties that act to loosen dirt and to cause water to sheet evenly over the glass instead of beading.

- E. Tempered Float Glass: Class I, Type I, clear, meeting ANSI Z97.1. Minimum thickness 1/4".

2.3 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E2190, and complying with other requirements specified.

2.4 TINTING

- A. If applicable, all exterior glass shall be tinted to match existing.

2.5 GLAZING GASKETS

- A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:
 1. Neoprene complying with ASTM C864.
 2. EPDM complying with ASTM C864.
 3. Silicone complying with ASTM C1115.
 4. Thermoplastic polyolefin rubber complying with ASTM C1115.

2.6 GLAZING SEALANTS

- A. General:
 1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 3. Sealants used inside the weatherproofing system, shall have a VOC content of not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 4. Sealants used inside the weatherproofing system shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
 5. Colors of Exposed Glazing Sealants: per Owner.

2.7 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for

application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:

1. AAMA 804.3 tape, where indicated.
2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

2.8 MISCELLANEOUS GLAZING MATERIALS

- A. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- B. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- C. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- D. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- E. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
- F. Perimeter Insulation for Fire-Resistive Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.

2.9 INSULATING-GLASS TYPES

- A. Glass Type: Tinted insulating glass.
 1. Overall Unit Thickness: 1 inch.
 2. Outdoor Lite: Minimum ¼" thick, tinted fully tempered float glass.
 3. Interspace Content: Argon gas.
 4. Indoor Lite: Minimum ¼" thick, clear fully tempered float glass.
 5. Provide safety glazing labeling.
 6. Provide low emissivity coating on the No. 3 surface.
 7. Provide ceramic backed spandrel glass panels in areas as indicated on the drawings. ¼" heat-strengthened glass with ceramic frit on the #2 surface. Color to be chosen at the time of construction by the Owner. Submit samples of standard color options. Core to consist of 2 lb. Density Polystyrene insulation. Fire-rated gypsum board substrate ½" thick. Interior finish to be clear anodized aluminum. Spandrel glass panels by MapeSpan or approved equal.

PART 3 - EXECUTION

3.1 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.
- C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
- D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- G. Provide spacers for glass lites where length plus width is larger than 50 inches.
- H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

3.2 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Apply heel bead of elastomeric sealant.
- F. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- G. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.3 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.4 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.5 CLEANING AND PROTECTION

- A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.
- C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

- D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

END OF SECTION

SECTION 09330

QUARRY AND CERAMIC TILE

PART 1 – GENERAL

1.1 DESCRIPTION

- A. General Conditions and Division 1 shall apply to this Section.

1.2 WORK INCLUDED

- A. This Contractor shall provide all labor, materials, equipment, transportation and incidentals noted, specified or required, to complete the work of this Section to the full extent of the Contract Drawings and Specifications.
- B. The work to be performed by this Contractor shall be obtained by a careful examination of the detail Drawings and the Specifications.
- C. Requirements for supply and installation of tile.

1.3 RELATED WORKS

- A. Section 03300: Cast-in-Place Concrete
- B. Section 04220: Concrete Masonry Units

1.4 SAMPLES

- A. Submit shop drawings and tile samples and specifications to Engineer for review in accordance with Section 01300.

1.5 PROTECTION

- A. Provide adequate mechanical ventilation during installation.
- B. Install tiles generally after the completion of all trades.

1.6 QUALITY ASSURANCE

- A. The installer shall have minimum five (5) years of satisfactory experiences installing products specified in this Section.
- B. All products shall be lead free.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Quarry and Ceramic Tile

1. Floor Tile: Match existing; field verify 4" x 4" x ½" unglazed quarry tiles / heavy duty ceramic tiles as supplied by Olympia Tile International Inc. or approved equal.
 2. Wall Tile: Match existing; field verify 5" x 8" x ¼" glazed ceramic wall tiles as supplied by Olympia Tile International Inc. or approved equal.
 3. OWNER to select color and pattern from samples at time of construction. The intention is to match the existing floor and wall tiles as closely as possible.
 4. Provide cove bottom with round top for first wall coursing making up base. Provide internal and external round top cove trim as required to achieve complete installation.
 5. Provide additional spare 5 ft² tile to OWNER.
- B. Tile Sealer - As recommended by tile manufacturer.
- C. Quarry Tile Adhesive and Grout
1. Match existing
 2. Adhesive and Grout
 - a. Mapei Ultraflex 2 adhesive or reviewed equal.
 - b. Mapei Ultra color ker 700 Series grout or reviewed equal. Color to be selected by OWNER at time of construction.
- D. Mixing Materials
1. Components:
 - a. Portland Cement - conform to ASTM C150-86
 - b. Hydrated Lime - conform to ASTM 207-06.
 - c. Dry Set Mortar - conform to ANSI A118.1.
 - d. Sand - clean, washed sharp, sand.
 - e. Water - clean, fresh and potable.
 2. Levelling Coat (by Volume if required):
 - a. 1 part Portland Cement
 - b. 4 parts sand
 - c. 1/10 part latex additive (minimum)
 - d. 1 part water (includes latex additive)
 3. Mortar Bed (by Volume if required):
 - a. 1 part Portland Cement
 - b. 1/5 to 1/2 parts hydrated lime (as suitable for job conditions)

BARTON AND SOUTH INDUSTRIAL PUMP STATIONS ELECTRICAL IMPROVEMENTS

- c. 4 parts sand
 - d. 1 part water
 - 4. Adhesive:
 - a. As per manufacturer's instructions.
 - 5. Grout:
 - a. As per manufacturer's instructions.
 - 6. Sealer and Wax:
 - a. Approved sealer following by 1 coat of wax.
- E. Thinset Systems
 - 1. Flextile 53 wall mix Flextile Ltd. and fuller grout as supplied by Olympia.
 - 2. Additive for wall mix: "Laticrete 4237" latex mortar additive.
 - 3. Color of grout: To the OWNER's approval and to match tile.
 - 4. Additive for wall grout: "Laticrete 3701" latex mortar additive.

PART 3 - EXECUTION

3.1. GENERAL

- A. Top elevation of new tile shall match top elevation of existing tile. Mechanically chip and remove sub base as required.
- B. Installation according to Tile Council of America Handbook for Ceramic Tile Installation-2007.
- C. Ambient air temperature and structural base temperature not less than 13°C during application of work throughout curing period.
- D. Ensure that all structural surfaces are structurally sound, plumb, level and true and free from dust, dirt, grease, calcimine, water or other foreign matter.
- E. True and smooth minor variations in floor and wall surfaces (3 mm or less) with a skin coat of adhesive applied with flat trowel.
- F. Allow to dry before spreading adhesive for setting tile.
- G. Seal all openings around pipes, fixtures, by packing adhesive into openings.
- H. Adhesive specified contains flammable solvent. Ventilate areas to receive tile, suspend smoking and any flame or spark producing operation while work is in progress.
- I. Forced ventilation will be required when working in enclosed areas when using epoxy components.

3.2. INSTALLATION

A. Underbed (if required):

1. When structural slab is absolutely clean, prepare and apply with stiff broom a neat Portland Cement grout, scrubbing thoroughly into surface of slab. Proceed to lay underbed before grout has dried, and evenly screed to required level and provide slopes as indicated.

B. Tile Installation:

1. Neatly cut tile around fitments, fixtures and drains. Form intersections, corners and returns accurately.
2. Joints in tile to be uniform in width, subject to normal variance in tolerance allowed in tile size.
3. Watertight without voids, cracks, excess mortar, or grout.
4. Joints between sheets to be of same width as joints between individual tiles.
5. All internal angles of base to be coved; external angles to be bullnose.
6. Spread adhesive with a notch trowel having approximate dimensions: 60°V notches, ¼" deep, spaced 3/8" o.c.
7. Carefully plan layout of tile to provide symmetrical pattern.
8. Set wall tile with slight twist motion to assure suitable contact with the adhesive; set tile within 45 minutes after spreading the adhesive.
9. Remove excess adhesive from face of tile.
10. Sound tile after setting and remove and replace hollow backed tile.
11. Allow minimum 24 hours after setting prior to grouting.

C. Grouting

1. Force grout into joints, avoiding air traps or voids.
2. Strike or tool joints of cushion edge tile to depth of cushion.
3. Hold joints flush with square edge tile.
4. Using diagonal strokes, across joints, remove all excess grout. Check for gaps or air holes filling same, using clean water in initial cleaning.
5. Remove surface laitance with dry cloth.
6. Do not use acid in final cleaning.
7. Follow manufacturer's recommendations.

D. Cleaning and Sealing

1. At completion of tile work, clean surfaces with Tri-sodium Phosphate to remove all foreign materials.
2. Seal tiles with one seal coat.

E. Protection

1. Protect tile work during period of installation.
2. Do not permit foot traffic for minimum of 48 hours.
3. Completed work to be free of broken, damaged or faulty tile.

F. Waxing

1. Provide one application of floor wax prior to turn over to OWNER.

END OF SECTION

SECTION 09900

PAINTING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. It is the intent of this Section that all painting necessary to result in a complete, finished appearing facility be accomplished. As part of the work of this Section, prepare surfaces that are to be painted and furnish and apply paint materials. Paint schedules follow the text of this Section and define the surface preparation and coating systems required to paint the various types of surfaces that are to be painted. The Paint Application Table below identifies the areas to receive the paint systems specified in the paint schedules. For items or areas not listed in the Paint Application Table, consult the Engineer for the proper system to be used. Exclusion from the Paint Application table does not necessarily indicate that an item or area does not require painting.
- B. Acceptable manufacturers shall be Tnemec and Carboline.
1. The paint schedules that follow this specification have been developed for Tnemec products. If Carboline products are to be used, submit schedules describing Carboline's equal products and colors for review and approval.
- C. South Industrial Pump Station – Paint Application Table
- Schedule M2: Interior Metal
- Paint the following interior metal items: new process piping and new valves.
- D. Barton Pump Station – Paint Application Table
- Schedule C1: Interior Concrete
- Paint all interior concrete building ceilings and beams that are exposed to view within the new electrical room, the generator room, and the lower level pump room.
- Painting work under Schedule C1 is not required on concrete floors or walls.
- Choice of color required. Number of colors: One per room.
- Schedule C2: Interior Masonry
- Paint all interior masonry building walls and other related work that are exposed to view in the new generator room.
- Painting work under Schedule C2 is not required on masonry walls that are not exposed to view in the final work, or on walls with glazed tile.
- Choice of color required. Number of colors: Three (max.) per room.
- Schedule C3: Exterior Concrete
- Paint all concrete beams, fascia and soffit around the entire perimeter of the building at both roof levels.

Schedule C7: Interior Concrete Floors

Paint all exposed interior concrete floors and housekeeping pads within the new electrical room, and new generator room.

Painting of floors shall not be performed until all significant construction activities have been completed.

Choice of color required. Number of colors: One per room.

NOTE: Only concrete hardener shall be applied to the storage building floor.

Schedule M1: Exterior Metal

Paint all steel lintels, exterior surfaces of all hollow metal doors and frames, all louvers and dampers in exterior walls, all metal exterior mechanical and electrical equipment except equipment with a baked on factory finish, and all related work.

Painting work under Schedule M1 is not required on prefinished metal siding, aluminum doors and windows, exterior signage or prefinished metal roofing and siding. Pretreatment (Schedule M3) followed by touch-up painting of damaged galvanizing on galvanized metal items with a zinc-rich primer shall be performed before application of paint.

Choice of colors required. Multiple colors may be required for certain items. Number of colors: Six (max).

Schedule M2: Interior Metal

Paint the following interior metal items: existing monorails, new structural steel framing, all steel lintels, all hollow metal doors and frames, new piping and valves, motor stands, equipment base plates, new piping and plumbing, piping and plumbing hangers and supports, new exposed-to-view metallic electrical conduits and wiring device enclosures, new gas piping, all new mechanical and electrical equipment except equipment with a baked-on factory finish, and all related work.

Painting work under Schedule M2 is not required on aluminum-framed metal doors and windows, fire extinguishers, or galvanized steel ductwork. Pretreatment (Schedule M3) followed by touch-up painting of damaged galvanizing on galvanized metal items with a zinc-rich primer shall be performed before application of paint.

Painting of piping shall not occur with water moving through the piping. Any piping covered by a support or hanger shall be painted before placement on the support or in the hanger, no unpainted sections of pipe shall be allowed.

Choice of colors required. Multiple colors will be required for different items. Number of colors: Twelve (max).

Schedule M7: Pretreatment of Galvanized and Nonferrous Metals

Pretreating is required on copper and galvanized pipe, aluminum items that will be painted under schedules M1 and M2, items in contact with concrete or dissimilar metals, and on damaged galvanizing of galvanized metal items prior to touch-up painting. Pretreating is not required on galvanized steel, aluminum or other nonferrous materials for items that do not require touch-up painting or are not specified to be painted.

Schedule P1: Interior Plastics

Paint plastic piping, plumbing and conduit and all related work.

Painting work of this Section is not required for room identification signs or equipment identification tags.

Choice of color required. Multiple colors will be required for different items. Number of colors: Six (max).

- D. In addition to the painting indicated in the above Paint Application Table, paint all aluminum surfaces that will be in contact with concrete or dissimilar metals using two coats of the prime coat specified for Exterior Metal. Coordinate painting with the fabrication of components and with the work of other trades so as to ensure the full and correct application of paint materials.
- E. In addition to the painting indicated in the above Paint Application Table, apply touch-up paint to finish defects and field cuts, welds, and penetrations of galvanized metal. Prepare and pretreat surfaces in accordance with Schedule M3 above and finish paint according to the appropriate paint schedule.
- F. Prime and finish painting, regardless of the location in which the work is performed, shall conform to all requirements of this Section. Coordinate painting with the fabrication of components and with the work of other trades so as to ensure the full and correct application of paint materials.

1.2 DEFINITIONS

- A. For the purposes of this Section, the following definitions apply: "Exposed to View" means all surfaces in the final work that could be seen from any vantage point from any height. "Paint" means all pretreatment, prime, intermediate and final coatings specified herein including clear, translucent and opaque materials.

1.3 QUALITY ASSURANCE

- A. Applicator's Quality Assurance: Submit list of a minimum of 3 completed projects of similar size and complexity to this Work completed within the last 5 years. Projects shall demonstrate experience working on comparable structures. Include for each project:
 - 1. Project name and location.
 - 2. Name of project Owner, include a contact name and phone number.
 - 3. Name of General Contractor is different than Contractor holding this contract.
 - 4. Name of Engineer, include a contact name and phone number.
 - 5. Name of coating manufacturer.
 - 6. Approximate area of coatings applied.
 - 7. Date of completion.
- B. Use only qualified journeyman painters for the mixing and application of paint on exposed surfaces. In the acceptance or rejection of installed painting, no allowance will be made for lack of skill on the part of painters.

- C. Apply paints following the recommendations in the "Applications Manual for Paint and Protective Coatings" published by McGraw-Hill.

1.4 FIELD QUALITY CONTROL

- A. Inspector's Services: The Contractor shall hire Dixon Engineering or Nelson Tank (third party satisfactory to the Owner), at no additional expense to the Owner, to perform field inspections of items 1-4 below and prepare the field inspection reports described in item 5 below:
 - 1. Verify coatings and other materials are as specified.
 - 2. Verify surface preparation and applications are as specified.
 - 3. Verify proper environmental conditions (i.e. humidity, dew point, ambient temperature, surface temperature, etc.)
 - 4. Verify DFT of each coat and total DFT of each coating systems are as specified using wet film and dry film gauges.
 - 5. Coating Defects: Check coatings for film characteristics or defects that would adversely affect performance or appearance of coating systems.
 - 6. Report:
 - a. Submit written reports describing inspections made and actions taken to correct nonconforming work.
 - b. Report nonconforming work no corrected.
 - c. Submit copies of report to Owner and Contractor.

1.5 SUBMITTALS

- A. Provide submittals in accordance with Division 1 of the Specifications. Prior to ordering and delivering paint materials to the project site, submit the following:
 - 1. Manufacturer literature demonstrating compliance with these Specifications and indicating paint formulation, rate of coverage, recommended uses and recommended application method.
 - 2. Color chips for the full range of colors available in each product.
- B. The paint products indicated in these Specifications establish the required standard of paint quality. Requests for substitution will not be considered.

1.6 PRODUCT HANDLING

- A. Deliver all paint materials to the job site in their original unopened containers with all labels intact and legible at time of use. Store only the approved materials at the job site. Store them in a suitable and designated area restricted to the storage of paint materials and related equipment. Use all means necessary to ensure the safe storage and use of paint materials and the prompt and safe disposal of waste. Store volatile solvents, rags and cleaning materials in a well ventilated area.

- B. Use all means necessary to protect paint materials before, during, and after application and to protect the installed work and materials of all other trades. In the event of damage, immediately make all repairs and replacements necessary at no additional cost to the Owner.

1.7 EXTRA STOCK

- A. Upon completion of the work of this Section, deliver to the Owner an extra stock of paint equaling approximately 2% of each color and gloss used in each coating material with all such extra stock tightly sealed in clearly labeled containers that have not been previously opened.

1.8 GUARANTEE

- A. Furnish a 1-year warranty from the date of substantial completion on workmanship. Manufacturer to provide an unlimited warranty on the materials.

2.0 PRODUCTS

2.1 PAINT MATERIALS

- A. Provide paint materials in accordance with the paint schedules that follow the text of this Section.
- B. All paint materials for each paint system shall be the products of a single manufacturer. All paint materials and equipment shall be compatible in use: finish coats shall be compatible with prime coats, prime coats shall be compatible with the surface to be coated, and all tools and equipment shall be compatible with the coating to be applied. Thinners, when used, shall be only those thinners specifically recommended for that purpose by the manufacturer of the material to be thinned.
- C. Furnish finish paint in the colors selected by the Owner from the manufacturer's standard available colors (a minimum of 12 colors must be available for each finish paint requiring color choice). Specially mixed colors may be required to achieve OSHA approved safety colors and to provide the piping and plumbing line colors to meet the Owner's color scheme. The City of Ann Arbor Color Coding of Piping schedule is appended to this specification for reference.

3.0 EXECUTION

3.1 SURFACE CONDITIONS

- A. Prior to beginning the work of this Section, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this application may properly commence. Verify that paint finishes may be applied in strict accordance with all pertinent codes and regulations and the requirements of these Specifications. In the event of discrepancy, immediately notify the Engineer. Do not proceed with application in areas of discrepancy until all such discrepancies have been fully resolved. Application of paint materials shall be deemed to indicate acceptability of the existing surface conditions.

3.2 SURFACE PREPARATION

A. General

1. Prior to beginning surface preparation and painting operations, completely mask, remove, or otherwise adequately protect all hardware, accessories, machined surfaces, plates, equipment identification tags/nameplates, lighting fixtures, and all work of other trades that are not to receive the paint coating. Before applying paint, thoroughly clean and prepare all surfaces according to the specified surface preparation method. Schedule all cleaning and painting so that dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
2. Spot prime all necessary areas prior to beginning field painting.

B. Preparation of Concrete and Masonry Surfaces

1. The surface finishing of concrete is specified in Division 3.00 of these Specifications. Do not begin paint application until these requirements have been met and concrete has cured for at least 28 days.
2. Prior to painting, grind or scrape off all surface defects such as fins, protrusions, bulges, and mortar spatter. On concrete surfaces, remove non-degraded release agents, oil, wax and grease by scraping off heavy deposits and washing with hot trisodium phosphate solution (2 lbs trisodium phosphate per gallon 160°F water). After cleaning flush with warm water to remove residual cleaning solution.
3. Where the paint schedule calls for brush-off blast cleaning, dry sandblast concrete using silica sand passing a 16 mesh screen. Sandblast until the surface has been lightly abraded without entirely removing the surface or exposing underlying aggregate. After sandblasting, remove dust, sand and loose particles by vacuuming or blowing off with high pressure air.

C. Preparation of Metal Surfaces

1. Prepare metal surfaces for painting by following the method indicated on the appropriate paint schedule. Preparation methods are referenced to the Steel Structures Painting Council (SSPC) Specifications. Do not prepare metal for painting when the relative humidity is higher than 85% or the metal is less than 5°F above the dew point. After surface preparation, thoroughly clean all surfaces of any remaining dirt, oil and grease and leave it ready to receive prime paint.

D. Preparation of Plastic Surfaces

1. Clean plastic surfaces of all dirt, oil and foreign substances using a mild solvent cleaner.

3.3 PAINT APPLICATION

- A. Apply paint in accordance with paint schedule requirements, the cited reference, all codes and regulations, and the recommendations of the paint manufacturer. Apply prime paint to metal surfaces within 24 hrs after surface preparation. Do not apply paint in areas where dust is being generated.

- B. Do not apply paint when the surrounding air temperature as measured in the shade is below 40°F or when the temperature of the surface to be painted is below 35°F. Do not apply paint when it is expected that the relative humidity will exceed 85% or that the air temperature will drop below 40°F within 18 hrs after the application of paint. Dew or moisture condensation should be anticipated and if such conditions are prevalent, delay painting until certain that the surfaces can be kept above the dew point. Follow all additional environmental limitation requirements of the paint manufacturer.
- C. Paint material mil thicknesses and numbers of coats that are indicated in the paint schedules are based on brush or roller application. Spray application of paint materials will be allowed in the field only for areas or surfaces that are very difficult to paint with brush or roller. Field spray application must be approved by the Engineer before its initiation. For areas that are spray painted, apply as many coats as necessary to achieve specified mil thicknesses.
- D. Allow sufficient drying time between coats of paint. During adverse weather, extend length of drying time as recommended by the paint manufacturer.
- E. Prior to applying each paint coating after the first, check mil thickness of previously applied coating(s). Correct for insufficient paint thickness by increasing the mil thickness of subsequent applications, if allowed by the paint manufacturer or by applying additional coatings to provide the specified paint thickness.
- F. Spot sand between coatings to remove paint defects visible to the unaided eye from a distance of five feet.
- G. Ventilation: Provide ventilation during coating evaporation stage in confined or enclosed areas in accordance with AWWAD 102.
- H. Paint system for the concrete floors shall not be applied until all other work by other trades is complete.

3.4 CLEAN UP

- A. During the progress of the work, do not allow the accumulation of empty containers or other excess items except in areas specifically set aside for that purpose. Following completion of painting in each area, promptly remove all masking and temporary protection. After paint has dried, reinstall all items removed for painting. Upon completion of this portion of the work, visually inspect all surfaces and remove paint and traces of paint from surfaces not scheduled to be painted.

SCHEDULES FOLLOW

PAINT SCHEDULE C1
SERVICE: INTERIOR CONCRETE

09900-8

Surface Preparation: Surface must be dry, clean, and free from contaminants. On concrete, remove non-degraded release agents, oil, wax, and grease by washing with a hot trisodium phosphate solution. Brush off blast cleaning (concrete) SSPC SP13/ICRI CSP 2 – 4 Surface Preparation of Concrete

Paint Manufacturer	Application	Product Name	Generic Type	No. of Coats	Dry Mils/ Coat	Sq Ft Covered/ Gallon	Comments
Tnemec	Finish	H.B. Tneme- Tufcoat Series 114	Waterborne Acrylic Epoxy	two	4-6	-	Gloss

Note: Product is self-priming on concrete

PAINT SCHEDULE C2
SERVICE: INTERIOR MASONRY

09900-9

Surface Preparation: Surface must be dry, clean, and free from contaminants. On concrete, remove non-degraded release agents, oil, wax, and grease by washing with a hot trisodium phosphate solution. Brush off blast cleaning (concrete) SSPC SP13/ICRI CSP 2 – 4 Surface Preparation of Concrete

Paint Manufacturer	Application	Product Name	Generic Type	No. of Coats	Dry Mils/ Coat	Sq Ft Covered/ Gallon	Comments
Tnemec	Primer	Envirofill Series 130 Masonry Filler	Waterborne cementitious Acrylic	one	-	-	
Tnemec	Finish	H.B. Tnemec-Tufcoat Series 114	Waterborne Acrylic Epoxy	two	4-6	-	Gloss

PAINT SCHEDULE C3

09900-10

SERVICE: EXTERIOR CONCRETE FLOORS

Surface Preparation: Surface must be dry, clean, and free from contaminants. On concrete, remove non-degraded release agents, oil, wax, and grease by washing with a hot trisodium phosphate solution. Brush off blast cleaning (concrete) SSPC SP13. Complete removal of existing paint will be required.

Paint Manufacturer	Application	Product Name	Generic Type	No. of Coats	Dry Mils/ Coat	Sq Ft Covered/ Gallon	Comments
Tnemec	Finish	Series 6 Tneme-Cryl	Acrylic Latex	two	2.5	-	

Note: Product is self-priming on concrete.

PAINT SCHEDULE C3

09900-11

SERVICE: INTERIOR CONCRETE FLOORS

Surface Preparation: Surface must be dry, clean, and free from contaminants. On concrete, remove non-degraded release agents, oil, wax, and grease by washing with a hot trisodium phosphate solution. Brush off blast cleaning (concrete) SSPC SP13/ICRI 3 – 5 Surface Preparation of Concrete.

Paint Manufacturer	Application	Product Name	Generic Type	No. of Coats	Dry Mils/ Coat	Sq Ft Covered/ Gallon	Comments
Tnemec	First Coat	Series 201 Epoxoprime	Modified Polyamine Epoxy	one	6-8	-	
Tnemec	Finish Coat	Series 281 Tneme-Glaze	Modified Polyamine Epoxy	two	6-8	-	self-leveling pigmented

Alternate Finish Coats:

1. Tnemec	Finish Coat	Series 280	Modified Polyamine Epoxy	two	6-8	-	high viscosity leaves stippled effect
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Provide samples for Owner review.

Final selection by Owner.

Concrete floor painting shall not occur until all other work at the facility has been completed.

PAINT SCHEDULE M1
SERVICE: EXTERIOR METAL

09900-12

Surface Preparation: SSPC-SP6 Commercial Blast Cleaning

Paint Manufacturer	Application	Product Name	Generic Type	No. of Coats	Dry Mils/ Coat	Sq Ft Covered/ Gallon	Comments
Tnemec	Shop Primer	Hi-Build Epoxoline Series 66	Polyamide Epoxy	one	3-5		
Tnemec	Field Primer	Hi-Build Epoxoline Series 66	Polyamide Epoxy	touch-up	3-5		
Tnemec	Finish	Endura-shield Series 1074	Aliphatic Acrylic Polyurethane	two	2-3		Not for immersion service

PAINT SCHEDULE M2
SERVICE: INTERIOR METAL

09900-13

Surface Preparation: SSPC-SP6 Commercial Blast Cleaning

Paint Manufacturer	Application	Product Name	Generic Type	No. of Coats	Dry Mils/ Coat	Sq Ft Covered/ Gallon	Comments
Tnemec	Shop Primer	F.C. Typoxy Series 27	Polyamide Epoxy	one	4-6		
Tnemec	Field Primer	F.C. Typoxy Series 27	Polyamide Epoxy	touch-up	4-6		
Tnemec	Finish	H.B. Tneme- Tufcoat Series 114	Waterborne Acrylic Epoxy	one	4-6		Series 114 - Gloss

PAINT SCHEDULE M3

09900-14

SERVICE: PRETREATMENT OF GALVANIZED AND NONFERROUS METALS

Surface Preparation: **Prepare surfaces by sanding, abrading or using Clean N Etch as manufactured by Great Lake Laboratories or Owner approved equal. SSPC-SP1 Solvent Cleaning**

For all galvanized items that require touch-up painting, pretreat items as indicated in the surface preparation, then apply a zinc-rich primer to all areas requiring touch up.

For galvanized and non-ferrous metal items to be painted following pretreatment and touch-up, refer to Schedule M1 for Exterior Metal items and Schedule M2 for Interior Metal Items.

PAINT SCHEDULE P1
SERVICE: INTERIOR PLASTICS

09900-15

Surface Preparation: Abrade to generate a profile for mechanical adhesion

Paint Manufacturer	Application	Product Name	Generic Type	No. of Coats	Dry Mils/ Coat	Sq Ft Covered/ Gallon	Comments
Tnemec	Primer	F.C. Typoxy Series 27	Polyamide Epoxy	one	4-6	-	
Tnemec	Finish	H.B. Tneme- Tufcoat Series 114	Waterborne Acrylic Epoxy	one	4-6	-	Series 114 - Gloss

**CITY OF ANN ARBOR WTP
STANDARD PAINT SCHEDULE**

COLOR CODING OF PIPING

Potable Water: High Service, Transfer, & Wash Water (includes manhole covers)	Clear Sky en17 (tnemec)
Plant Pressure	PL12 (tnemec)
Non-Potable Water: River, Filter Infl. & Effl. (Includes manhole covers)	Frosted mint GB48 (tnemec)
Sludge (includes pipes, equipment and manhole covers)	Chipmunk yb23 (tnemec)
Natural Gas	Safety Yellow SC01 (tnemec)
Fire Service Water	Safety Red sc09 (Tnemec)
Compressed Air	Safety Green sc07 (tnemec)
Steam	Safety Purple sc08 (tnemec)
Used Wash Water	Light gray IN01 (tnemec)
Carbon Dioxide	White wh01 (tnemec)
valve handles and handrails indoors	Safety Orange sc03 (tnemec)
Fluoride	Hunter Green pl20 (tnemec)
Ammonia	lemonade yb16 (tnemec)
Sodium Hydroxide	Kastrel blue gr18 (tnemec)
Handrails and Platforms outside	beige yb38 (tnemec)
shafts for basins and flocs	pota-pox series beige yb38 (tnemec)
exterior tanks, containments, reservoir vents, fence	foliage en08 (tnemec)
new door frames	terra cotta en13 (tnemec)
new black doors	black IN06 (tnemec)
hot water	mountain shadow gb07 (tnemec)
	blue summit pl11 (tnemec)

NOTE: If existing field conditions show a different color than listed above, contact the Owner/Engineer for clarification.

END OF SECTION

SECTION 10522

FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 THE REQUIREMENT

- A. Furnish and install fire extinguishers and cabinets as shown on the Drawings or as directed by the OWNER and specified herein.

1.2 REFERENCE SPECIFICATIONS, CODES, AND STANDARDS

- A. Without limiting the generality of these Specifications the Work shall conform to the applicable requirements of the following documents:
 - 1. NFPA 10 - Portable Fire Extinguishers

1.3 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Section 01300, Submittals, submit the following:
 - 1. Complete detail and installation drawings for Fire Extinguisher Cabinets.
 - 2. Manufacturer's data sheets and verification of U.L. ratings.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with the Specifications provide products from one of the following manufacturers:
 - 1. Kidde Fire Extinguisher Company
 - 2. Ansul Fire Protection
 - 3. Potter - Roemer
 - 4. J. L. Industries

2.2 MATERIALS

- A. Dry Chemical (DC) Fire Extinguishers
 - 1. Provide where indicated on drawings, 10 lb. capacity (nominal factory charge), hand portable, with wall mount, tri-class dry chemical type, with Underwriters' Laboratories rating of 4-A: 60 BC.
 - 2. Provide cabinets with all fire extinguishers. 18 ga. baked white enamel steel; continuous hinge; glass panel. Cabinets shall be suitable for 10 lb. capacities.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fire extinguishers shall be installed where directed by the OWNER.
- B. Cabinets for extinguishers shall be securely mounted to masonry with stainless steel bolts.

END OF SECTION

SECTION 13300

PRE-ENGINEERED BUILDING SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Metal Building System:
 - 1. Structural steel framing system.
 - 2. Metal roof system.
 - 3. Metal wall system.
 - 4. Roof and wall insulation systems.
 - 5. Gutters and downspouts.

1.2 RELATED REQUIREMENTS

- A. Section 03300 – Cast-In-Place Concrete
- B. Section 05120 – Structural Steel
- C. Section 08110 – Hollow Metal Doors and Frames
- D. Section 08334 – Overhead Rolling Doors
- E. Section 09900 - Painting
- F. Section 14300 – Hoisting Equipment

1.3 REFERENCE STANDARDS

- A. American Institute of Steel Construction (AISC):
 - 1. AISC Specification for Structural Steel Buildings.
 - 2. AISC Serviceability Design Considerations for Low-Rise Buildings.
- B. American Iron and Steel Institute (AISI):
 - 1. AISI North American Specification for the Design of Cold-Formed Steel Structural Members.
- C. American Welding Society (AWS):
 - 1. AWS D1.1 / D1.1M – Structural Welding Code – Steel.
 - 2. AWS D1.3 / D1.3M – Structural Welding Code – Sheet Steel.

D. Association for Iron & Steel Technology (AISE):

1. AISE 13 – Specifications for Design and Construction of Mill Buildings.

E. ASTM International (ASTM):

1. ASTM A 325 – Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
2. ASTM A 653 / A 653M – Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
3. ASTM A 792 / A 792M – Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
4. ASTM B 117 – Standard Practice for Operating Salt Spray (Fog) Apparatus.
5. ASTM C 518 – Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
6. ASTM C 1363 – Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus.
7. ASTM D 522 – Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings.
8. ASTM D 523 – Standard Test Method for Specular Gloss.
9. ASTM D 968 – Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive.
10. ASTM D 1308 – Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
11. ASTM D 2244 – Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
12. ASTM D 2247 – Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity.
13. ASTM D 2794 – Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
14. ASTM D 3361 – Standard Practice for Unfiltered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings.
15. ASTM D 4214 – Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films.
16. ASTM E 84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
17. ASTM E 96 / E 96M – Standard Test Methods for Water Vapor Transmission of Materials.

18. ASTM E 1592 – Standard Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.
 19. ASTM G 87 – Standard Practice for Conducting Moist SO₂ Tests.
- F. FM Global:
1. FMRC Standard 4471 – Approval Standard for Class 1 Roofs for Hail Damage Resistance, Combustibility, and Wind Uplift Resistance.
- G. Metal Building Manufacturers Association (MBMA):
1. MBMA Metal Building Systems Manual.
- H. North American Insulation Manufacturers Association (NAIMA):
1. NAIMA 202 – Standard For Flexible Fiber Glass Insulation to be Laminated for Use in Metal Buildings.
- I. The Society for Protective Coatings (SSPC):
1. SSPC-Paint 15 - Primer for Use Over Hand Cleaned Steel performs to SSPC-Paint 15 standards.
 2. SSPC-SP2 – Hand Tool Cleaning.
- J. Underwriters Laboratories (UL):
1. UL 580 – Standard for Tests for Uplift Resistance of Roof Assemblies.
 2. UL 723 – Standard for Test for Surface Burning Characteristics of Building Materials.
- K. US Army Corps of Engineers (COE):
1. COE Unified Facilities Guide Specification Section 07 61 13.

1.4 PREINSTALLATION MEETINGS

- A. Conduct preinstallation meeting 2 weeks before start of installation of metal building system.
- B. Require attendance of parties directly affecting work of this section, including CONTRACTOR, ENGINEER, installer, and metal building system manufacturer's representative.
- C. Review materials, installation, protection, and coordination with other work.

1.5 SUBMITTALS

- A. Comply with Section 013300 – Submittal Procedures.
- B. Product Data: Submit metal building system manufacturer's product information, specifications, and installation instructions for building components and accessories.

- C. **Erection Drawings:** Submit metal building system manufacturer's erection drawings, including plans, elevations, sections, and details, indicating roof framing, transverse cross-sections, covering and trim details, and accessory installation details to clearly indicate proper assembly of building components.
- D. **Certification:** Submit written "Certificate of design and manufacturing conformance" prepared and signed by a Professional Engineer, registered to practice in Michigan verifying that the metal building system design and metal roof system design (including panels, clips, and support system components) meet indicated loading requirements and codes of authorities having jurisdiction.
 - 1. Certification shall reference specific dead loads, live loads, snow loads, wind loads/speeds, tributary area load reductions (if applicable), concentrated loads, collateral loads, seismic loads, end-use categories, governing code bodies, including year, and load applications.
 - 2. Submit certification on the metal building system manufacturer's letterhead.
- E. Submit certification verifying that the metal roof system has been tested and approved by Underwriter's Laboratory as Class 90.
- F. Submit certification verifying that the metal standing seam roof system has been tested in accordance with ASTM E 1592 test protocols.
- G. **Dealer Certification:** Submit certification as part of bid that the metal building system supplier or metal roof system supplier is a manufacturer's authorized and franchised dealer of the system to be furnished.
 - 1. Certification shall state date on which authorization was granted.
- H. **Installer Certification:** Submit certification as part of bid that the metal building system or roof system installer has been regularly engaged in the installation of building systems of the same or equal construction to the system specified.
- I. **Warranty Documentation:** Submit manufacturer's warranty.

1.6 QUALITY ASSURANCE

- A. **Manufacturer's Qualifications:**
 - 1. Manufacturer regularly engaged, for past 10 years, in manufacture of metal building systems of similar type to that specified.
 - 2. Accredited based on IAS Accreditation Criteria AC472 and requirements in International Building Code (IBC), Chapter 17.
- B. **Installer's Qualifications:**
 - 1. Installer regularly engaged, for past 10 years, in installation of metal building systems of similar type to that specified.
 - 2. Employ persons trained for installation of metal building systems.

- C. Certificate of design and manufacturing conformance:
1. Metal building system manufacturer shall submit written certification prepared and signed by a Professional Engineer, registered to practice in Michigan verifying that building system design and metal roof system design (including panels, clips, and support system components) meet indicated loading requirements and codes of authorities having jurisdiction.
 2. Certification shall reference specific dead loads, live loads, snow loads, wind loads/speeds, tributary area load reductions (if applicable), concentrated loads, collateral loads, seismic loads, end-use categories, governing code bodies, including year, and load applications.
 3. Certificate shall be on metal building system manufacturer's letterhead.
 4. Refer to Submittals article of this specification section.
- D. Material Testing:
1. In addition to material certifications of structural steel, metal building system manufacturer shall provide, upon request at time of order, evidence of compliance with specifications through testing.
 2. This quality assurance testing shall include testing of structural bolts, nuts, screw fasteners, mastics, and metal coatings (primers, metallic coated products, and painted coil products).

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Storage and Handling Requirements:
1. Store and handle materials in accordance with manufacturer's instructions.
 2. Keep materials in manufacturer's original, unopened containers and packaging until installation.
 3. Do not store materials directly on ground.
 4. Store materials on flat, level surface, raised above ground, with adequate support to prevent sagging.
 5. Protect materials and finish during storage, handling, and installation to prevent damage.

1.8 WARRANTY

- A. Metal building system manufacturer shall provide a written weathertightness warranty for a maximum of 25 years against leaks in roof panels, arising out of or caused by ordinary wear and tear under normal weather and atmospheric conditions.

1. Warranty shall be signed by both the metal roof system manufacturer and the metal roof system installer.
- B. Metal building system manufacturer shall provide a written warranty for 25 years against perforation of metal roof panels due to corrosion under normal weather and atmospheric conditions.
1. Warranty shall be signed by metal roof system manufacturer.
- C. Metal building system manufacturer shall provide a paint film written warranty for 25 years against cracking, peeling, chalking, and fading of exterior coating on painted roof and wall panels.
1. Warranty shall be signed by metal building system or roof system manufacturer and state that the coating contains 70 percent "Kynar 500" or "Hylar 5000" resin.
 2. Metal building system manufacturer shall warrant that the coating shall not peel, crack, or chip for 25 years.
 3. For a period of 25 years, chalking shall not exceed ASTM D 4214, #8 rating and shall not fade more than 5 color difference units in accordance with ASTM D 2244.
- D. Metal Building System Manufacturer's Certification: If requested, metal building system manufacturer shall submit a signed written Certification as part of bid, stating that the metal roof system manufacturer or approved representative will provide warranties and Inspection and Report Service specified in this specification section.
1. Warranty terms.

PART 2 – PRODUCTS

2.1 MANUFACTURER

- A. Metal Building System Manufacturer: Butler Manufacturing, PO Box 419917, Kansas City, Missouri 64141. Phone 816-968-3000. Website www.butlermfg.com.
- B. Or approved equal.

2.2 BUILDING DESCRIPTION

- A. Building Dimensions: Indicated on the Drawings.
 1. Horizontal Dimensions: Measure to inside face of wall sheets.
 2. Eave Height: Measure from top of finished floor to intersection of insides of roof and sidewall sheets.
 3. Clear Height Between Finished Floor and Bottom of Roof Steel: Indicated on the Drawings.

- B. Primary Structural Members:
1. Primary Framing System: Butler Manufacturing framing system as specified in this specification section.
 2. Frames: Welded-up plate section columns and roof beams, complete with necessary splice plates for bolted field assembly as specified in this specification section.
 3. Bolts for Field Assembly of Primary Steel: High-strength bolts as indicated on erection drawings of metal building system manufacturer.
 4. Beam and Post Endwall Frames: Endwall corner posts, endwall roof beams, and endwall posts as required by design criteria.
 5. Exterior Columns: Welded-up "H" sections or cold-formed "C" sections.
 6. Interior Columns: "H" sections or tube columns.
 7. Connection of Primary Structural Members: ASTM A 325 bolts through factory-punched holes.
 8. Primary Structural Members: Paint with metal building system manufacturer's standard primer with surface preparation as specified in this specification section.
- C. Secondary Structural Members:
1. Secondary Framing System: Butler Manufacturing framing system as specified in this specification section.
 2. C/Z Purlins and Girts: Acrylic-coated G30 galvanized finish.
- D. Metal Roof System: Butler Manufacturing metal roof system as specified in this specification section.
- E. Metal Wall System: Butler Manufacturing metal wall system as specified in this specification section.
- F. Where metal panels are required to be painted, use coating system as specified in this specification section.

2.3 DESIGN LOADS

- A. Governing Design Code:
1. Structural design for the building structural system shall be provided by the metal building system manufacturer for the following design criteria:
 - a. Governing Building Code: International Building Code.
 - b. Year/Version: 2009.
 - c. Occupancy Category: S-2.

B. Roof Snow Load:

1. Roof snow load used for designing the structure shall not be reduced and shall be the product of the following criteria:
 - a. Snow Load Coefficient (C_e): 1.0.
 - b. Thermal Factor (C_t): 1.0.
 - c. Snow Importance Factor (I): 1.0.
 - d. Ground Snow Load (P_g): 25 psf.
 - e. Roof Snow Load (P_f): 18 psf.
2. Design snow load shall include the effects of minimum flat roof load limits, rain on snow, drifting snow, and unbalanced snow load as defined in the governing building code specified above.

C. Wind Load:

1. Wind load used for designing the structure shall be the product of the following criteria:
 - a. Wind Exposure Category: C.
 - b. Wind Velocity Pressure Exposure Coefficient (K_z): 0.85.
 - c. Wind Topographic Factor (K_{zt}): 1.0.
 - d. Wind Directionality Factor (K_d): 0.85.
 - e. Wind Velocity (V), miles per hour: 90.
 - f. Wind Importance Factor (I_w): 1.0.
 - g. Building Wind Load (q_z): 14.96 psf.
2. Wind Pressure Coefficients and the design pressures shall be applied in accordance with the governing code.

D. Seismic Load:

1. Seismic load used for designing the structure shall be based on the following criteria:
 - a. Spectral response acceleration for short periods (S_s): 15 % g.
 - b. Spectral response acceleration for 1-sec. period (S_1): 5% g.
 - c. Site Class: D.
 - d. Seismic Importance Factor (I): 1.0.

2. Seismic loads shall be applied in accordance with the governing code.
- E. Dead Load: Dead load shall consist of the weight of building system construction, such as roof, framing, and covering members.
- F. Collateral Load:
1. Collateral load in pounds per square foot shall be applied to the entire structure to account for the weight of additional permanent materials other than the building system, such as mechanical systems and electrical systems.
 2. This allowance does not include the weight of hung equipment weighing 50 pounds or more.
 3. Equipment loads of 50 pounds or more shall be indicated on the Drawings and the structure shall be strengthened as required.
- G. Auxiliary Loads: Auxiliary loads shall include dynamic loads, such as cranes and material handling systems, and will be defined in the Contract Documents.
1. Monorail load:
 - a. Lifting Capacity: 2 Ton
 - b. Manual trolley and hoist
 - c. Monorail beam as shown on Contract Drawings.
 - d. Anchorage of monorail beam to structure by monorail supplier.
 2. Building structure shall be designed for the monorail loads in accordance with the governing code.
- H. Load Combinations: Load combinations used to design primary and secondary structural members shall be in accordance with the governing code.

2.4 DEFLECTIONS

- A. Structural Members:
1. Maximum deflection of main framing members shall not exceed 1/240 of their respective spans.
 2. Maximum deflection due to snow load in roof panels and purlins shall not exceed 1/240 of their respective spans.
 3. Maximum deflection due to wind load in wall panels and girts shall not exceed 1/240 of their respective spans.
- B. Lateral deflections, or drift, at the roof level of the structure in relation to the floor or slab on grade, caused by deflection of horizontal force resisting elements, shall not exceed H/360.

- C. Calculations for deflections shall be done using only the bare frame method.
 - 1. Reductions based on engineering judgment using the assumed composite stiffness of the building envelope shall not be allowed.
 - 2. Drift shall be in accordance with AISC Serviceability Design Considerations for Low-Rise Buildings.
 - 3. Use of composite stiffness for deflection calculations is permitted only when actual calculations for the stiffness are included with the design for the specific project.
 - 4. When maximum deflections are specified, calculations shall be included in the design data.

2.5 STRUCTURAL STEEL FRAMING SYSTEM

- A. General:
 - 1. Design of Structural System: Clear span rigid frame with tapered or straight columns and roof beams, with gable slope roof.
 - 2. Actual Building Length:
 - a. Structural line to structural line.
 - b. Same as nominal; i.e., number of bays times length of bays.
 - c. Structural Line: Defined as inside face of wall sheets.
 - 3. Actual Building Width:
 - a. Structural line to structural line.
 - b. Nominal building width.
 - 4. Roof Slope: 1/2 inch in 12 inches.
 - 5. Components and Parts of Structural System:
 - a. Indicated on the Drawings or the Specifications.
 - b. Clearly marked.
 - c. Erection Drawings: Supply for identification and assembly of parts.
 - d. Drawings: Carry stamp of a registered professional engineer in the State of Michigan.
 - 6. Foundations:
 - a. Foundations, Including Anchor Bolt Embedment Length: Properly designed by qualified engineer, retained by other than metal building

system manufacturer, in accordance with specific soil conditions for building site.

b. Reactions for Proper Design of Foundations: Supplied by metal building system manufacturer.

c. Anchor Bolts:

1) Anchor Bolt Diameter: Indicated on anchor bolt layout drawings furnished by metal building system manufacturer.

2) Anchor Bolts: Supplied by Contractor, not metal building system manufacturer.

3) Anchor Bolts on Moment-Resisting Column Bases: Nuts above and below base plates.

B. Structural Steel Design:

1. Structural Mill Sections or Welded-up Plate Sections: Design in accordance with AISC Specification for Structural Steel Buildings.

2. Cold-Formed Steel Structural Members: Design in accordance with AISI North American Specification for the Design of Cold-Formed Steel Structural Members.

3. Structural System: Design in accordance with specified building code (Refer to Design Loads and Building Codes).

C. Primary Framing:

1. Rigid Frames:

a. Frames: Welded-up plate section columns and roof beams, complete with necessary splice plates for bolted field assembly.

1) Base Plates, Cap Plates, Compression Splice Plates, and Stiffener Plates: Factory welded into place and connection holes factory fabricated.

2) Columns and Roof Beams: Fabricated complete with holes in webs and flanges for attachment of secondary structural members and bracing, except for fieldwork as noted on erection drawings furnished by metal building system manufacturer.

b. Bolts for Field Assembly of Frame Members: ASTM A 325 high-strength bolts as indicated on erection drawings furnished by metal building system manufacturer.

2. Endwall Structural Members: Cold-formed channel members designed in accordance with AISI North American Specification for the Design of Cold-Formed Steel Structural Members or welded-up plate sections designed in accordance with AISC Specification for Structural Steel Buildings.

- a. Endwall Frames: Endwall corner posts, endwall roof beams, and endwall posts as required by design criteria.
 - 1) Splice Plates and Base Clips: Shop fabricated complete with bolt connection holes.
 - 2) Base Plates, Cap Plates, Compression Splice Plates, and Stiffener Plates: Factory welded into place and connection holes shop fabricated.
 - 3) Beams and Posts: Factory fabricated complete with holes for attachment of secondary structural members, except for field work as noted on erection drawings furnished by metal building system manufacturer.
- b. Intermediate Frames: Substituted for end-wall roof beams, when specified.
 - 1) Factory fabricate necessary endwall posts and holes for connection to intermediate frame used in endwall.

D. Secondary Structural Members:

- 1. Purlins:
 - a. Purlins:
 - 1) "Z"-shaped, precision-roll-formed, acrylic-coated G30 galvanized steel in different gauges to meet specified loading conditions.
 - 2) 7-inch, 8-1/2-inch, 10-inch, or 11-1/2-inch-deep "Z" sections.
 - b. Outer Flange of Purlins: Factory-punched holes for panel connections.
 - c. Attach purlins to main frames and endwalls with 1/2-inch-diameter bolts.
 - d. Brace purlins at intervals indicated on erection drawings furnished by metal building system manufacturer.
 - e. Concentrated Loads: Hung at purlin panel points.
- 2. Eave Members:
 - a. Eave Struts: Factory punched 7-inch, 8-1/2-inch, 10-inch, or 11-1/2-inch-deep "C" sections, precision-roll-formed, acrylic-coated G30 galvanized steel in different gauges to meet specified loading conditions.
- 3. Girts:
 - a. "Z" or "C"-shaped, precision-roll-formed, acrylic-coated G30 galvanized steel in different gauges to meet specified loading conditions.

- b. 7-inch, 8-1/2-inch, 10-inch, or 11-1/2-inch-deep "Z" or "C" sections.
 - c. Outer Flange of Girts: Factory-punched holes for panel connections.
4. Bracing:
- a. Locate bracing as indicated on the Drawings.
 - b. Diagonal Bracing:
 - 1) Hot-rolled rods of sizes indicated on the Drawings.
 - 2) Attach to columns and roof beams as indicated on the Drawings.
 - c. Optional fixed-base wind posts or pinned-base portal frames may be substituted for wall rod bracing on buildings as required.
 - d. Flange Braces and Purlin Braces: Cold formed and installed as indicated on the Drawings.
- E. Welding:
- 1. Welding Procedures, Operator Qualifications, and Welding Quality Standards: AWS D1.1 - Structural Welding Code – Steel and AWS D1.3 - Structural Welding Code – Sheet Steel.
 - 2. Welding inspection, other than visual inspection as defined by AWS D1.1, paragraph 6.9, shall be identified and negotiated before bidding.
 - 3. Certification of Welder Qualification: Supply when requested.
- F. Painting of Structural Steel Framing System:
- 1. General:
 - a. Structural Steel: Prime paint as temporary protection against ordinary atmospheric conditions.
 - b. Perform subsequent finish painting, if required, in field as specified in the painting section.
 - c. Before painting, clean steel of loose rust, loose mill scale, dirt, and other foreign materials.
 - d. Steel Fabricator: Not required to sand blast, flame clean, or pickle steel before painting, unless otherwise specified.
 - 2. Primary Frames:
 - a. Clean steel in accordance with SSPC-SP2.

- b. Factory cover steel with 1 coat of gray water-reducible alkyd primer paint formulated to equal or exceed performance requirements SSPC-Paint 15.
- c. Minimum Coating Thickness: 1.0 mil.
- 3. Secondary Structural Members – Roll-Formed:
 - a. Hot-dipped zinc coating, ASTM A 653, G30; followed by 1 coat of clear acrylic finish.
 - b. Acrylic-Coated G30 Galvanized Steel: Equal or exceed performance requirements of SSPC Paint-15.

2.6 METAL ROOF SYSTEM

- A. Metal Roof System: Butler Manufacturing “Butlerib®II” roof system.
- B. Roof System Design:
 - 1. Design roof panels in accordance with AISI North American Specification for the Design of Cold-Formed Steel Structural Members.
 - 2. Design roof panels to support a 200-pound load distributed evenly over a 2-foot square area centered between purlins, without exceeding a panel deflection-to-span ratio of 1/180 in a 2-span condition.
 - 3. Design roof paneling system for a minimum roof slope of 1/2 inch in 12 inches.
 - 4. Design roof paneling system to support design live, snow, and wind loads.
- C. Roof System Performance Testing:
 - 1. UL Wind Uplift Classification Rating, UL 580: Class 90.
 - 2. Structural Performance Under Uniform Static Air Pressure Difference: Test roof system in accordance with ASTM E 1592.
 - 3. FM Global (Factory Mutual):
 - a. Roof system has been tested in accordance with FMRC Standard 4471 and approved as a Class 1 Panel Roof.
 - b. Metal Building System Manufacturer: Provide specific assemblies to meet required wind rating in accordance with FM Global.
 - c. Installation modifications or substitutions can invalidate FM Global approval.

D. Roof Panels:

1. General:

- a. Factory roll-formed to provide width coverage of 3 feet.
- b. Four major corrugations spaced 12 inches on center.
- c. Each Major Corrugation: 1-1/2 inches high, 2-7/8 inches wide, tapering 1-9/32 inches wide at top, with no intermediate minor corrugations.
- d. In Panel Flat: Two additional minor corrugations, 1 inch wide, 1/8 inch high, spaced 4 inches on center, between major corrugations.

2. Roof Panel Side Laps:

- a. Overlap 1 major corrugation.
- b. One of the Outboard Corrugations: Formed as overlapping corrugation.
- c. Other Outboard Corrugation: Formed as underneath corrugation.
 - 1) Full corrugation to provide bearing support to side lap.
 - 2) Formed with continuous-length sealant groove.

3. Roof Panel End Laps:

- a. 6 inches.
- b. Supply maximum possible panel lengths, up to 38'-9", to minimize panel end laps.
- c. Factory punch roof panel end laps (top panel with a round hole and bottom panel with a slotted hole) to provide for expansion and contraction and panel alignment.
- d. Design end laps to occur over and be fastened to secondary structural members.

4. Ridge Panels:

- a. One-piece, factory formed to match roof slope.
- b. Ridge Panel Cross Section: Match roof panels.
- c. Ridge Panel Splices: Occur over first purlin on either side of building center.

5. Eave Panels: Extend beyond building structural line.

6. Factory punch roof panels at panel ends to match factory-punched or field-drilled holes in structural members to ensure proper alignment.
 - a. Upper End of Eave and Splice Panels: 3/4-inch-long slots to provide for expansion and contraction of panels.
 7. Panel Material and Finish:
 - a. 24-gauge painted Galvalume aluminum-zinc alloy (approximately 55 percent aluminum, 45 percent zinc), ASTM A 792.
 - b. Paint with exterior colors of “Butler-Cote™” finish system, full-strength, 70 percent “Kynar 500” or “Hylar 5000” fluoropolymer (PVDF) coating.
 - c. PVDF Coating Warranty: Metal building system manufacturer shall warrant coating for 25 years for the following.
 - 1) Not to peel, crack, or chip.
 - 2) Chalking: Not to exceed ASTM D 4214, #8 rating.
 - 3) Fading: Not more than 5 color-difference units, ASTM D 2244.
- E. Provision for Expansion and Contraction:
1. Optional Factory-Punched Roof Panels: 5/16-inch by 3/4-inch-slotted holes at upper end and 5/16-inch-diameter holes at lower end.
 2. Slotted Holes: Permit thermal movement of panels without detrimental effect on roof panels.
- F. Fasteners:
1. Fastener Locations and Quantities: Indicated on erection drawings furnished by metal building system manufacturer.
 2. Panel-to-Structural Connections: Type 410 stainless steel “Scrubolt™” fasteners, 3/8-inch hex head, with 3/4-inch OD aluminum-backed EPDM washers.
 3. Panel-to-Panel Connections: #14-14 by 7/8-inch stainless steel 3/8-inch hex-head mini-point self-drilling screws, with 5/8-inch OD aluminum-backed EPDM washers.
- G. Accessories:
1. Accessories (i.e., ventilators, skylights, eave and gable trim, gutters, jacks, and curbs): Standard with metal building system manufacturer, unless otherwise noted and furnished as specified.
 2. Metal Coating on Gutters, Downspouts, Gable Trim, and Eave Trim: “Butler-Cote™” finish system, full-strength, 70 percent “Kynar 500” or “Hylar 5000” fluoropolymer (PVDF) coating.

3. Location of Standard Accessories: Indicated on erection drawings furnished by metal building system manufacturer.

2.7 METAL WALL SYSTEM

- A. Exterior Metal Wall System: Butler Manufacturing™ “Butlerib® II” wall system.
- B. Wall System Design: Design wall panels in accordance with AISI North American Specification for the Design of Cold-Formed Steel Structural Members.
- C. Wall Panels:
 1. Roll-formed panels, 3 feet wide with 4 major corrugations, 1-1/2 inches high, 12 inches on center, with 2 minor corrugations between each of the major corrugations entire length of panel.
 2. One piece from base to building eave. Steel coating both sides with layer of acrylic-coated Galvalume aluminum-zinc alloy (approximately 55 percent aluminum, 45 percent zinc) applied by continuous hot-dip method.
 3. Upper End of Panels: Fabricate with mitered cut to match corrugations of “Butlerib® II” roof panels of 1/2 inch to 12 inches and square cut for all other roof panels and slopes.
 4. Factory punch or field drill wall panels at panel ends and match factory-punched or field-drilled holes in structural members for proper alignment.
 5. Panel Material and Finish:
 - a. Paint with exterior colors of “Butler-Cote™” finish system, full-strength, 70 percent “Kynar 500” or “Hylar 5000” fluoropolymer (PVDF) coating.
 - b. PVDF Coating Warranty: Metal building system manufacturer shall warrant coating for 25 years for the following.
 - 1) Not to peel, crack, or chip.
 - 2) Chalking: Not to exceed ASTM D 4214, #8 rating.
 - 3) Fading: Not more than 5 color-difference units, ASTM D 2244.
 6. Panel Material and Finish: Special materials, gauges, or colors as applicable for custom designs.
- D. Fasteners:
 1. Wall Panel-to-Structural Connections: Torx-head “Scrubolt™” fasteners.
 2. Wall Panel-to-Panel Connections: Torx-head self-drilling screws.
 3. Fastener Locations: Indicated on erection drawings furnished by metal building system manufacturer.
 4. Exposed Fasteners: Factory painted to match wall color.

- E. Accessories:
1. Accessories (i.e., doors, windows, louvers): Standard with metal building system manufacturer, unless otherwise noted and furnished as specified.
 2. Location of Standard Accessories: Indicated on erection drawings furnished by metal building system manufacturer.
- F. Metal Liner Panels:
1. General: Provide factory-formed metal liner panels designed for interior side of metal wall panel assemblies and field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners in side laps. Include accessories required for a complete installation.
 2. Flush-Profile Metal Liner Panels: Solid panels formed with vertical panel edges and flat pan between panel edges; with flush joint between panels.
 3. Metallic-Coated Steel Sheet: Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 50 (Class AZM150 coating designation, Grade 340); structural quality. Prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
 4. Nominal Thickness: 22 ga./0.034 inch. Panel Width: 12 inches. Panel Corrugation Height: 1.0 inches.
 5. Exposed Finish: 2-coat fluoropolymer. Color: As selected by Owner from manufacturer's full range.

2.8 ACCESSORIES

- A. Gutters:
1. Formed in sections not less than twenty feet in length, complete with end pieces, outlet tubes, and special pieces that may be required. Provide expansion joint with cover if required. Provide gutter supports at 48" o.c. (max.) constructed of the same metal as gutters. Provide stainless steel wire ball strainers at each outlet. Gutters shall be minimum 24-gage roll formed steel. Standard with metal building system manufacturer, unless otherwise noted and furnished as specified.
- B. Downspouts:
1. Formed in sections not less than ten feet in length complete with any special pieces that may be required. Join sections with riveted and sealed joints. Downspouts shall be 24 gage roll formed steel. Furnish to match gutter or wall panels. Gutter straps shall be spaced 8 feet on center max. and be the same material as the gutter.
- C. Exterior Metal Coating on Gutters, Downspouts, Gable Trim, and Eave Trim: "Butler-Cote™" finish system or approved equal, full-strength, 70 percent "Kynar 500" or "Hylar 5000" fluoropolymer (PVDF) coating.

- D. Location of Standard Accessories: Indicated on erection drawings furnished by metal building system manufacturer.
- E. Material used in flashing and transition parts and furnished as standard by metal building system manufacturer may or may not match roof panel material.
 - 1. Parts: Compatible and not cause corrosive condition.
 - 2. Copper and Lead Materials: Do not use with Galvalume panels.

2.9 INSULATION

- A. Laminated Fiberglass: Owens-Corning Fiberglas, NAIMA 202, "Certified R" metal building insulation.
 - 1. TIMA Insignia and Insulation Thickness: Ink-jet printed on fiberglass.
- B. Back-Fill Insulation: Owens-Corning Fiberglas unfaced "Pink Metal Building Insulation Plus".
- C. Roof Insulation:
 - 1. Certified R-Value: 26.
- D. Wall Insulation:
 - 1. Certified R-Value: 19.
- E. Roof and Wall Insulation Facing: PSK Standard Duty (WMP-10).
 - 1. 0.0015-inch-thick, UV-stabilized, white metalized polypropylene laminated to 14-pound Kraft paper, reinforced with glass-fiber scrim.
 - 2. Adhere facing to Owens-Corning Fiberglas "Certified R", NAIMA 202, fiberglass blanket.
 - 3. Assembly of Insulation Blanket and Facing:
 - a. Flame Spread Rating: Less than 25.
 - b. UL Label: Submit as specified in Submittals article of this section.
 - c. Perm Rating: 0.02.

2.10 METAL COATING SYSTEM

- A. Metal Coating System: Butler Manufacturing™ "Butler-Cote™" finish system a factory-applied, exterior metal coating system
- B. Substrate Preparation:
 - 1. AZ50 Galvalume: Factory-controlled chemical-conversion treatment.

- C. Coating:
1. Material: "Fluropon". Full-strength, 70 percent, "Kynar 500" or "Hylar 5000" fluoropolymer (PVDF) color coating.
 2. After steel preparation, coat exterior exposed surface with primer and "Fluropon".
 - a. Nominal Total Dry Film Thickness: 1.0 mil.
 3. Interior Exposed Surfaces: Coat with polyester color coat.
 4. Apply coatings to entire material dimensions of steel sheets before forming of panels.
- D. Physical Characteristics of Exterior Coating:
1. Resistance to failure through cracking, checking, peeling, and loss of adhesion.
 2. Measure by the following laboratory weather-simulating tests to obtain test results justifying metal building system manufacturer's 25-year warranty:
 - a. Humidity resistance at 100 degrees F and 100 percent relative humidity, ASTM D 2247.
 - b. Salt-spray resistance at 5 percent salt fog, ASTM B 117.
 - c. Reverse impact resistance, ASTM D 2794.
 - d. Resistance to accelerated weathering, Atlas Model XW-R Dew Cycle Weather-O-Meter, ASTM D 3361.
 - e. Resistance to dry heat.
 - f. Abrasion resistance, ASTM D 968.
 - g. Chemical/acid/pollution resistance, ASTM D 1308 and G 87.
 - h. Maintain gloss of finish evenly over entire surface, ASTM D 523

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine area to receive metal building system.
- B. Notify Engineer of conditions that would adversely affect installation or subsequent use.
- C. Do not begin installation until unacceptable conditions are corrected.

3.2 ERECTION – STRUCTURAL STEEL FRAMING SYSTEM

- A. Erect structural steel framing system in accordance with the Drawings and metal building system manufacturer's erection drawings.

- B. Field Modifications:
 - 1. Require approval of metal building system manufacturer.
 - 2. Responsibility of building erector.
 - 3. Field Modifications to Truss Purlins: Not allowed, unless indicated on erection drawings furnished by metal building system manufacturer.
- C. Fixed Column Bases: Grout flush with floor line after structural steel erection is complete.

3.3 INSTALLATION – METAL ROOF SYSTEM

- A. Metal Roof System Installation: Butler Manufacturing™ Butlerib® II roof system.
 - 1. Install roof system in accordance with metal building system manufacturer's instructions at locations indicated on the Drawings.
 - 2. Install roof system weathertight.
 - 3. Factory cut-to-length roof panels in accordance with erection drawings furnished by metal building system manufacturer.
 - 4. Position and align roof panels to hold 3-foot module throughout building length.
 - a. Position and align optional factory-punched roof panels by matching factory-punched holes in panels with factory-punched holes in roof structural members.
 - 5. Install side laps with minimum of 1 full corrugation.
 - 6. End Laps:
 - a. Minimum of 6 inches.
 - b. Fasten together over and to structural members.
 - 7. Panel Side and End Laps: Seal with "Panlastic" sealant to prevent entry of capillary moisture.

3.4 INSTALLATION – METAL WALL SYSTEM

- A. Metal Wall System Installation: Butler Manufacturing™ "Butlerib® II" wall system.
 - 1. Install wall system in accordance with metal building system manufacturer's instructions at locations indicated on the Drawings.
 - 2. Install wall system weathertight.
 - 3. Verify structural system is plumb before wall panels are attached.
 - 4. Align and attach wall panels in accordance with erection drawings furnished by metal building system manufacturer.
 - 5. Install side laps with minimum of 1 full corrugation.

6. Seal wall panels at base with metal trim and foam or rubber closures.
7. Exterior Trim: Apply same finish as exterior color of wall panels, except the following:
 - a. Gutters, Downspouts, Eave Trim, Gable Trim, Door-Side Flashings, and Header Flashings: Paint with exterior colors of “Butler-Cote™” finish system, full-strength, 70 percent “Kynar 500” or “Hylar 5000” fluoropolymer (PVDF) coating in standard color of metal building system manufacturer.
 - b. Windows: Factory paint aluminum extrusions (thermally broken).
8. Flashings, Trim, Closures, and Similar Items: Install as indicated on erection drawings furnished by metal building system manufacturer.

3.5 INSTALLATION – INSULATION

- A. Insulation Installation: Install insulation in accordance with metal building system manufacturer’s instructions at locations indicated on the Drawings.
 1. Install roof insulation system on Butler Manufacturing™ Classic structural system.

3.6 PROTECTION

- A. Protect installed metal building system to ensure that, except for normal weathering, metal building system will be without damage or deterioration at time of Substantial Completion.

END OF SECTION

SECTION 14300
HOISTING EQUIPMENT

PART 1 - GENERAL

1.1 SCOPE

- A. Furnish, install, and test hoisting equipment and appurtenances as indicated and specified.

1.2 QUALITY ASSURANCE

- A. Permanently mark with contrasting paint, the capacity of the hoist and trolley in easy to read letters and in a position such that operators can read.
- B. Provide only safety type hooks.
- C. Do not use hoists for construction purposes of any nature.
- D. Hoists to be the product of one manufacturer.
- E. Welding: In accordance with latest applicable American Welding Society Code.

1.3 REFERENCES

- A. Requirements of Regulatory Agencies: Comply with applicable federal, state and municipal codes, and with requirements of authorities having jurisdiction.
- B. ASME B30.16 "Overhead Hoists (Underhung)"
- C. ASME HST-2M "Performance Standard for Hand Chain Manually Operated Chain Hoists"
- D. JIS B 8802 "Manually Operated Chain Hoists"
- E. UL: Underwriters Laboratory regulations.
- F. American Welding Society (AWS) "Structural Welding Code" D1.1.
- G. American Society for Testing and Materials (ASTM) Publications:
 - 1. A36: Specifications for Structural Steel.
 - 2. A48: Specification for Gray Iron Castings.
 - 3. A322: Specification for Steel Bars, Alloy, Standard Grades.
- H. American National Standards Institute (ANSI):
 - 1. B3.15: AFBMA Standard, Load Ratings and Fatigue Life for Ball Bearings.
 - 2. B3.16: AFBMA Standard, Load Ratings and Fatigue Life for Roller Bearings.

1.4 SUBMITTALS

- A. Submit the following in accordance with Section 01300:
 - 1. Shop and erection drawings with attachment points and loads.
 - 2. Manufacturer's data for accessory items (catalog cuts, manufacturer's literature).
 - 3. Manufacturer's literature to supplement product data.
 - 4. Operating and maintenance instructions and parts lists.
 - 5. Shop Manuals.
 - 6. Recommendations for both short and long term storage.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The trolley and hoists shall be supplied by the same manufacturer. All equipment shall be provided as a complete and working system, the hoist manufacturer is responsible for the system as a whole.
- B. Provide one (1) hoist and one (1) trolley as indicated in the Drawings.
- C. Hoist and trolley system shall have the following properties:

Capacity:	2.0 Ton Capacity
Lift:	15'
Hand Chain Drop:	9'+/- (coordinate drop with final monorail, hoist and trolley vertical dimensions so that hand chain hangs 3'0" above finished floor)
Chain:	Nickel Plated – DIN Chain
Trolley Type:	Wheeled Push Trolley
Trolley Capacity:	2 Ton
Beam Size:	3.23 – 6.02 Inch Flange Range. Verify and coordinate with monorail supplier and pre-engineered building manufacturer.
Options Include:	Nickel Plated Hand Chain and Load Chain, Integral Chain Container
Crane Hook:	2 Ton Capacity

2.2 MONORAIL BEAM

- A. Monorail beams and stops will be supplied by the monorail supplier and/or the Contractor. The beams will be designed with sufficient strength and rigidity to prevent undue vertical deflection for the wheel loading of the monorail. The beams will be installed straight and level, at the elevation and location as specified in drawings. Refer to 05500 Metal Fabrications for submittal requirements.

2.3 HOIST

- A. Hoist shall be a hand chain manually operated chain hoist and shall be rated for 2 tons.
- B. Hoists shall employ a split load double reduction spur gear transmission.
- C. Hoist shall be equipped with a dry Weston type mechanical load brake that incorporates two redundant pawls, four braking surfaces, and non-asbestos brake pads that resist humidity and moisture. The brake shall be totally enclosed for protection from impact, dirt, and moisture.
- D. Hoist shall be equipped with a single fall of Grade 100 load chain for capacities 3 US Tons and below. Load chain shall be nickel plated to resist corrosion.
- E. Hoist shall be equipped with hooks that are drop forged from carbon steel, and which are designed for ductile mode failure upon overload. The hooks shall have measurement nubs to facilitate inspection measurements. The hooks shall be equipped with spring loaded latch type throat closures. The bottom hook shall be designed for 360 degree swivel.
- F. Hoist shall be equipped with two contoured chain guides that are tucked into the hoist body where they are out of the way and free from potential interference.
- G. Hoist shall have a load sheave with at least four pockets for the load chain. It shall be equipped with a stripping device that keeps the load sheave free of debris.
- H. Hoist shall have a hoist body featuring a rugged steel housing and double steel plate construction for load bearing.
- I. Hoists shall be equipped with a slip-clutch device that prevents the hoist from being used to lift damaging loads beyond rated capacity.
- J. Hoist shall be supplied with an integral chain container appropriately sized for the specified length and size of load chain. Chain container shall be constructed of vinyl coated canvas with a steel frame or an aluminum container. Chain container shall be designed specifically for use with the hoist supplied.
- K. Acceptable manufacturers:
 - 1. Hoist shall be Model CF020, by Harrington Hoists Inc., Manheim, PA, or approved equal by Liftech International, Muskegon, MI, or Yale Hoisting Equipment Division, Forest City, AK

2.4 TROLLEY

- A. Trolleys shall be a wheeled manual push type units with a hole for attaching suspension hook. Trolleys shall be 4-wheels units fabricated from heavy steel or aluminum sections with sides extending beyond wheel flanges to provide bumper protection. Trolley capacity shall be 2 tons.
- B. Trolley wheels shall have machined treads that are surface hardened and set at proper angle to bear load evenly on supporting beam flanges.
- C. Provide trolley wheels with permanently lubricated ball or roller bearings.

- D. Coordinate trolley size with monorail beams as indicated in the Drawings and with the pre-engineered building manufacturer and monorail supplier.
- E. Acceptable manufacturers:
 - 1. Trolley shall be a model PT Push Trolley by Harrington Hoists Inc., Manheim, PA, or approved equal by Liftech International, Muskegon, MI, or Yale Hoisting Equipment Division, Forest City, AK

2.5 SAFETY STOPS

- A. Provide safety stops on open ends of track and where indicated to prevent trolley from running off ends or damaging building. Stops are to have capability of withstanding impact imposed by motion of fully loaded hoist and trolley.

2.6 PAINTING

- A. Give ferrous surfaces not to be painted a shop coat of grease or other rust-resistant coating.

2.7 SPARE PARTS

- A. Provide in accordance with Manufacturer's Instructions.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE AND HANDLING

- A. Shipping:
 - 1. Ship equipment and material complete except where partial disassembly is required by transportation regulations or for protection of components.

3.2 INSTALLATION

- A. Provide all materials, labor, and equipment to install hoisting equipment as specified and indicated.
- B. Provide services of factory trained service engineer, specifically trained on the type of equipment specified, to assist in placing the equipment in operation and to correct deficiencies in installation, equipment, or material, for not less than the specified time period.
 - 1. The service engineer is to supervise location of anchor bolts; setting, leveling, alignment, field erection and installation; coordination of piping, electrical, and miscellaneous utility connections.
 - 2. Time Period:
 - a. Not less than 1/2 person day, exclusive of travel time for each hoisting equipment.

3. Any additional time required of the factory trained service engineer to assist in placing equipment in operation or to correct deficiencies in installation, equipment, or material shall be provided at no additional cost to the Authority.
- C. Verify dimensions and clearances in field prior to erection for proper fitting and operation of equipment.
- D. Install hoisting equipment as specified and indicated in accordance with hoisting equipment manufacturer's printed recommendations and under direct supervision of manufacturer's representative.

3.3 CHECKOUT AND TESTING

- A. Perform physical checkout, and field and functional testing as required by Manufacturer and in accordance with Section 01810, Commissioning.
 1. Test hoisting equipment for compliance with specification and drawings. Test the equipment at rated load. Furnish test load. Test hoisting equipment functions including hoisting and lowering, trolley travel, limit switches, and locking safety devices. Equipment shall operate as specified and indicated.
 2. Include a check of horizontal and vertical alignment of rails.

3.4 FIELD PAINTING

- A. Refer to Specification Section 09900 for painting requirements.

3.5 VENDOR TRAINING

- A. Provide 4 hrs. of Owner Training in use Equipment and Maintenance.

END OF SECTION

SECTION 15010

MECHANICAL BASIC MATERIALS AND METHODS

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Basic materials and methods and related items for heating, ventilating, air conditioning systems and plumbing systems.

1.2 RELATED DOCUMENTS

- A. General Conditions and requirements of Division 1 apply to Work of this Section.
- B. Related work specified in other Division 15 Sections:
 - 1. 15075 – Mechanical Identification
 - 2. 15100 – Process Piping
 - 3. 15250 – Mechanical Insulation
 - 4. 15400 – Plumbing and Drainage
 - 5. 15440 – Plumbing Fixtures and Specialties
 - 6. 15621 – Gas Fired Unit Heaters
 - 7. 15861 – Fans
 - 8. 15890 – Ductwork
 - 9. 15910 – Ductwork Accessories
 - 10. 15990 – Mechanical Testing and Balancing

1.3 SUBMITTALS

- A. Submit under provision of Section 01330, Submittal Procedures.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Deliver new, unused materials to the job site in original, unbroken factory packaging.

PART 2 – PRODUCTS

2.1 MECHANICAL PIPING & FITTINGS

- A. Provide mechanical piping and fittings per the specification.

- B. Mechanically formed tee connections in copper piping.
 - 1. Contractor may use mechanically formed Tee connections in copper piping in lieu of tee fitting only where main piping is 2 1/2" or larger and where branch connection is 3/4" or smaller. Joint must be brazed. Tool manufacturer: T-Drill.

2.2 UNIONS AND COUPLINGS

- A. Size 2 inch and under: 300 psi malleable iron, bronze to iron ground joint unions for threaded ferrous piping. Provide wrought copper or brass couplings for copper piping. Provide brass unions for all ferrous to copper piping connections.
- B. Size 2-1/2 inch and over: 150 psi forged steel slip-on flanges for ferrous piping and 150 psi bronze flanges for copper piping. Gaskets: 1/8 inch thick, preformed synthetic rubber with impregnate cloth suitable for service intended, high temperature type, 286°F.
- C. Use grooved mechanical couplings to engage and lock grooved or shouldered pipe ends and to allow for some annular deflection, contraction and expansion. Couplings consist of malleable iron housing-clamps, C-shaped composition sealing gasket and steel bolts. Use galvanized couplings for galvanized pipe. For di-electric connection in grooved piping, use manufacturer's di-electric nipple. Manufacturers: Grinnell/Gruvlok Di-Lok Nipple, Victaulic Style 47 Di-electric Waterway.
- D. Unions shall be installed preceding and after each control valve, strainer, pump, coil & any other piece of equipment to enable removal.
- E. Di-electric unions are not allowed, unless noted otherwise.

2.3 BOLTS, STUDS AND NUTS

- A. Steel bolts, studs, and nuts: Comply with the current ASTM A-307, Grade B, or equal.
- B. Threads: American National form right hand machine cut threads complying with the current American Standard for Screw Threads ANSI B1-1, Coarse Thread Series, Class 2 fit.
- C. Provide zinc plated carbon steel bolts and nuts for flanged pipe joints.
- D. Provide stainless steel Type 304 bolts and nuts for underground pipe joints, for all bolts set into concrete, for all bolts securing mechanical equipment, and for all exterior/rooftop bolts
- E. Bolt heads and nuts: Semi-finished, hexagonal, complying with the dimensions for the current American Standard for Wrench Head Bolts and Nuts and Wrench Openings, ANSI B18.2, Heavy Series.

2.4 PIPE SLEEVE

- A. Provide pipe sleeve for all new piping thru existing or new building construction.
- B. Material: Seamless pipe, galvanized, ASTM A120 for penetrations through outside walls and floors, unless noted otherwise. Provide seamless, black steel ASTM A53 elsewhere, unless noted otherwise.
- C. Sleeve Size: Large enough to accommodate the pipe, link seal, and its covering, wall sleeves to be flush on both sides, and floor sleeves to be extended 2 inch above floor level. Where escutcheon plates are required, extend the sleeves 1/4 inch above the floor.

- D. Modular mechanical type seal: Use for the annular space between pipes and sleeves to seal against water or earth, consisting of interlocking synthetic rubber links compressed to positive seal by through bolts bearing on delrin plastic pressure plates. Provide 316 stainless steel bolts. Provide linkseal by PSI/ Thunderline.

2.5 VALVES

A. General

1. All valves shall comply with the applicable Manufacturers Standardization Society of the Valves and Fittings Industry.
2. All valves shall have fullport openings and be of the serviceable type.
3. Manually operated valves used in fuel systems shall have levers with locking devices.
4. Manually operated valves 10 feet A.F.F. or higher shall have chain wheel operators with chains reaching to within 4'-0" A.F.F.
5. Unless otherwise noted, valves shall be rated for a minimum of 125 psi W.S.P/250 psi (cold water, oil, gas).
6. Valves through 2" shall have screwed connections for steel piping and sweat connections for copper piping. Valves 2-1/2" and larger shall be flanged. Grooved connections are permitted where specified.
7. Gate valves shall be repackable under pressure whether open or closed.
8. Provide extended valve stems for insulated piping.
9. Where valves are installed outdoors, all components including the gear wheel operators shall be weatherproofed.
10. Unless noted otherwise, all butterfly valves shall be full lug construction, suitable for bi-directional dead end service, and have open position memory stop. Manually operated butterfly valves 4" and larger shall have enclosed worm gear operators with position indicators.
11. Unless noted otherwise, valves shall be same size as piping.

B. Shut-Off Valve and Check Valve Application Schedule (unless noted otherwise on drawings or specifications)

System	Shut-Off Valve and Check Valve Type and Size		
	2" and Less	2" - 4"	6" and Larger
Cold Water	A, E	B, F	B, F
Natural Gas	A	G	G

C. Shut-Off Valve and Check Valve Types

1. Type A: Ball Valves provide 2-piece, full port, bronze body, stainless steel ball and stem with PTFE seats. Valves for natural gas shall be AGA approved.

2. Type B: High Performance Butterfly Valves, provide iron body, PTFE seat, one-piece stainless steel shaft and bearing, 316 stainless steel disk, Teflon stem packing, memory stop and lug pattern rated for 150 psi, 450 degrees F., ANSI class.
 3. Type C: Standard Butterfly Valve, full lug, carbon steel body, stainless steel disc, shaft and bearing, EPDM seat, Teflon stem packing. Rated for 125 psi, 250 degrees F.
 4. Type D: Gate Valve, bronze body and trim, screwed, rising stem, double wedge or disc. Deep stuffing box with gland and back seating capacity.
 5. Type E: Swing Check Valve, bronze body and trim.
 6. Type F: Silent Check Valve, proved stainless steel spring loaded, resilient disc, silent type, bronze body.
 7. Type G: Lubricated Plug Valve, semi-steel body, single gland, wrench operated, flanged ends, MSS SP-78, 175 psi.
- D. Drain Valve
1. Ball valve with 3/4" hose thread and cap. Bronze body, stainless steel ball and stem.
- E. Water Pressure Regulating Valve
1. Bronze valve body, renewable stainless steel seat. Adjustable reduced pressure range, built-in bypass, diaphragm type with spring cage and orifice. Pressure to be adjustable from a top screw on the valve. Valve to comply with ASSE Standard 1003.
- F. Water Pressure Relief Valves
1. ASME rated, sized for the full installed capacity of the low pressure side of the regulating station. Factory set valve at not more than 20% above low side pressure. Furnish seat material suited for the service.

2.6 STRAINERS

- A. Body shall be bronze, cast steel or cast iron, to match piping materials. Strainers shall be same size as piping, with screwed connections on piping 2" and smaller, and flanged connections on piping 2-1/2" and larger. Where grooved piping is specified, grooved joint strainers may be used. Screen area shall be twice internal area of piping. Pressure rating shall be that of piping system, minimum 125 lbs. Provide 3/4 ball valve blow down valve on all strainers 2" and larger.
- B. For water screen material shall be stainless steel, with maximum openings of 0.033" (maximum) for pipes 2" and smaller and 3/64" for pipe sizes 2-1/2" and larger.
- C. For air and gas service, screen material shall be stainless steel, with maximum openings of 0.006" (maximum) for pipes 2" and smaller and 0.009 for pipe sizes 2-1/2" and larger.

2.7 FLEXIBLE METAL HOSE CONNECTORS:

- A. Length and end fittings as shown in drawings, with an inner corrugated hose made of type 304, 321, or 316 stainless steel and outer braid made of 304 stainless steel.

- B. For copper piping systems, use copper construction braided hoses.
- C. Connectors shall be rated for minimum 125 psi and 450°F.

2.8 FIRE STOPPING

- A. Provide UL classified fire stopping system for mechanical penetrations through rated walls and floors to maintain the fire rating.
- B. Manufacturers: TREMCO Fyrshield, Manville Duxseal, 3M.

2.9 ACCESS PANELS

- A. Furnish access panels to access valves, traps, control valves or devices, dampers, damper motors, etc. Access panels shall be sized as necessary for ample access, or as indicated on drawings, but no smaller than 12" x 12" where devices are within easy reach of operator, and at least 24" x 24" when operator must pass through opening in order to reach the devices. Architectural Trades shall install access panels coordinated with Mechanical Trades.
- B. Access panels in fire rated walls or ceiling must be U.L. labeled for intended use. Unless otherwise indicated on plans, access doors shall be hinged flush type steel framed panel, 14 gauge minimum for frame, and with anchor straps. Only narrow border shall be exposed. Hinges shall be concealed type. Locking device shall be flush type and screw driver operated. Metal surfaces shall be prime coated with rust-inhibitive paint. Panels shall be compatible with architectural adjacent materials. Color by Owner.

2.10 EQUIPMENT MOTORS

- A. Provide motors with all motor driven equipment, complete with drives and controls. Electrical starters will be provided by electrical trade unless part of packaged equipment. See equipment specifications.
- B. All motors used shall conform to all applicable requirements of NEMA, IEEE, ANSI & NEC standards. All motors shall comply with:
 - 1. NFPA 70, "National Electric Code", 1999.
 - 2. NEMA MG-1, "Motors and Generators", 1998.
 - 3. UL 1004, "Motors, Electric".
- C. General
 - 1. Frequency Rating: 60 Hz.
 - 2. Voltage rating of motor shall be determined by voltage of circuit to which motor is connected.

120 V Circuit:	115 V - motor rating
208 V Circuit:	200 V - motor rating
240 V Circuit:	230 V - motor rating
480 V Circuit:	460 V - motor rating
 - 3. Temperature Rise: Based on 40 degree ambient except as otherwise indicated.

4. Service Factor: 1.15 unless noted otherwise.

D. Three Phase Motors

1. General: Energy Efficient, squirrel-cage induction-type, NEMA Design B conforming to the following requirements except as otherwise indicated.
2. Enclosure: Totally Enclosed Fan Cooled (TEFC) unless otherwise noted in equipment specifications and schedules.
3. Motor Efficiency: Nominal (nameplate) full load efficiency and corresponding minimum efficiency equal to or greater than that stated in NEMA MG-1, Table 12-10 for that type and rating of motor.

NEMA TABLE 12-10 - ENERGY EFFICIENT MOTORS
NOMINAL FULL LOAD EFFICIENCIES

Horse-power	Open Drip Proof (ODP)			Total Enclosed Fan Cooled (TEFC)		
	2-Pole 3600 rpm	4-Pole 1800 rpm	6-Pole 1200 rpm	2-Pole 3600 rpm	4-Pole 1800 rpm	6-Pole 1200 rpm
1.0		82.5	80.0	75.5	82.5	80.0
1.5	82.5	84.0	84.0	82.5	84.0	85.5
2.0	84.0	84.0	85.5	84.0	84.0	86.5
3.0	84.0	86.5	86.5	85.5	87.5	87.5
5.0	85.5	87.5	87.5	87.5	87.5	87.5
7.5	87.5	88.5	88.5	88.5	89.5	89.5
10	88.5	89.5	90.2	89.5	89.5	89.5
15	89.5	91.0	90.2	90.2	91.0	90.2
20	90.2	91.0	91.0	90.2	91.0	90.2
25	91.0	91.7	91.7	91.0	92.4	91.7
30	91.0	92.4	92.4	91.0	92.4	91.7
40	91.7	93.0	93.0	91.7	93.0	93.0
50	92.4	93.0	93.0	92.4	93.0	93.0
60	93.0	93.6	96.6	93.0	93.6	93.6
75	93.0	94.1	93.6	93.0	94.1	93.6
100	93.0	94.1	94.1	93.6	94.5	94.1
125	93.6	94.5	94.1	94.5	94.5	94.1
150	94.5	95	94.5	94.5	95.0	95.0
200	94.5	95	94.5	95.0	95.0	95.0

4. For motors used with variable speed drives, provide inverter duty motors in accordance with NEMA MG-1 Part 31, with insulation Class F and insulation temperature rise rating of Class B.

E. Single-Phase Motors

1. Provide internal thermal overload protection for motors.

F. Manufacturers

1. Motors 2 HP and larger shall be manufactured by one of the following: Reliance, Baldor, Dayton, Toshiba, General Electric, U.S. Motor.
2. Requirements in other Sections shall apply.

2.11 ACCEPTABLE MANUFACTURERS

A. Caulking

1. Interchem Presstite
2. Foster Sealer

B. Hatches with safety grating

1. ITT
2. Bilco

C. Flexible Connectors in Pipe

1. Flexonics
2. Twin City Hose
3. Metraflex
4. Mason

D. Pipe Thread Sealing Compound

1. Teflon Seal Tape-Jomar
2. Teflon Dope-Jomar "Gimme the Teflon Stuff"
3. Teflon Whitlam T-U Type 555

E. Couplings

1. Dresser w/ S.S. Hardware

F. Pressure Gauges

1. Trefice

G. Pressure and Temperature Plugs

1. Pete's Plug
2. Schrader
3. Sisco

H. Strainers

1. Mueller
2. Armstrong
3. Grinnell
4. Conbraco Industries
5. Metraflex
6. Spirax-Sarco
7. NIBCO
8. Watts

- I. Thermometers (Industrial Grade)
 - 1. Ashcroft
 - 2. Terice
 - 3. Weiss Instruments
 - 4. Weksler

- J. Vacuum Breakers
 - 1. Hoffman
 - 2. Watts
 - 3. Zurn

- K. Ball Valve
 - 1. Jomar S-100-SS and T-100-SS
 - 2. NIBCO S-585-70-66
 - 3. Watts B-6081-SS
 - 4. Grinnell 3700-6 and 3700-SJ-6

- L. Swing Check Valve
 - 1. Milwaukee 509
 - 2. Crane 37
 - 3. Grinnell 3300
 - 4. NIBCO

- M. Silent Check Valve
 - 1. APCO 300
 - 2. Milwaukee Series 1400
 - 3. Keystone Prince
 - 4. Grinnell Series 400

- N. High Performance Butterfly Valve
 - 1. Dezurik BHP
 - 2. Keystone K-LOK 32
 - 3. Grinnell WINN
 - 4. Watts QF Series X

- O. Standard Butterfly Valve
 - 1. Grinnell Series 8000
 - 2. Dezurik BRS
 - 3. Keystone Model K-LOK 312
 - 4. NIBCO Series 2000 or 3000
 - 5. Watts Series BG

- P. Gate Valves
 - 1. Grinnell 3090
 - 2. NIBCO T134
 - 3. Crane 428

Q. Water Pressure Regulating Valves

1. Watts
2. Bell & Gossett Model 350
3. Conbraco
4. Wilkins

R. Water Pressure Relief Valves

1. Bell & Gossett
2. McDonnell Miller
3. Watts

S. PVC/CPVC Pipe, Fittings & Valves

1. Orion
2. Enfield
3. Spears

PART 3 – EXECUTION

3.1 INSTALLATION

- A. For soldered joints, use non-acidic and lead-free flux on cleaned pipe and fittings. Cut pipe square and ream ends before assembly. Fill joints with solder by capillary actions, with solder covering joint periphery. Wipe joints clean. Apply heat carefully to prevent overheating and damage to pipe, fittings, and valves. Strict adherence to manufacturer's installation recommendations when heating and soldering valves is mandatory.
- B. Terminal units shall be properly supported to wall studs by use of backing plate spanning stud-to-stud.
- C. Cut copper tube square and ream before assembly. Keep piping capped during construction to prevent intrusion of construction debris.
- D. Support piping drops through finished ceiling from structure above to prevent any lateral or up/down movement. Other outlet drops shall be supported from walls, columns, or work benches using appropriate hangers, anchors, or unistrut.
- E. CONTRACTOR shall provide his own survey to locate pipes, elevations, ducts, conduits, etc. and prepare his own shop drawings. Variations to suit existing conditions, structural features or mechanical equipment shall be his responsibility.
- F. Cut pipe accurately and install without springing or forcing. All burrs shall be removed after cutting.
- G. Install plumbing to applicable code requirements.
- H. Install all domestic supply piping for fixtures through the sidewalls unless otherwise noted on the Plans.
- I. Install shock absorbers on the water supply at flush valves or self-closing valves and at equipment with solenoid valves.

- J. Install above ground water piping so as to be completely drainable with accessible drain valves installed at the low points of the system.
- K. Lubricate domestic clean out plugs with mixture of graphite and linseed oil.
- L. Install chrome-plated compression stops for all fixtures.
- M. Make screwed joints with full cut standard taper pipe threads.
- N. Install piping to permit complete draining. Provide capped hose end ball drain valves at all low points.
- O. Installed piping shall be free from sagging. Provide for expansion and contraction of piping in an approved and safe manner by means of loops or offsets, where mechanical expansion joints are not specifically called for.
- P. Branch connections for gaseous systems shall be taken off mains on top, up at a 45E angle, or off the side.
- Q. Branch piping shall be valved at the branch connection points.
- R. Provide fittings and specialties necessary to properly interconnect all items and specialties whether or not shown in detail.
- S. Clean and swab-out all piping before installation. Piping left open for extended periods shall be capped.
- T. Lay out pipe lines straight, plumb and in true alignment. Offset as required to avoid interference with other work, to conceal piping, to allow maximum headroom and to avoid interference with windows and doors. Lay out all pipes and establish their levels from bench marks, existing floors or finished grades.
- U. Piping shall be concealed unless indicated otherwise on drawings. Do not conceal piping until it has been inspected, tested, flushed and approved.
- V. Route pipes in groups where possible.
- W. Run pipes perpendicular and parallel to building walls.
- X. Use eccentric reducing fittings to increase or decrease pipe sizes. Bushings are not acceptable. Orient reducers to prevent trapping of water.
- Y. Pipe extending into finished areas shall have chrome plated escutcheons large enough to cover pipe sleeves and shall fit snugly over pipe or insulation.
- Z. Pitch piping as follows (unless noted otherwise):
 - 1. Vent piping back toward waste at 1/16" per foot.
 - 2. Waste, and compressed air piping down in direction of flow at 1/8" per foot.
 - 3. Natural gas piping level or at 1/4" per 15 foot toward drip leg.

3.2 INSTALLATION OF WELDED PIPING

A. CONTRACTOR Qualification:

1. CONTRACTOR shall submit the welding procedure and the welder qualification per ASME - Boiler and Pressure Vessel Code, Section IX, in order to perform welding in accordance with the ASME - Boiler and Pressure Vessel Code and the ASME B31 Code for Pressure Piping.

B. Preparation:

1. The edge of surface or part to be joined by welding shall be prepared by flame cutting or machining and shall be cleaned of oil or grease and excessive amount of scale, rust or other foreign material.
2. The work area shall be kept clean at all times.
3. Tie-ins to existing pipes shall be done after emptying the pipe and blowing the pipe with nitrogen.
4. The following precautions must be followed when welding or torch cutting is required in area which contains flammable liquids processing equipment in services:
 - a. All open-ended lines and valves shall be blind flanged prior to commencing of the job.
 - b. As much piping as practical shall be prefabricated.
 - c. Tie-ins to existing pipes shall be cold cut, stople and flange procedure.
5. No welding allowed on materials to be joined when their temperature is below 40 degrees F. The material must be preheated to 65 degrees F.

C. Welding Criteria:

1. Carbon steel piping:
 - a. In sizes 1-1/2 inches and smaller, the welding shall be performed by means of the gas welding (oxyacetylene) process.
 - b. In sizes 2 inches and larger, the welding shall be performed by the metallic arc process with coated electrodes.
 - c. In sizes 1 inches and larger the welding may be done by wire welding process (gas metal arc welding).
2. Stainless steel piping, type 304 SS or 316 SS.
 - a. The welding shall be done by gas tungsten arc welding process using a non-consumable electrode of thoriated tungsten.
 - b. Filler metal shall be 316 ELC (extra low carbon).
 - c. Shielding gas and internal purge gas shall be welding grade argon.

- d. Post weld heat treatment: Annealed min. 1925 degrees F and rapidly cooled if corrosion resistance is required.

D. Weld Quality and Repairs:

1. 100 percent penetration is required on the entire length of the welded joints. Welds shall be free of defects, (undercoating, lack of penetration, cracks, etc.) Inside and outside of welds shall be smooth as possible. Add filler rod as necessary. The outside of all welds shall be cleaned by brushing.
2. All welds should be made with one pass.
3. Contractor shall be responsible for any defective welds, including the labor costs to repair or replace the defective weld and the cost of the x-ray of any such welds, until the welds pass inspection.
4. Weld repairs failing three attempts shall be cut out and replaced with new spool piece at Contractor's expense. Quality procedures shall then apply as new weld.

3.3 FLASHING

- A. Flash and counterflash where mechanical equipment passes through weather or waterproofed walls, floors, and roofs.
- B. Flash vent and soil pipes projecting 12 inch minimum above finished roof surface with galvanized steel or aluminum flashing and neoprene boots. Flashing to match equipment materials. For pipes through outside walls turn flange back into wall and caulk.
- B. Secure all flashing w/ S.S. hardware.

3.4 SLEEVES

- A. Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeves.
- B. Install seals and provide floor plate.
- C. Where piping or ductwork passes through floor, ceiling or wall where no potential moisture exists, close off space between pipe or duct and construction with non-combustible insulation. Provide tight fitting metal caps on both sides and caulk.
- D. Install chrome plated escutcheons where piping passes through finished surfaces.

3.5 VALVES

- A. General:
 1. Provide valves of same manufacturer throughout where possible.
 2. Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.
 3. Install valves with stems upright or horizontal, not inverted.

4. Install ball valves for shut-off and isolating service, to isolate equipment, part of systems or vertical risers.

3.6 EXPANSION COMPENSATION

A. Installation:

1. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation.
2. Accomplish structural work and provide equipment required to control expansion and contraction of piping, loops, pipe offsets, and swing joints and provide corrugated bellows type expansion joints where required.
3. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end.
4. Rigidly anchor pipe to building structure where necessary. Provide guides so that movement takes place along axis of pipe only.
5. Install flexible connections on the suction and discharge lines of each pump, except in-line booster pumps, unless noted otherwise.

3.7 TESTING

A. General:

1. Test new systems only, from point of connection to the existing systems. Perform initial tests and correct deficiencies prior to requesting acceptance test.
2. Perform acceptance pressure tests in the presence of the Owner and authorities having jurisdiction. Acceptance test must be satisfactorily completed before piping surfaces are concealed.
3. Pneumatic tests shall be conducted using dry, oil free compressed air, carbon dioxide or nitrogen. Evacuate personnel not directly involved in testing prior to performing pneumatic testing. Perform testing in two stages, initial and acceptance. Conduct initial testing at 5 psi or less. Swab joints with a commercial leak detector. Repair deficiencies prior to testing at higher pressure.
4. Components shall be removed or isolated during testing if damage may occur due to test pressure and/or test media.
5. Provide pumps, gauges, instruments, test equipment personnel and clean auxiliary water. After tests have been made, remove all test equipment and drain all pipes.
6. Submit a complete test report to the Owner.
7. Operate pumps which have mechanical seal only with water in the system.
8. Test prior to painting, installation and insulation, or concealment.
9. Tests may be made on sections of piping as installed.
10. Re-test repaired or revised piping.

B. Pressure Systems:

1. Test pressure: 150 percent of the operating pressure or at test pressure in table below, whichever is greater.
2. Refer to Division 11 for other requirements.

System	Test Media	Test Pressure	Permissible Pressure Drop
Underground Potable Water	Water	150 psig	0 psig in 4 hours
Above Ground Water	Water	150 psig	1 psig in 2 hours
Natural Gas	Air	100 psig	0 psig in 2 hours

C. Gravity System

1. Waste, drain, and vent systems, downspouts, rain leaders and their branches.
2. Entire System: Close all openings except the highest and fill system with water to point of overflow.
3. Sections: Close all opening, except highest, and provide a head of 10 feet. In testing successive sections, at least the upper 10 feet of next preceding section shall be included so that every joint and pipe in the whole system (except the uppermost 10 feet) shall have been subjected to a head of 10 feet of water.
4. After system or section under test has been filled with water, wait at least 15 minutes before starting inspection.
5. After 2 hours (minimum) there shall be no evidence of leakage.
6. Test waste, drain and vent pipe system before fixtures are installed and retest after fixtures have been installed.

3.8 LUBRICATION

- A. Ensure that all motors and equipment, as required, are properly lubricated before such items are accepted by the Owner.

3.9 CLEANING OF DOMESTIC PIPING SYSTEMS

- A. All work shall comply with AWWA, NSF and the City of Ann-Arbor Standards.
- B. Domestic water: Flush with chlorine solution-AWWA C6-168 "Disinfecting Water Mains".
- C. Compressed Air and Natural Gas: Blow clear of chips and scale with 100 psig air.

3.10 PIPE AND EQUIPMENT IDENTIFICATION

- A. Pipe and equipment identification is specified in Section 15075, Mechanical Identification.

3.11 SPARE FILTERS

- A. Provide two years of spare filters for all equipments.
- B. Store filters in a location designated by the Owner.
- C. Label the filters to indicate the matching piece of equipments,

END OF SECTION

SECTION 15075

MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The work includes identification of all process, mechanical and plumbing piping, equipment and ductwork.

1.2 RELATED DOCUMENTS

- A. General and Supplementary Conditions and requirements of Division 1 apply to work of this Section.
- B. Related work specified in other Sections:
 - 1. Division 15 – All Sections

1.3 SUBMITTALS

- A. Submit shop drawings in accordance with Division 1 of these Specifications.
- B. Submit product data information including a description of all markers, paint and tags.
- C. Submit comprehensive list of all pipes, valves, fans, ducts and other equipment to be labeled. List shall include label and equipment number as required by the OWNER.

1.4 QUALITY ASSURANCE

- A. All identification markers shall comply with ANSI A13.1.

PART 2 - PRODUCTS

2.1 PIPE MARKERS

- A. Pre-printed, color-coded, pre-curved plastic pipe markers of the full-bank semi-rigid, snap-on type, extending 360 degrees around pipe.
- B. Piping identification materials shall be large, legible labels, 3-1/2" high on piping 10" and larger, 2-1/2" high on piping smaller than 10", and 3/4" lettering on piping 3/4" and smaller.
- C. Provide marker with lettering describing piping system and flow arrow. Abbreviations for pipe flow type will be provided by the OWNER.

2.1 DUCT MARKERS

- A. Plastic, adhesive type color-coded duct markers with arrow indicating direction of flow and with fan system identified (see Table 2, below).

TABLE 2

Service/Duct Label	Drawing	Letter and Label Color
Supply Air (Equip #)	SA	White on Green
Return Air (Equip #)	RA	White on Green
Exhaust Air (Equip #)	EA	Black on Yellow
Outdoor Air (Equip #)	OA	White on Green

- B. Provide plastic adhesive duct access door markers indicating item and associated equipment accessed, and appropriate safety and procedural information (eg. Fire Damper AHU-1).

2.3 EQUIPMENT MARKERS

- A. Provide engraved plastic equipment markers on **ALL EQUIPMENT AND ACCESSORIES**, indicating drawing identification and service (i.e.: HWP-1 Heating Hot Water Pump) and nominal capacity (cfm, tons or gpm). Scale marker and lettering to equipment labeled.
- B. Contact OWNER for next available equipment number for all equipment.
- C. Markers shall be phenolic tags with white background and black engraved lettering. Markers shall be securely pinned to equipment with stainless steel pins, stainless steel chains or provided with self-sticking backing, as appropriate to the individual equipment and surfaces to which markers are to be attached.
 - 1. Lettering shall be as large as possible up to 1-1/2" in height. For equipment with limited tag spacing, lettering may be reduced in size to a minimum 1/2" as necessary.
- D. Submit a list of all items to be marked as Shop Drawing for OWNER approval prior to ordering markers.

2.4 VALVE IDENTIFICATION

- A. Mechanical CONTRACTORS shall tag all valves with phenolic tags with white background and 1/4" black engraved lettering attach securely to valve by stainless steel chain. Include valve tag charts bound in operating manuals and submit one set of charts, under glass, in metal frames to OWNER.
- B. All main and branch line valves are to be tagged in accordance with the OWNER's numbering system.
- C. Contact OWNER for next available valve number where adding valves to existing buildings.

2.5 ACCEPTABLE MANUFACTURERS

- A. Identification Labels:
 - 1. Seton
 - 2. Brady
 - 3. Bramer
 - 4. Markcraft

PART 3 - EXECUTION

3.1 LOCATION OF MARKERS

- A. Arrows and markers shall be mounted to provide unobstructed visibility from floor level.
- B. Locations for pipe and duct markers in equipment rooms, chases, tunnels and shafts shall be as follows:
 - 1. Adjacent to each valve and fitting (except on plumbing fixtures and equipment).
 - 2. At each branch and riser take-off.
 - 3. At each passage through wall, floor and ceiling construction.
 - 4. At each passage to underground.
 - 5. At each access panel location.
 - 6. On all horizontal runs-marked every 10'-0".
- C. Locations for pipe and duct markers above ceilings in finished areas:
 - 1. Adjacent to each valve.
 - 2. On all horizontal runs-marked every 10'-0".

END OF SECTION

SECTION 15100

PROCESS PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Under this Section the CONTRACTOR shall provide at his own expense all labor, materials, tools and equipment required to furnish and install all pipes, fittings, and accessories for the piping systems as shown on the Plans and specified herein.
- B. Appended to this Section are individual pipe data sheets which specify pertinent pipe data for the various services.

1.2 RELATED SECTIONS

- A. Section 09900 – Paints and Coatings
- B. Section 15010 – Mechanical Basic Materials and Methods
- C. Section 15075 – Mechanical Identification
- D. Section 15110 – Process Valves

1.3 REFERENCES

- A. Piping installations shall conform to:
 - 1. All applicable Federal, State and local codes.
 - 2. Applicable industry codes:
 - a. ANSI - American National Standards Institute Code for Pressure Piping.
 - b. ASME - Boiler and Pressure Vessel Code, Section 1, Power Boiler
 - 3. OWNER's Plans and/or Piping Specifications.

1.4 SUBMITTALS

- A. Submittals shall be in accordance with Division 1 of these specifications and shall include catalog cutsheets, manufacturers data and certification on all items in this section including but not limited to the following:
 - 1. Ductile iron pipe and fittings.
 - 2. Flanged, mechanical, coupled joints, restraining joints and sleeves.
 - 3. PVC pipe, fittings, joints, solvents and adhesives.
 - 4. Detailed scaled pipe layout showing dimensions of each component, their relationship with each other and other equipment and valves, pipe supports, anchors and other accessories.

1.5 ACCEPTANCE AT SITE

- A. Prior to fabrication and/or installation, all piping, fittings, valves and equipment shall be inspected as required. Any materials not meeting the specifications, or obviously faulty material, shall be rejected by the ENGINEER and removed from the job site by the CONTRACTOR.

1.6 MATERIAL PREPARATION

- A. All pipe, fittings and accessories shall be free of all foreign matter. Any accumulations of dirt, rust, scale, mud, etc., shall be removed prior to installation. All pipe ends shall be reamed and deburred to prevent loose particles from getting into the pipe line.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All materials that will potentially be in contact with the finished potable drinking water supply must be certified by Underwriters Laboratory (UL) or the National Sanitary Foundation (NSF) for use in a potable water system. These materials include pipe coatings, pipe metals, cement linings, and joint lubricants and gaskets.

2.2 DUCTILE IRON PIPE AND FITTINGS

- A. Pipe
 - 1. All exposed ductile iron pipe shall be flanged. Flanged pipe shall be fabricated in accordance with ANSI/AWWA C115.
 - 2. Ductile-iron pipe shall meet all the requirements of the latest revision of ANSI/AWWA C151.
 - 3. Ductile iron pipe shall be Thickness Class 53 in accordance with the latest revision of ANSI/AWWA C150.
 - 4. All ductile iron pipe shall be manufactured in the United States of America.
 - 5. All flanges for ductile iron pipe shall be manufactured in the United States of America.
- B. Ductile Iron Fittings
 - 1. Ductile iron fittings shall meet all the requirements of the latest revision of ANSI/AWWA C110 and be flanged joint type.
 - 2. Ductile iron flanged joint fittings shall be rated for a minimum 250 psi working pressure.
 - 3. All ductile iron fittings and flanges shall be manufactured in the United States of America.

C. Coatings

1. The outside of all ductile iron pipes installed inside the structure shall be primed and painted per Section 09900, Painting. These coatings, after drying 48 hours, shall have no deleterious effect upon the quality, color, taste or odor of potable water. Painting may not occur while water is moving through the pipes.

D. Lining

1. Ductile iron pipe and fittings shall be furnished with a bituminous seal coated double cement-mortar lining in conformance with the latest revision of the ANSI/AWWA C104.

E. Gaskets

1. Gaskets for flanged joint pipe shall be 1/8-inch thick SPR rubber, full-faced or ring style, as appropriate for a given diameter of pipe. Gasket shall be compatible with flanges conforming to ANSI/AWWA C115, ANSI/AWWA C110 and ASME B16.1. Gaskets shall be rated for minimum 250 psi working pressure.
2. Gaskets for flanged pipe shall be US Pipe Flange-Tyte gaskets.

F. Bolts, Nuts & Washers

1. Bolts and nuts for above exposed flanged piping shall be as specified under Section 15010, Mechanical Basic Materials and Methods.
2. Size, length and number of bolts shall conform to ANSI/AWWA C110.

G. Restrained Flange Adapters

1. Restrained flange adapters shall be used where indicated in the Plans. Flange adapters shall be made of ductile iron conforming to ASTM A536 and have flange bolt circles that are compatible with ANSI/AWWA C110/A21.10.
2. Restraint for the flange adapter shall consist of a plurality of individual actuated gripping wedges to maximize restrain capability. Torque limiting actuating screws shall be used to insure proper initial set of gripping wedges.
3. The flange adapters shall be capable of deflection during assembly or permit lengths of pipe to be field cut to allow a minimum 0.6" gap between the end of the pipe and the mating flange without affecting the integrity of the seal.
4. For Ductile Iron pipe, the flange adapter shall have a safety factor of 2:1 minimum.
5. The flange adapter shall be the SERIES 2100 MEGAFLANGE adapter as produced by EBAA Iron, Inc., or approved equal.

2.3 POLYVINYL CHLORIDE PIPE AND FITTINGS

A. PVC Pipe

1. Schedule 80 PVC (ASTM D1785) pipe, Type 1.
2. Samples of pipe and physical and chemical data sheets, shall be submitted to the ENGINEER for review and his review shall be obtained before pipe is purchased.
3. The pipe shall be homogeneous throughout and free from cracks, holes, foreign inclusions or other defects. The pipe shall be as uniform as commercially practical in color.
4. Pipe shall be jointed with solvent bell ends.
5. The workmanship, pipe dimensions and tolerances, outside diameters, wall thickness eccentricity, sustained pressures, burst pressures, flattening, extrusion quality, marking and all other requirements of Commercial Standards CS 256 shall be conformed within all respects.
6. The PVC pipe shall bear the National Sanitation Foundation (NSF) seal of approval.
7. The pipe shall be shipped with one coupling factory applied. Pipe shall have a ring painted around the uncoupled end in such a manner as to allow field checking of setting depth of pipe in the socket. If belled-end pipe is specified, the same ring shall be painted around the male end of the pipe.
8. Pipe must be delivered to job site by means which will adequately support it, and not subject to it undue stresses. In particular, the load shall be so supported that the bottom rows of pipe are not damaged by crushing. Pipe shall be unloaded carefully and strung or stored as close to the final point of placement as is practical.
9. PVC must be stored so as to be protected from prolonged heat or direct sunlight. Any protective covering may be used which will not absorb much heat and which will deflect the direct rays of the sun. Ventilation should be provided with any type of cover used.

B. PVC Fittings

1. Fittings shall be of the same material as the pipe, and in no case shall have thinner walls than that of the pipe furnished. All fittings must be made of NSF approved material.
2. Sample of each type fitting must be submitted for the ENGINEER's review and his review must be obtained before all fittings are used.
3. The dry fit of fittings and coupling sockets must be snug. If the fit is such that it is loose, the pipe and/or fittings will be rejected as faulty because of improper size. Building up the joint to overcome a loose fit with multiple layers of filler solvent will not be permitted.

4. PVC couplings - the 2" and 3/4:" PVC couplings may be of the molded type. The 1" through 8" shall be of the extruded type, designed to be interference fit for at least one-half of the socket depth. They shall have a beveled entrance to prevent the wiping off of the solvents on male end while being installed. The wall thickness of the PVC couplings shall be equal to the pipe SDR or shall be 0.10 of an inch thick, whichever is greater. Elbows shall be long radius bends with minimum walls equal to that of the pipe joining or shall be 0.10 of an inch thick, whichever is greater. Tapered welding sockets shall be equal to those required for couplings.

C. PVC Welding Solvents

1. The solvent cement should meet all the requirements of ASTM Tentative Specification for Solvent Cement for Polyvinyl Chloride (PVDC) Plastic Pipe and Fittings ASTM Designation: D2564.
2. PVC welding solvent shall be compounded to conform with the socket fit and the weather conditions at the time of installation and be such as to assure minimum installation cost and a weld of maximum strength.
3. Since PVC welding solvent is engineered and formulated to perform with a given joint design, all solvent must be purchased from the manufacturer of the pipe.
4. PVC solvent cements should be stored in a cool place except when actually in use at the job site. These cements have a limited shelf life when not stored in hermetically sealed containers.

PART 3 - EXECUTION

3.1 PIPE RECEIVING, HANDLING AND STORING

- A. Cleanliness in all piping systems is of paramount importance and procedures used in receiving, handling and storing shall be directed toward assuring that all lines are clean and free of rust, scale, dirt, and all foreign material that can damage equipment or contaminate potable systems or processes. Similar precautions must be taken in handling and storing of fittings, valves, pumps and other equipment to insure a clean pipeline assembly.
- B. Any pipe damage in transport or handling shall be rejected and removed from the job site by the CONTRACTOR.
- C. Care shall be taken not to injure any pipe or pipe coating and no damaged or imperfect pipe shall be used in the work except that minor damage which may be repaired subject to the review of the ENGINEER.

3.2 INSTALLATION

- A. General
 1. Only personnel competent at installing the various types of pipe shall be employed on this phase of the work and complete suitable equipment necessary for the execution of same is required. Any incompetency observed by the ENGINEER must be removed at his request, and where improper equipment or

lack of same appears to be impairing the quality or speed of the work, such adjustments in same shall be made to the ENGINEER's satisfaction.

2. Piping shall be installed straight and true, with approved offsets around obstructions as shown on the Plans or as required for satisfactory installation and operation. Horizontal piping shall be sloped to permit drainage. All vertical pipe shall be installed plumb and parallel with the building lines.
3. Piping shall be run in an orderly manner consistent with good operation, neatness of appearance and safety of operating personnel. Wherever possible interior piping will be grouped in banks with a change in elevation when a change in direction occurs. Provisions shall be made in establishing piping runs to allow for maximum accessibility for servicing. Space allowance shall be made for possible future changes or additions. Pockets which will prevent complete drainage of a line shall be avoided. Valves, gauges, controls, and other piping specialties shall be conveniently located for operating and servicing. Piping shall not be run through electrical control rooms or over electrical equipment.
4. Piping shall not be run in such a manner as to interfere with the operation, adjustment or maintenance of equipment. Piping shall not be located directly over pumps, motors, or equipment so as to impede their removal.
5. A minimum clearance of 8'-0" headroom shall be maintained over working areas, passageways and platforms.
6. Compressed air branch lines and air-hose connections shall be made off the top of the main header, unless the branch line is also intended to serve as a drain for the header.
7. Branch lines off main headers such as process, water and air shall have shut-off valves to permit maintenance on equipment or piping without disrupting service to other areas. Valves in sludge line branches shall be located close to the main line to present plugging ahead of the valve.
8. Where pipe sections are pre-fabricated, it shall be the CONTRACTOR's responsibility to check all dimensions and possible interferences in the field. Provisions shall be made to adjust for any discrepancies which may occur between routing and dimensions shown on the Plans to avoid possible interferences and to compensate for final field placement of equipment.
9. All cutting of the pipe shall be done in a neat workmanlike manner with the least amount of waste and without damage to existing or new lines. A fine tooth saw, tubing or pipe cutter or similar tool shall be used to cut the pipe. Cuts must be square and ragged edges removed with a burring tool and/or file.
10. After cutting bell and spigot or socket pipe, a stop mark shall be made with a pencil or crayon using dimensions as shown by the manufacturer's instructions or by using another pipe in the field as a guideline.
11. At the termination of pipe installation any open ends of pipeline shall be closed off by a suitable cover until installation operations are resumed.
12. All piping connections to equipment shall be aligned and supported in such manner that no load or thrust will be exerted upon the equipment by the piping at installation or in operating conditions.

B. Sleeves

1. Penetrations for all pipes passing through concrete or masonry structures shall be sleeved or formed as specified herein.
2. Sleeves for pipe sizes up to 24" diameter shall be molded non-metallic high density polyethylene Model CS Century-Line® sleeves as manufactured by PSI-Thunderline/Link-Seal®. Model CS sleeves shall have integrally formed hollow water stop sized having a minimum of four inches larger than the outside diameter of the sleeve itself and allowing 1/2" movement between wall forms to resist pour forces. Each sleeve assembly shall have end caps manufactured of the same material as the sleeve itself and installed at each end of the sleeve so as to prevent deformation during the initial concrete pour, and to facilitate attaching the sleeve to the wall forms. End caps shall remain in place to protect the opening from residual debris and rodent entry prior to pipe insertion.
3. For pipes 24 inches and larger, penetrations shall be formed using Cell-Cast® Hole Forming Disks as manufactured by PSI-Thunderline/Link Seal, per the manufacturer's installation instructions.
4. Link Seals with stainless steel hardware shall be provided on all penetrations.
5. The CONTRACTOR shall furnish the shop drawings of sleeves to the ENGINEER for his review.

C. Drains and Overflows

1. Provision shall be made for valved drain connections from low points of all piping systems to permit complete drainage after shutdown. Drains shall be provided where a pocket of liquid can form above a control or shut-off valve or other obstruction.
2. Overflow piping and drains from all tanks and vessels shall be provided to suitable drain or sewer and shall be visible to prevent unnecessary losses or contamination.

D. Miscellaneous Connections

1. Small size connections (for gauges, instruments, samples, etc.) to large size pipe or headers may be made with weld-o-lets, threaded-o-lets, couplings or half couplings welded onto steel piping, tapped bosses on cast and ductile iron fittings, or tapping saddles.

E. Pipe Supports, Hangers, Guides, Anchors, Sway Bracing for Process Piping

1. Hangers for process piping will normally be clevis hangers with mild steel rod, and malleable or wrought steel beam clamps, with entire assemblies to be hot dip galvanized. Piping may be supported by the resting type of proper structural designed brackets or racks, as indicated in the drawings. No welding to structural steel building members shall be permitted without review of the ENGINEER. Welding to auxiliary steel pipe support beams will be permitted. Suitable anchors, guides, sway braces, vibration dampeners, and flexible joints shall be provided to prevent excessive vibration or expansion forces on equipment. Heavy valves shall be supported to keep undue strain off of piping

and adjacent equipment. Where supporting piping at valves, pumps, heat exchangers and equipment requiring periodic maintenance, support to allow easy removal of equipment with a minimum of temporary supports. Where pipe resting on beam supports to stanchions, is subject to linear or lateral movement, teflon slides or graphite pipe slides cemented to pipe and support members shall be used to eliminate abrasion and corrosion which commonly occurs at these points.

2. Hangers and supports shall be in accordance with the ANSI Code for Pressure Piping B31.1. These shall be the product of Plasti Fab, Inc., Grinnell Company, Power Piping Company, or equal.
3. Hanger rods shall be connected to beam clamps or concrete inserts. These devices shall be Underwriters' Laboratories approved. "C" clamps will not be allowed.
4. Concrete anchors shall be stainless steel epoxy set anchors, Hilti HY-150 or equal. Expansion anchors may not be used. Drilling of holes in concrete shall be made by rotary drill only - not by hammers of any kind.
5. Unless otherwise noted on the drawings, vertical piping shall be supported at each floor or grating level with approved riser clamps except where prohibited by piping flexibility requirements. Lateral movement of exposed vertical piping at building walls shall be restrained by anchor devices attached to walls except where prohibited by piping flexibility requirements. Riser clamps shall be Grinnell Figure 261, Power Piping Company, Figure 36, or equal. Provide retaining straps when clamps are used.

F. Piping Joints

1. Flanged joints or unions shall be provided at connections to equipment, valves, instruments, etc., as required for removal and/or servicing. Provisions must be made for removal and reinstallation of units located between flanged or union joints by providing flexibility in the piping, use of elbow connections, or other means approved by the ENGINEER.
2. Aside from connections at equipment, valves instruments, etc., joints in the pipe line shall be held to a minimum consistent with cleaning or servicing requirements. Flanged joints are preferred to union joints. Welded joints are preferred to screwed joint. Mechanical joints are preferred to caulked joints.
3. For welded pipe joints, pipe ends shall be square cut for pipe with wall thickness of .065 inch or less. For wall thickness over .065 inch the ends shall be beveled 37-1/2 degrees with a 1/16 inch thick land base. Use of welding rings shall be avoided.
4. Screwed joint compound shall be TFE tape or other ENGINEER reviewed material suitable for the particular service. Joint compound shall be applied only to the male thread. Care shall be exercised to prevent component from reaching the pipe interior.

G. Cleaning and Flushing

1. Unless special cleaning procedures are noted in the respective piping specifications, these general methods shall apply for cleaning lines before start-

up. Installations of all piping shall be done with extreme care to insure clean pipe lines free of scale, rust, weld splatter or beads, sand, dirt, grease and all other impurities or foreign matter. All piping shall be installed to permit cleaning by flushing through all portions of the piping system with provisions made to open the lines at all low points to permit release of any accumulation of foreign material and to drain off the flushing fluid. Where this flushing operation may be detrimental to specialties and/or equipment, provisions must be made for isolation or removing these components from the system. When feasible, this flushing operation shall be done with the same medium that will normally be conveyed in the line, i.e., air for air or gas lines, water for water lines and liquids, oil for oil pipings, etc. At branch connections to operating equipment provision must be made to blow down through an open pipe line.

H. Testing

1. Field pressure testing the installed pipe line shall normally be done at a pressure as specified on the individual pipe data sheets at the end of this Section. Testing shall be by hydrostatic means. The pipe ends may be valved or blanked off and the test pressure shall be maintained a sufficient length of time to permit an inspection of all joints and connections for any leaks or failures. All pressure piping such as steam, water, oils and gasses shall be tested in accordance with latest ANSI B31.1 code or pressure piping. Provision shall be made for completely draining a pipe line after hydrostatic testing is completed. Testing of non-ferrous piping, plastics, fiberglass reinforced resin and other materials shall be made within the recommended limits of the manufacturer.

3.3 DISINFECTING

A. Chlorination

1. All new mains and pipe or any existing mains contaminated by the CONTRACTOR shall be chlorinated to a minimum residual chlorine concentration of fifty (50) parts per million with commercial liquid chlorine solution or approved equal. The chlorinated water shall be allowed to stand in the mains for 24 hours. The end of the 24-hour period the chlorinated water at all parts of the mains shall show a free available chlorine residual of not less than twenty-five (25) parts per million. If less than twenty-five (25) parts per million residual is shown at the end of the first 24 hours period, additional chlorine shall be added until a residual of not less than twenty-five (25) parts per million at all parts of the system is shown after a subsequent 24 hour period. The chlorinated water shall then be removed from the mains and the mains flushed with potable water for bacteriological testing. No flushing shall take place between the two required bacteriological testing.
2. CONTRACTOR shall submit a flushing plan to the ENGINEER for review, which shall include the quantity of flushing water and location where the water will be discharged. If there is any possibility that the chlorinated discharge will cause damage to the environment, then a neutralizing chemical shall be applied to the water to neutralize the residual chlorine prior to discharge. Refer to Appendix C of AWWA C651 for information on neutralizing chemicals. Where necessary, Federal, State, County and local regulatory agencies should be contacted to determine special provisions for the disposal of heavily chlorinated water.

B. Bacteriological Testing

1. The CONTRACTOR shall coordinate and schedule with the ENGINEER to take bacteriological samples of the water in the mains for analysis at two different times. The CONTRACTOR is responsible for taking samples and transporting them to the OWNER's laboratory under the accompaniment and supervision of the ENGINEER. The OWNER shall provide sample testing services for two rounds of sampling per pipe section tested, any additional sample testing shall be at the CONTRACTOR's expense. The first samples will be taken 24 hours after the mains have been satisfactorily chlorinated, flushed and filled with potable water. The second sample will be taken 24 hrs later. No flushing shall be done during or between tests, unless supervised and approved by ENGINEER.
2. The CONTRACTOR shall provide a sufficient number of corporation cocks and copper tubing for taking samples. Samples shall not be collected from hoses or hydrants.
3. If analysis of any sample indicates that the water is unsafe for human consumption, the disinfection sampling and analysis procedures shall be repeated until samples obtained on two (2) consecutive days are found to be safe.

END OF SECTION

MATERIAL TO BE HANDLED: Potable water

SERVICE: Process piping spool pieces within pump station.

TEMPERATURE RANGE: 32°F - 100°F

PRESSURE: Operating 100 psig; test 150 psig

PIPE: Ductile Iron Thickness Class 53

LINE JOINT: Flanged

FITTINGS: Flanged

GASKETS: See pipe specifications

BOLTING: See pipe specifications

COLOR CODE: Match existing

LINE LABEL: Every 10 ft; see Specification Section 15075

INSULATION: None

LINING: Double cement mortar

NOTE: –

MATERIAL TO BE HANDLED: Storm

SERVICE: Sump pump discharge piping for footing/crawlspace drains sump

TEMPERATURE RANGE: 32°F - 100°F

PRESSURE: Operating 25 psig; Test 50 psig

PIPE: PVC Schedule 80

LINE JOINT: Solvent Cement Socket

FITTINGS: Solvent Cement Socket

GASKETS: -

BOLTING: -

COLOR CODE: -

LINE LABEL: Every 6 ft; see Specification Section 15075

INSULATION: -

LINING: -

NOTE: -

MATERIAL TO BE HANDLED:	Sanitary
SERVICE:	Sump pump discharge piping for floor drains sump
TEMPERATURE RANGE:	32°F - 100°F
PRESSURE:	Operating 25 psig; Test 50 psig
PIPE:	PVC Schedule 80
LINE JOINT:	Solvent cement socket
FITTINGS:	Solvent cement socket
GASKETS:	-
BOLTING:	-
COLOR CODE:	-
LINE LABEL:	Every 6 ft; see Specification Section 15075
INSULATION:	-
LINING:	-
NOTE:	-

SECTION 15110

PROCESS VALVES AND ACCESSORIES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Valve work shall include the furnishing, by the Contractor, of all labor, materials and services necessary for installing all the valves, valve operators, and necessary equipment shown on the Plans and specified herein for a complete and functioning installation in accordance with the Contract Documents for process systems. This work does not include plumbing systems or underground buried valves.

1.2 STANDARDS

- A. All valves and operators installed under this Specification shall conform to the applicable requirements of AWWA, ASTM, and ANSI standards governing materials of construction, dimensional tolerances and workmanship of the valves. Every valve and operator shall carry the name or trademark of the manufacturer. Each valve shall have a permanent position indicator easily readable from operating position.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Specification Section 15440, Plumbing Fixtures and Specialties
- B. Specification Section 15400, Plumbing and Drainage

1.4 SHOP DRAWINGS

- A. Shop drawings shall be submitted to the Engineer for his review in accordance with the requirements of Division 1 of these Specifications.

1.5 INSTRUCTION MANUALS AND INSTRUCTIONS

- A. The Contractor shall obtain from the manufacturer of all major valves Operations and Maintenance Manuals instruction manuals covering maintenance, service and lubrication of the valves, in accordance with the requirements of Division 1 of these Specifications.
- B. The Contractor shall provide a competent field service representative to inspect and install and make necessary adjustments and calibration of the valves and controls and instruct the Owner's personnel in the proper operating of valves, actuators, and controls.

PART 2 - PRODUCTS

2.1 PVC BALL VALVES

- A. Valves 2-1/2 inches and larger shall have a polyvinyl chloride (PVC) body with a minimum non-shock W.O.G. working pressure rating as specified in the valve schedule. Seats shall be TFE easily removable for replacement. Stem shall be PVC with "O" ring viton seal or Engineer approved equal. Valves shall have a union and connector for ease in access to the ball and seats. Valves shall have ANSI 125 lb standard drill flat faced flanges and "T" handle operators unless otherwise specified or shown on the Plans.

- B. Valves 2 inches and under shall have a polyvinyl chloride (PVC) body and ball with a minimum non-shock W.O.G. working pressure rating as specified in the valve schedule. Seats shall be PTFE easily removable for replacement. Stem shall be PVC with "O" ring viton seal or Engineer approved equal. Valves shall have double union and connectors to allow body removal without disturbing the piping system. Valve ends shall be socket and operators shall be "T" handle unless otherwise specified or shown on the Plans.

2.2 SLANTING DISK CHECK VALVE WITH BOTTOM BUFFER

- A. Valve body shall be heavy two piece cast iron, fabricated steel is not acceptable. The two (2) body halves and body seat shall be O-ring sealed and bolted together in a manner to sandwich the body seat on a 55° angle. Each body half must have an access covered hole for internal inspection and each body half and the disk must be fully machined to accept attachment of a Bottom Buffer or Top Mounted Oil Dashpot. The seat ring and disc ring must be of the design that permits replacement in the field without need for special tools or machining. The pivot pins in the body and the bushings in the disc lugs must be stainless steel of different hardnesses to prevent galling. The bushings shall be press fit to prevent wear. An indicator shall be provided to show position of the disc. The area throughout the valve body must be equal to full pipe area. The area thru the seat section shall be 40% larger than the inlet and outlet of the valve to achieve lowest head loss.
- B. The valve must have a bottom mounted buffer for free open and positive non-slam closing. The buffer shall be designed to contact the disc during the last 10% of closure and thereafter control the disc closure until the valve is shut in a manner to minimize or prevent water hammer. The rate of hydraulic control and the initial point of buffer contact to the disc closure must be externally adjustable and variable to suit the water column reversal time. The bottom buffer hydraulic system must be self-contained and independent from pipeline media to prevent contamination of the media and protect the cylinder against corrosion.
- C. The manufacturer shall have been regularly engaged in the design and manufacture of Slanting Disc Check Valves for at least five (5) years and submit at least five (5) similar installations in service for a minimum of five (5) years, for engineer approval prior to release to manufacturer. An Operating & Maintenance Instruction Manual shall be furnished with submittal Drawings.
- C. Valve shall be equipped with an external valve position sensor to confirm the valve has returned to the "closed" position. Refer to Electrical Drawings for additional details.
- D. Slanting disk check valves with bottom buffer shall be DeZurik/APCO series 800B, model number: CSD,800,F1,DI,DI-BRZ*BMB, or OWNER approved equal.

2.3 PVC CHECK VALVES

- A. Valves 2-1/2 inches larger shall be Schedule 80 PVC, full port, true union valves, designed for easy removal and plastic ball in elastomer square cut seat. End connections shall be ANSI 125 lb standard flat face flanges. Valve seal material shall be EPDM.
- B. Valves 2 inches and under shall be Schedule 80 PVC, full port, true union valves, designed for easy removal and plastic ball in elastomer square cut seat. End connections shall be socket. Valve seal material shall be EPDM.
- C. Valve manufacturer shall be Hayward, NIBCO or Owner approved equal.

PART 3 - EXECUTION

3.1 VALVE SCHEDULE

- A. Refer to the Plans for listing the size, type, function and general accessories of major valves to be furnished and incorporated in the Contract.
- B. Miscellaneous valves, such as valves for the heating system, valves for the plumbing system, stop valves and the like shall be furnished and installed under appropriate sections of the Specifications and are not included herein.
- C. The Valve Schedule does not limit the Contractor's responsibility to install all valves and accessories which are to be provided under this section of the Specifications and as shown on the Plans. No consideration or allowance will be granted for failure to examine the Plans for any alleged misunderstanding of valves and accessories to be furnished and installed.

3.2 PAINTING FOR VALVES

- A. All iron work of valves, stem guides, operating stands and accessories to be installed within buildings shall be painted as specified in Section 09900, Painting. Valve nameplates shall not be painted over, but shall be neatly taped off prior to painting.

3.3 VALVE TAGS

- A. Each valve must be tagged as indicated under Section 15075, Mechanical Identification for numbering and coding as directed by the Engineer. Tags shall be permanently attached to valve body or with chain on small valves.

END OF SECTION

SECTION 15250

MECHANICAL INSULATION

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The work required under this section of the specifications shall consist of furnishing all material and performing all labor required for the thermal insulation of all hot water and cold water piping, potable and non-potable water lines, equipment and ductwork all as described in these specifications and/or as shown on the Drawings and/or as identified in the Insulation Schedule herein.
- B. All items to be insulated shall be completely primed and painted per specification Section 09900 prior to insulating.
- C. The work includes but not limited to:
 - 1. New cold water and hot water lines.
 - 2. Horizontal and vertical runs of storm drains including entire roof drain piping and including roof drain sump.
 - 3. New exterior and interior supply and return ductwork.
 - 4. New intake and exhaust damper housings.
 - 5. Generator exhaust pipe and muffler
 - 6. Do not insulate the following:
 - a. Exhaust air ducts.
 - b. Existing pipes, equipment, etc.
 - 7. All insulated items except for aluminum coverings shall receive the PVC jacket, with color to match the painting scheme.

1.2 DEFINITIONS

- A. The term "concealed work" as used herein refers to piping and ductwork above suspended ceilings and within walls, partitions, shafts, concrete encasement or service spaces and not normally exposed to view.
- B. The term "exposed work" refers to piping, ductwork or equipment normally exposed to view within rooms and open areas.
- C. The term "Exterior work" refers to piping, ductwork or equipment normally exposed to view located outside exposed to weather.

1.3 SUBMITTALS

- A. Submit shop drawings to Engineer for review and approval as set out in Division 1.

PART 2 - PRODUCTS

2.1 HOT AND COLD WATER

- A. Armaflex Insulation System:
 - 1. Shall be insulated with Armacell Armaflex insulation, 1" thick and PVC jacket.
 - 2. Flexible closed cell elastomeric pipe insulation, ASTM C534, conductivity of 0.27 at 75 degrees F, water vapor permeability of 0.10. Composite flame spread/smoke density of 25/50. With PVC jacket over all insulated surfaces. PVC jacket shall be 0.03" thick, 6,000psi tensile strength (ASTM D-638), passing ASTM-E84 25/50. All jacketing applied shall be factory formed and oven cured. Jacketing shall be continuous utilizing solvent weld jointing system. Each pipe shall be color coded. Colors shall be selected by the Owner/Engineer at the submittal process
 - 3. Apply Armaflex 520 BLV Adhesive to seal all seams and joints.
 - 4. Installation shall be in accordance with manufacturer's published installation instructions and of the highest quality and finish appearance.

2.2 DUCTWORK INSULATION

- A. Exposed Ductwork:
 - 1. Armaflex Insulation System:
 - a. Shall be insulated with Armacell Armaflex, 1" thick with aluminum jacket.
 - b. Apply Armaflex 520 Adhesive to metal duct surface and backside of Armaflex and bond when tacky. Also seal all seams and joints.
 - c. Installation shall be in accordance with Armstrong's published installation instructions and of the highest quality and finished appearance.
- B. Intake/Exhaust Damper Housings and Exhaust Fan Wall Boxes:
 - 1. Provide 1" thick Styrofoam SM rigid insulation board of shapes and sizes to suit damper and wall box housing sizes. Aluminum sheet metal enclosures fabricated by Contractor shall enclose the insulation.
 - 2. Refer to mechanical and/or general trades drawings for details including locations and sizes.

2.3 GENERATOR EXHAUST PIPE AND MUFFLER (SILENCER)

- A. Insulate entire interior portion of exhaust system with 75 mm (3") pink calcium silicate pipe insulation in two layers with staggered joint construction, secured with S.S. 316 bands at 300 mm (12") centers.

- B. Cover insulation with magnesium aluminium alloy jacket (.025" thickness) smooth style applied with circumferential and longitudinal joints sealed. Secure jacketing with S.S. 316 snap-straps on 300 mm (12") centers. Prefabricated jackets shall be used at all bends and fittings. Seal exposed ends of insulation with high temperature mastic (1100°F) to ensure jacketing is moisture proof.
- C. Ensure that drain plugs are extended to project beyond finished surface of insulation.
- D. Insulation shall be as manufactured by Owens Corning.

2.4 MECHANICAL INSULATION SCHEDULE

- A. All piping, valves, ductwork and tanks identified in the attached schedule to be insulated with the type of material as identified in the schedule. Refer back to the various items previously described in this section for required insulation thickness.
- B. Any mechanical insulation omitted from the Schedule but shown on the drawings shall be supplied and installed by the Contractor.
- C. The Contractor shall not claim for any extra costs for mechanical insulation that have not been listed, but which are shown on the Drawings.

MECHANICAL INSULATION SCHEDULE

Description	Diameter Ranges (inch)	Insulation Type	Covering
Hot and cold water piping and related work	½" and up	Armaflex	PVC Jacket
Supply and Return Ductwork		Armaflex	Aluminium Jacket
Exterior Supply and Return Ductwork		Fiberglass	Bakelite Waterproofing + Aluminium Jacket
Roof Drain Sump and Storm Piping	3" to 12"	Armaflex	PVC Jacket
Generator Exhaust Pipe and Muffler		Owner's Corning Calcium Silicate	Magnesium Aluminium Alloy Jacket

2.5 JACKETS

- A. Polyvinyl Chloride (PVC):
 - 1. One-piece molded type with pre-formed shapes as required.
 - 2. Minimum service temperatures: -4°F.
 - 3. Maximum service temperature: 149°F.
 - 4. Moisture vapor transmission: 0.02 perm.

5. Fastenings
 - a. Use solvent weld adhesive compatible with insulation system to seal laps and joints.
- B. Aluminum:
 1. To ASTM B209.
 2. Thickness: 1/50 inch sheet.
 3. Joining: Longitudinal and circumferential slip joints with 2 inch laps.
 4. Fittings: 1/50 inch thick die-shaped fitting covers with factory-attached protective liner.
 5. Metal jacket banding and mechanical seals: stainless steel, $\frac{3}{4}$ inch wide, 1/50 inch thick at 12 inch spacing.
- C. Finishes:
 1. Exposed steam pipes in boiler room: Aluminum jacket.
 2. Exposed condensate water in boiler room: Aluminum jacket.
 3. Concealed, indoors: canvas on valves, fittings. No further finish.
 4. Use vapor retarder jacket compatible with insulation.
 5. Finish attachments: SS bands, at 6 inch oc. Seals: closed.

PART 3 - EXECUTION

3.1 WORKMANSHIP

- A. Insulation shall be installed in a smooth, clean workmanlike manner. Joints shall be tight and finished smooth. Cracked or chipped sections shall not be used in the work.
- B. All surfaces to be insulated shall be dry and free of loose scale, rust, dirt, oil or water when insulation is applied.
- C. Insulation shall fit tightly against the surface to which applied to prevent air circulation between the insulation and the pipe, equipment or ductwork to which it is applied.
- D. Insulation applied to piping, equipment and ductwork shall be completely vapor sealed, free of pin holes or other openings.
- E. Do not apply seal or cement until previous applications of cement and adhesives have thoroughly dried.
- F. Any existing insulation and surface finish disturbed or damaged during the course of the work shall be restored in a manner acceptable to the Engineer.

- G. All insulated finish surfaces shall be neat and uniform with a high level of workmanship and shall be reviewed and accepted by the Engineer.
- H. Defects and/or poor workmanship found by the Engineer shall be repaired or replaced to the satisfaction of the Engineer at no additional cost.

END OF SECTION

SECTION 15400

PLUMBING AND DRAINAGE

PART 1 - GENERAL

1.1 SCOPE OF THE WORK

- A. The work required under this Section of the Specifications shall include all labor, equipment and materials to complete all plumbing and drainage work as indicated on the drawings and specified herein including the following briefly described: (Not all inclusive)
 - 1. Cold water, potable and non-potable water systems shall include all associated piping, equipment and accessories specified herein and shown on the drawings.
 - 2. Storm drainage system shall include all above and below ground piping, equipment and accessories specified herein or shown on the drawings for a complete system within the building.
 - 3. Process drainage system shall include all above and below ground piping, equipment and accessories specified herein or shown on the drawings for a complete system within the building.
 - 4. Natural gas system shall include all underground and above ground piping specified herein and/or shown on the drawings for a complete system within the building.

1.2 CODES, APPROVALS AND PERMITS

- A. Perform the entire installation in accordance with the latest codes and regulations as specified herein.
- B. All equipment installed must be approved by the related national and international standards, Underwriter's Laboratories where applicable and other approval agencies.
- C. Conform to the applicable codes and regulations of the Office of the Fire Marshal, UL and all other state and local municipal regulations.

1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 09900 - Finish Painting
- B. Section 15990 - Mechanical Testing and Balancing
- C. Section 15250 - Mechanical Insulation

1.4 MATERIALS

- A. All materials shall be new and acceptable by State of Michigan, City of Ann Arbor and all other applicable jurisdictions of first quality, subject to the approval of the Engineer. To avoid delay in the work, materials must be ordered as soon as Contract is awarded. Report at once to the Engineer any delay in delivery that would retard completion of the work.

1.5 SERVICE CONNECTIONS

- A. The location of water, gas and sewer services as shown on the drawings are taken from believed to be reliable records. If found to be inaccurate, the Contractor shall make connections to or plug at the location where he finds the service.
- B. All present gas or water services not re-used shall be plugged or removed in accordance with local regulations and as indicated on drawings. Water services not used shall be brought back to the nearest tee to eliminate any dead end.

1.6 GENERAL REQUIREMENTS

- A. Furnish and install all piping systems in accordance with applicable requirements of specifications.
- B. Make all required potable water and drainage connections to equipment specified in this Section and other Sections or shown on the drawings.
- C. Piping, valves, fittings and trim shall be polished chromium plated when exposed in finished areas, such as washrooms.
- D. All equipment, fixtures, trim, exposed piping surfaces and accessories shall be adjusted, tested, polished and cleaned to the satisfaction of the Engineer prior to final acceptance.
- E. All pipes penetrating floors, walls or ceilings in finished areas shall be provided with solid polished chromium plated escutcheon plates or as shown on the drawings.
- F. Floor drains shall be set 1/4" below the normal finished floor elevation unless otherwise shown on the drawings.
- G. Rough-in shall be accurately laid out before setting fixtures. Set fixtures uniformly, making connections at right angles to walls.

1.7 TESTS AND DEMONSTRATIONS

- A. Leak testing of all piping systems installed under this Section shall be performed only after due notice to and in the presence of the Engineer and local authorities having jurisdiction.
- B. After final adjustment of all valves, regulating devices and equipment their satisfactory operation shall be demonstrated to the satisfaction of the Engineer. Any items not functioning properly shall be re-adjusted or replaced as required.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS - UNDERGROUND

- A. Storm Drain - Inside Building:
 - 1. PVC Schedule 80 pipe and fittings for with solvent cemented fittings unless indicated otherwise on the drawings.

- B. Process and Indirect Drains - Inside Building:
 - 1. PVC Schedule 80 pipe and fittings with solvent cemented fittings unless indicated otherwise on the drawings.
- C. Natural Gas Piping:
 - 1. Polyethylene pipe, orange or yellow color as per Gas Company standard with fused joints or black steel Schedule 40 A53 pipe with welded A-234 150 lb. fittings and yellow jacket pipe covering including heat shrink sleeves for buried service.
- D. Potable & Non Potable Water Service Piping:
 - 1. Soft copper Type "K" for ASTM B88-83 with Mueller Series 110 compression fittings and couplings unless noted otherwise on the drawings.

2.2 PIPING MATERIALS - ABOVEGROUND

- A. Waste, Vent and Storm Drainage Piping:
 - 1. Where specifically noted on the drawings, above ground sanitary drain, storm and vent piping shall be standard weight ductile iron MJ pipe and fittings for 4" diameter and up, and copper drainage and vent for 3" diameter and smaller piping.
 - 2. Provide preformed galvanized storm collar flashing with neoprene grommet for vents through roof.
- B. Indirect Drain Lines (Indirect Drain):
 - 1. For sizes up to 2" diameter:
 - a. Copper Pipe Type "L". Refer to copper pipe specifications in Section 15100 - Process Piping & Fittings. Piping shall bear certification to ASTM B88-83.
 - 2. For sizes greater than 2" diameter:
 - a. PVC Schedule 80 pipe and fittings with solvent cemented fittings.
 - 3. Natural Gas Piping:
 - a. Schedule 40, black continuous weld steel pipe in accordance with ASTM A53 or A120.
 - b. Fittings 2" and smaller to be 150 lb. black malleable iron, screwed ends, in accordance with ASTM Specification A 197.
 - c. Unions to be 300 lb, malleable iron, ground joint with brass seat.
 - d. Fittings 2½" and larger to be standard weight seamless steel, butt-welded in accordance with ASTM Specification A 234.

- e. Pipe joints connecting dissimilar metals to be insulating dielectric connections rated to withstand temperature, pressure and other characteristics of the intended service, including test pressure. Screwed joints to be made with insulating unions. Flanged joints to have insulating gaskets, bolt sleeves and washers.
 - f. Dirt leg at gas piping drops. Finish paint as specified in Section 09900.
4. Cold Water and Potable & Non Potable Water Piping:
- a. Hand drawn type "L" deoxidized copper tube with sweat solder copper couplings and fittings. Piping shall bear certification to ASTM B88-83.
5. Gate Valves:
- a. Refer to Gate Valves in Section 15110 - Valves.
6. Domestic Water Valves:
- a. Refer to Ball Valves (Bronze/Brass) in Section 15110 - Valves.
7. Natural Gas Valves:
- a. For 2½" and larger size valves:
 - b. 125 psi lubricated plug cock, cast iron body, wrench operated, regular pattern shut-off valves with bronze key type operating wrench.
8. Unions
- a. Unions on copper shall be all brass construction with ground joints and solder ends.
9. Link Seals:
- a. Made from synthetic rubber to resist aging, ozone, sunlight, water and chemical action, with Type 304 stainless steel bolts and metal parts.
10. Fire Stop Protection:
- a. All plastic piping systems for plumbing and drainage systems including chemical and process piping systems passing through horizontal or vertical fire separations shall be protected with 3M Fire Barrier Plastic Pipe Devices.
 - b. Each pipe penetration shall use a PPD (Plastic Pipe Device) as required. Pipes passing through generator room, electrical room, and motor rooms into other areas are required to receive fire stop protection.

2.3 CLEANOUTS

- A. Cleanouts for sanitary drains shall be at intervals of not more than 50 ft along their horizontal length and 100 ft for storm drains, 6" diameter and over in size at the end of all branches, at the base of all riser lines, on all exposed or accessible traps, at any point where change of direction greater than 45 degrees is made and at all points of the

system where indicated or required as necessary to remove obstructions. Cleanouts shall be placed on line in storm drains as shown on the drawing.

- B. Cleanouts shall be the full size of the trap and pipe up to 4" and 4" for larger pipes or traps. Full size Y or T branches shall be provided for cleanouts on all house drains. Cleanouts shall be located in readily accessible positions.
- C. Cleanouts shall be of type as follows:
 - 1. In concrete floor areas:
 - a. Fusion bonded, powder epoxy coated cast iron floor cleanout with integral anchor flange, neoprene "O" ring secondary seal and adjustable 5" round, scoriated, Type 304 cast stainless steel combined access cover and plug with gasket seal.
 - 2. Ancon CO 1200-R, Enpoco equivalent or approved equal:
 - a. In line C.O.'s for plastic piping shall be ABS or PVC line cleanout with gasketed C.O. plug (threaded).
 - b. End of line and stack C.O.'s for drainage line shall be ABS or PVC fitting cleanout with polypropylene plug (threaded).

2.4 FLOOR, WALL AND CEILING PLATES

- A. All pipes passing through ceilings, floors or partitions and where such pipes are exposed shall be fitted with split chrome plated floor, ceiling and wall plates, equal to Crane B & C floor and ceiling plates, pressed steel, chromium plated. Ceiling plates shall be complete with set screw.

2.5 MISCELLANEOUS PLUMBING EQUIPMENT AND ACCESSORIES

- A. Air chambers shall be capped air chambers at least 18" long at each fixture and wherever else necessary to prevent water hammer. Chambers shall be concealed in the rough work and shall be one pipe size larger than supply piping.

2.6 PIPE IDENTIFICATION

- A. Refer to Division 15.

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

- A. Underground:
 - 1. Establish and layout all lines as indicated.
 - 2. Slope all straight runs to a minimum of 2.0% or as otherwise specified.
 - 3. Use Surveyor's optical level or other approved means to determine all grades and inverts.
 - 4. Bedding and backfill per the requirements of Division 2.

BARTON AND SOUTH INDUSTRIAL PUMP STATIONS ELECTRICAL IMPROVEMENTS

3.2 CHARACTER OF PIPE WORK

- A. In general, lay the pipe in the location as shown on the plans. No work shall be altered unless layout has been approved by Engineer with whom this Contractor shall take up the proposed layout of all plumbing lines not shown on the plans and get approval of their erection before proceeding.
- B. All horizontal soil and waste lines shall have uniform drop of not less than 1/4" per foot except where conditions will permit, 1/8" per foot will be accepted if approved by local code.
- C. In the watermains and risers provide swing joints to take care of expansion and construction of piping in a proper manner.
- D. All connections to risers shall be taken off the mains with approved swing joints.
- E. All hot and cold water pipes shall have right angle turns for free expansion. All shall be laid on a pitch of not less than 1/4" in every 10 ft so that every portion of the system can be drained off through stop and waste cocks or valves at lowest point.
- F. No exposed piping about fixtures or in other conspicuous places shall show tool marks or more than one thread at the fitting.

3.3 EXPANSION OF PIPE WORK

- A. This Contractor shall be responsible for making adequate provision to compensate for the expansion and contraction of his pipe work. He shall erect all pipe in such a manner that the strain and weight does not come upon cast connection or apparatus.
- B. This Contractor shall provide and install all guiding as required for proper operation of expansion loops and shall provide and install all anchors wherever shown on plans and wherever necessary.

3.4 PIPE SLEEVES

- A. Supply for installation by others all necessary pipe sleeves of size and length required where piping passes through concrete floor slabs, walls or through masonry construction. Contractor shall be held responsible for proper location of sleeves and any subsequent cutting required due to failure to supply or wrong location of same shall be done by this Contractor and all cost shall be borne by him.
- B. All piping passing through poured concrete walls occupied on one side and unexcavated on other shall be set in place complete with holding flange prior to pouring of concrete.
- C. Core drill existing concrete floors as noted on the drawing.
- D. Refer to Section 15100, Process Piping & Fittings regarding sleeve materials.

3.5 PIPE HANGERS & SUPPORTS

- A. All horizontal runs of piping shall be suspended from the floor or roof construction as the case may be by means of approved hangers spaced as scheduled. Supports and hangers shall be installed to permit free expansion and construction in the piping systems. Where necessary to control expansion and construction, the piping shall be

guided and firmly anchored. No piping shall be self-supporting nor shall it be supported from the equipment connections.

- B. All hangers shall be properly sized to fit the pipe or the insulation around the pipe which they are supporting. At hangers where lateral and axial movement is allowed, provide hanger rods with welded or forged eye nuts or suitable sockets to permit movement without bending hanger rod.
- C. Hangers, pipe clamps and supports of a dissimilar metal to the pipe to have approved isolation made of 0.12" thick red rubber to prevent galvanic corrosion.
- D. Fit pipe hangers and rods with an adjusting nut or turn buckle and lock nut to allow for adjustment after erection while still under load. Screw adjustment to have a complete depth of thread.
- E. All hanger, rods and fastening hardware to be Type 304 stainless steel unless noted otherwise.
- F. Provide Type 304L stainless steel hangers and rods for all stainless steel piping systems.
- G. All ferrous metal hangers and supports to receive painting per Section 09900 prior to installation. Not required for stainless steel.
- H. Wall supported pipe brackets can be Aluminum or Type 304 stainless steel Unistrut or fabricated brackets with aluminum or stainless steel clamps & fasteners provided it is acceptable to the Engineer where they are being used.
- I. All pipes shall be painted where covered by hangers or supports.
- J. Space hangers for the support of all piping except as noted on the following centers:

SIZE (inches)	FEET ON CENTER (max.)
1/2" and 3/4"	6 ft.
1"	7 ft.
1 1/4"	9 ft.
1 1/2"	10 ft.
2" thru 12"	12 ft.
2" thru 12" plastic	8 ft.

- K. On wrought iron, steel or copper pipe, there shall be a hanger within 2 ft. of each elbow or tee. Additional supports shall be provided for valves, strainers and other equipment in the pipe line.
- L. Hanger rods for the support of hangers shall be sized as follows:

Piping Sizes in Inches	Rod Sizes in Inches
3/4" to 2"	3/8"
2 1/2" thru 4"	1/2"
6" thru 8"	5/8"

3.6 VALVES AND SHUT-OFFS FOR WATER LINES

- A. In general, control supply to each lavatory separately with chrome plated Dahl mini ball valves and to all other fixtures and equipment as instructed by the Engineer.

3.7 JOINTS

- A. All surfaces shall be clean and free of all dirt, grease, oil, loose mortar, dry and sound.
- B. The joints shall be made according to manufacturer's recommendations.
- C. Joints in threaded pipe shall be made up tight using approved pipe joint compound. Graphite and oil may be used for lubricant on end of pipe only. No lubricant shall be applied to fitting. Ream out all pipe ends and turn on end and rattle before installing. No leaks in screwed joints are to be repaired by peening or caulking. Remove all defective fittings or couplings and replace with perfect material.
- D. Joints in copper pipe shall be soldered with blowtorch using pure solder. Flux for soldering shall be as recommended by manufacturers of the copper pipe. All burrs in the piping shall be removed and mating surfaces shall be thoroughly cleaned before joining. The joint shall be evenly heated to ensure effective distribution of solder over the full area of contact.
- E. Joints for types of pipe shall be as follows:
 - 1. Cast Iron Pipe:
 - a. Joints shall be made with mechanical joint fittings according to manufacturer's recommendations.
 - 2. Copper Pipe:
 - a. Joints shall be as specified in this section.
 - 3. Steel Pipe:
 - a. Joints shall be as specified in this section.
 - 4. Connections between Dissimilar Pipes:
 - a. Connections between new copper lines and galvanized or black iron pipe shall be made through dielectric unions or flanges.

3.8 INSTALLATION OF SOIL AND VENT PIPING

- A. Vent pipes shall be installed as indicated or as required. When they reach the ceiling space they shall be enlarged so that no vent shall be less than 3" when passing through the roof.
- B. Soil and vent pipes are to be extended 12" above the roof, and left open.

3.9 CLEANING

- A. At the time the tests are made, all work shall be reasonably clean and clear of all rubbish and obstructions in order to enable the Engineer to examine in detail the arrangement of the piping and inspect the fixtures of fracture or bad marks.
- B. The maker's tags and labels showing the origin and grade of the goods shall remain until the inspection is made.

- C. When this Contractor shall have completed all his work, he shall send a written notice for final inspection. On this occasion, all work shall be thoroughly cleaned. All fixtures shall be clean from dirt, stain and finger marks.

3.10 PLUMBING AND DRAINAGE PIPE SCHEDULE

- A. A schedule of plumbing and drainage pipes has been included in these Specifications to assist the Contractor and may not be all inclusive.
- B. Any pipe omitted from the Schedule but shown on the Drawings shall be supplied and installed by the Contractor.
- C. The Contractor shall not claim for any extra costs for pipes that have not been listed, but which are shown on the Drawings.

**PLUMBING & DRAINAGE
PIPING SCHEDULE**

<u>Underground Service</u>	<u>Material</u>
Sanitary and Storm Sewer	PVC Schedule 80
Main Vent	PVC
Branch Vent	PVC
Natural Gas	Polyethylene or Steel Yellow Jacket or Permissible by the natural gas company
Cold Water Service	Copper Type "K"
<u>Aboveground Service</u>	<u>Material</u>
Sanitary	PVC Schedule 80
Storm	PVC Schedule 80
Waste	PVC
Indirect Drain	PVC
Main Vent	PVC
Branch Vent	PVC
Waste, Soil and Vents Exposed in Washrooms	Chrome-Plated Copper Pipe
City (Cold) Water	Copper Pipe Type "L"
Hot Water	Copper Pipe Type "L"
Cold Water exposing in Washrooms	Chrome-Plated Copper or Brass Pipe
Hot Water exposing in Washrooms	Chrome-Plated Copper or Brass Pipe
Potable & Non-Potable Water	Copper Pipe Type "L"
Condensate Drains	Copper Pipe Type "L"
Natural Gas	Carbon Steel

END OF SECTION

SECTION 15440

PLUMBING FIXTURES AND SPECIALTIES

PART 1 - GENERAL

1.1 SCOPE OF THE WORK

- A. The work required under this Section of the Specifications shall consist of furnishing all material and performing all labor required for the plumbing fixtures and trim as called for in the Specifications and shown on the drawings. The following work is briefly described (not necessarily all inclusive):

1. Plumbing Fixtures & Fittings.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 15250: Mechanical Insulation
- B. Section 15400: Plumbing and Drainage

PART 2 – PRODUCTS

2.1. PLUMBING FIXTURES

- A. General:
1. All fixtures shall be of the best of their respective kind, free of all defects and any fixture which in the opinion of the Engineer is defective or damaged shall be removed and replaced by a fixture which is acceptable. Fixtures shall include all trim, traps and wastes, water connections, flush valves, etc., usually classed as fittings and required to make units complete. All exposed metal parts of fixtures shall be brass heavily chrome plated. Manufacturer's fixtures numbers and trade names given herein are intended as an indicator of type and quality only.
 2. Plumbing fixtures that use water shall conform to the reduced water consumption rates. These rates are applicable for devices installed in any new building, or any additional/renovation.
 3. Plumbing fixtures not meeting the maximum flow rates shall be removed and replaced at no cost to the owner with new fixtures meeting the flow requirements.
 4. Fixtures shall be tested using a time and displacement test. Retesting is required on all replaced units. Submit data to Engineer for review.
- B. Products
1. Electric Domestic Hot Water Heater
 - a. ARISTON electric mini tank water heater Model No. GL 6 plus or approved equal model.

- b. Heater c/w wall mounting bracket, pressure relief valve, built-in electronic temperature controls and equipped with 120V plug-in power cord.
- c. Heater arranged for operation with 120 volt (plug in). 1,500W input 32°C (90°F) temperature rise at 7 GPH..

PART 3 - EXECUTION

3.1 FIXTURE CONNECTIONS

- A. Connections to the plumbing fixtures and fittings shall be of the sizes (min.) as listed on the drawings.

3.2 SURFACE AND JOINT PREPARATION

- A. General:
 - 1. All surfaces to be clean and free of all dirt, grease, oil, loose mortar, dry and sound.
 - 2. No exposed piping about fixtures or in other conspicuous places shall show tool marks or more than one thread at the fitting.
- B. Threaded Joints in Steel Pipe:
 - 1. Threaded joints shall be made with American Standard tapered threads cut to full length and all pipes shall be screwed up close to their shoulders.
 - 2. Joint compound shall be an approved type for all services and applied to the male thread only.
 - 3. All burrs must be reamed or smooth before installation.
 - 4. All joints and connections shall be gas and water tight.
- C. Copper Tubing Joints:
 - 1. Joints in copper tubing shall be made by cutting tube to proper length, squaring off the end, debarring the end and polishing same with steel wool.
 - 2. Apply solder flux to tube and fitting and solder into place by applying proper heat and solder as specified.
 - 3. While solder is still plastic, remove all excess solder, leaving a neat fillet of solder around cup of fitting.
 - 4. Proper allowances shall be made in all lines of expansion.
 - 5. Dielectric couplings shall be used where copper lines are joined to iron piping.
 - 6. Provide shut-offs on hot and cold water lines to and from connections to mains and at all branches to fixtures.

D. ABS PVC Pipe Solvent Chemical Joints

1. Joints in ABS/PVC piping shall be made by cutting pipe to proper length, squaring off the end and debarring the end.
2. Apply ABS/PVC pipe primer to clean and prepare the end of the pipe using a cloth and wiping down the outside of the pipe end.
3. Apply ABS/PVC primer to clean the inside sockets of all fittings using a cloth and wiping down the inside of the sockets of all fittings immediately before the cementing operation.
4. Apply ABS/PVC solvent cement to end of pipe and to inside of sockets on fittings. Insert pipe into sockets at the desired orientation. Remove excess solvent which may drip from joint and allow joint to set.

3.3 FIXTURES AND TRIM INSTALLATION

- A. Install all fixtures and fittings as shown on the drawings and as hereinafter specified making all connections thereto. Fixtures are not to be installed until directed by the Engineers. All roughing in shall be accurately laid out, no off-sets will be acceptable.
- B. All hot and cold water pipes shall have right angle turns and free expansion and shall be laid on a pitch of not less than 1/4" in every 10 ft so that every portion of the system can be drained off through stop and waste cocks or valves at lowest points.

3.4 CLEANING

- A. At the time specified tests are made, all work shall be reasonably clean and clear of all rubbish and obstructions in order to enable the Engineer to examine in detail the arrangement of the piping and inspect the fixtures for fracture or bad marks.
- B. The maker's tags and labels showing the original and grade of the goods shall remain until the inspection is made.
- C. When this Contractor shall have completed all of his work, he shall send a written notice for final inspection. On this occasion, all work shall be thoroughly cleaned. All fixtures shall be clean from dirt, stain and finger marks.

3.5 PERFORMANCE TESTS

- A. Test plumbing fixtures to verify that they have been adjusted and set up for the required low flow ratings. Provide field tested flow rate information to Engineer for review. Readjust all fixtures as required to meet flow rates and repeat time-displacement tests if necessary.

END OF SECTION

SECTION 15441

SUMP PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Under this Section the Contractor shall provide all labor, materials, and equipment necessary to furnish and install
 - 1. A new duplex ejector system to serve the Barton Pump Station floor drains, including fiberglass sump, submersible pumps, level control floats, sump cover, control panel and related items.
 - 2. Two submersible sump pumps to replace the existing footing drain pumps in an existing structure at the Barton Pump Station, including new level control floats and control panel

1.2 RELATED SECTIONS

- A. Division 9 – Finishes
- B. Section 15100 – Process Piping
- C. Section 15110 – Process Valves and Accessories
- D. Division 16 – Electrical.

1.3 SUBMITTALS

- A. Submit shop drawings and product data in accordance with Section 01330, Submittal Procedures: Manufacturer's literature, specifications and engineering data shall include the following:
 - 1. Complete product data and catalog cut sheets on all pumps, motors, sumps and control components.
 - 2. Performance data and curves showing overall pump efficiencies.
 - 3. Installation details.
- B. Submit operation and maintenance manuals in accordance with Section 01781, Operations and Maintenance Data.

PART 2 - PRODUCTS

2.1 SUMP PUMPS

- A. Each pump shall be a submersible, centrifugal pump with bottom suction and vertical discharge.

- B. Pump construction:
1. Pump Casing: Cast iron with epoxy coating.
 2. Motor Housing: Stainless steel.
 3. Impeller: Bronze – vortex or non-clog design
 4. Shaft: Stainless steel with double carbon/ceramic seals
 5. Discharge: 1½" NPT
 6. Floor Mount Style
 7. All nuts, bolts and exposed metal parts shall be stainless steel.
- C. Motor Construction
1. The pumps shall be directly driven by a high torque, capacitor start motor. The motor shall be minimum 115 volt, 60 Hertz, single phase. The motor winding shall incorporate a thermal breaker to protect the motor.
- D. The pumps shall be manufactured by Zoeller, Flygt, or Goulds.

2.2 ACCESSORIES

- A. A heavy duty stainless steel sump cover shall be furnished for installation over the existing sump. The sump cover shall have openings (2) through which the pumps may be installed and withdrawn and an opening through which the floats can be accessed. The discharge pipes (2), power cables (2), float cables (3), and existing crawlspace drain pipe shall pass through sealed connections in the cover plate. Cover shall be corrosion resistant and capable of spanning the opening without deflection.
- B. A heavy duty fiberglass basin of the size indicated in the drawings shall be installed for the new sanitary sump. The basin construction shall design shall incorporate ribs and be of suitable stiffness for complete concrete encasement. The basin shall also be compatible with the basin access cover.
- C. A stainless steel basin cover with a single hatch designed to fit the basin shall be furnished for installation with the new fiberglass basin. The hinged hatch shall allow for removal of each of the pumps and access to the floats. This cover shall have sealed penetrations for the discharge pipes (2), power cables (2), float cables and the hatch shall be gasketed. Entire assembly shall be gas-tight when hatch is closed.
- D. All sump pumps shall be provided with stainless steel lifting cables and cable brackets.
- E. Provide two check valves, a ball valve and union along each pump discharge. Refer to Section 15110 – Process Valves.
- F. Discharge piping shall be Schedule 80 PVC.

2.3 LOCAL CONTROL SYSTEM

- A. Controls for both sump pump installations shall be fed with 120/240V, 60Hz, single phase power. Controls shall consist of (but not be limited to) the following:

1. NEMA 4X Enclosure
 2. Main Disconnect
 3. Circuit Breakers
 4. HOA Switches
 5. High sump alarm light and audible alarm
 6. Pump run indicator light.
 7. 2 Year Warranty
 8. Wall mounted identification and pipe labels.
- B. Local control system shall be provided with three (3) non-mercury float switches. Provide one (1) minimum level "off" switch, one (1) "on" level switch and one (1) "alarm" level switch. Switches shall be mounted to a 1-inch diameter stainless steel pipe with stainless steel support brackets. Provide float switches by Anchor Scientific, Zoeller, or equal.
- C. Local control system enclosures shall be mounted as shown in the plans.

2.4 PUMP SCHEDULE

- A. Floor Drains Sump Pumps
1. Installation: Duplex dewatering system (2 pumps)
 2. Flow: 30 GPM (per pump)
 3. Total Head: 20 Feet
 4. Motor Size: $\frac{3}{4}$ HP (min)
 5. Motor RPM: 3,345 RPM
- B. Footing and Crawlspace Drain Sump Pumps
1. Installation: Duplex dewatering system (2 pumps)
 2. Flow: 20 GPM
 3. Total Head: 18 Feet
 4. Motor Size: $\frac{1}{2}$ HP (min)
 5. Motor RPM: 3,345 RPM

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with the Drawings, approved Shop Drawings and recommendations of the manufacturer.

- B. Inspect, calibrate, adjust, lubricate and otherwise prepare equipment for operation.
- C. Install all piping, valves and appurtenances as required to provide a complete and fully operational system.
- D. Provide check valves and shut-off valves on all pump discharge piping and as shown on the Drawings.
- E. Support piping independent of pump.
- F. Provide unions where shown on the Drawings and as required to facilitate pump removal.
- G. Coordinate sump pump installation with sump pit size and sump pit cover grating.

END OF SECTION

SECTION 15621

GAS FIRED UNIT HEATERS

PART 1 - GENERAL

1.1 SCOPE OF WORK

- A. The work required under this Section of the Specifications shall include all labor, equipment and materials to complete heating work indicated on the drawings and specified herein.
- B. Related Work Specified Elsewhere:
 - 1. Section 09900 - Finish Painting
 - 2. Section 15400 - Plumbing and Drainage
 - 3. Section 15990 - Testing, Balancing and Controls
 - 4. Division 16 - Electrical

1.2 SUBMITTALS

- A. Submit product information and shop drawings to Engineer for review and approval.

PART 2 - PRODUCTS

2.1. GAS FIRED UNIT HEATERS

- A. Unit heaters shall incorporate a single, one-piece burner assembly with a single orifice, be equipped with titanium stabilized, corrosion resistant aluminized steel. All heat exchangers shall be fabricated with no welding or brazing; only tool pressed mechanical joints. All units shall have a single venturi tube and orifice supplying fuel to one-piece burner housing.
- B. Unit heaters shall include fan limit safety controls, 24 volts control transformer, combustion air pressure switch, spark ignition with electronic flame supervision, access panel and baked enamel finish. Unit shall be suitable for ceiling suspension. Units shall be equipped with manual summer/winter switch.
- C. Unit heaters shall have a factory-installed power vent device to draw combustion air from outside of the building. The control compartment and the access door shall be sealed. Units shall include a flame rollout switch. Units shall be equipped with a centrifugal blower with direct drive from an open drip proof motor with internal overloads.
- D. Unit heater shall have a propeller type fan or blower type fan with optional summer/winter switch control relay and be equipped with 60° down turn nozzle when indicated w/ vertical louvers, single stage heavy duty room thermostat (24V) with summer-winter sub-base switch White Rodgers Model 1E50-303 with sub-base, guard with locking cover and master terminal vent cap.

- E. Provide concentric adapter box for connecting the combustion and vent air pipes from the unit to a type 'B' double roof exhaust vent to discharge to atmosphere. Vent shall have metal flashings and be sealed from the weather, supplied with inlet air guard and screened exhaust cap. Vents which discharge through roof shall be Type "B" double wall vent with proper C.O. fittings, deck plates, tall cone flashing and storm collar and terminal vent per standard drawing details located in the contract drawings.
- F. Unit heater capacities and power requirements shall be as shown in the Gas Fired Heating Equipment Schedule in the contract drawings
- G. Manufacturer:
 - 1. Reznor UDBS Series, or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install unit in location where shown on the Drawings complete with a minimum of 4 stainless steel rod supports for each unit, piping and sealing materials, all as required for a complete and workable system and as recommend by the manufacturer. Start unit up and adjust for proper operation and air flow patterns. Installations shall conform to or be better than the local authorities having jurisdiction.
- B. Arrange unit heaters to create flow patterns as indicated on Drawings. Mount units at mounting heights as indicated on drawings. Adjustments may be made to suit vent and piping installations.
- C. Installation and wiring of thermostat to be by Division 16. Place lamacoid labels on either side of thermostat to indicate "Summer - fan on" operation and "Winter - fan auto" operation.
- D. Install to mounting heights as indicated on drawings and with maximum 2 ft. long red-i-rod. Provide steel angle iron frame in addition as required to accommodate this arrangement. Install all 4 red-i-rod mounting points to rigid steel framing. Steel frame shall not be dipped galvanized.

END OF SECTION

SECTION 15861

FANS

PART 1 - GENERAL

1.1 SCOPE OF THE WORK

- A. The work required under this Section of the Specifications shall consist of furnishing all labor, materials, tools, equipment and services to perform all operations in connection with Fans to the full extent of the Drawings and Specifications.
- B. The principal items of work are as follows:
 - 1. Work consists of all roof, and inline fans shown on the drawings, specified or required to complete the building as shown. The work includes providing the equipment and services for the supply and installation of the exhaust fans specified hereinafter.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 15990: Mechanical Testing and Balancing

PART 2 - PRODUCTS

2.1 FANS - GENERAL

- A. Fans shall be of the models, sizes and capacities shown on the Schedule herein and/or on the drawings and installed in the location shown on the contract drawings.
- B. Construct fans in strict accordance with the standards of AMCA and rated in full conformance with the "Standard Test Code for Centrifugal and Axial Fans", (latest edition) approved jointly by the ASHRAE and the AMCA.
- C. Classification for Spark Resistant construction levels A, B, and C shall conform to AMCA 99.
- D. Comply with National Electrical Manufacturers Association (NEMA), standards for motors and electrical accessories.
- E. Shop drawings to include complete information on fan construction and performance, including certified performance curves, sound criteria data and prefabricated roof curb dimensions.
- F. The Engineer reserves the right to reject any fan whose noise level data appears objectionable for the particular application and to reject after installation any fan whose noise levels exceed that indicated by the data submitted with shop drawings. Failure to submit such data does not release the manufacturer of this liability.
- G. Motors shall be as specified under Division 16: Electrical Work.

- H. Unless otherwise specified or shown on the Drawings, equip fans with heavy duty grease lubricated ball or roller bearings with ample thrust provision to prevent end play during the normal life of the bearing. Bearings are to be designed for minimum 200,000 hr. life. All fans to have extended grease and lubricating lines to exterior of fan casings or housings.
- I. All roof exhaust fans shall have an enameled weather resistant finish compatible with the aluminum construction and as recommended by the manufacturer.
- J. Refer to Spec. Section 15910, Ductwork Accessories for prefabricated roof curbs information.

2.2 ROOF AND INLINE EXHAUST FANS:

- A. Aluminum exhaust fans shall be belt drive type. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced. The fan housing shall be constructed of heavy gauge aluminum with a rigid internal support structure and a corrosion resistant bird screen. Roof curb to be installed with the fan.
- B. Motors shall be heavy duty ball bearing type to match the fan load, and furnished at the specified voltage, phase and enclosure. Drive frame assembly shall be constructed of heavy gauge steel. Motors and drives shall be mounted on vibration isolators, out of the air stream. Fresh air for motor cooling shall be drawn into the motor compartment through a large space between the fan shroud and the motor cover. Motors and drives shall be readily accessible for maintenance.
- C. Motor pulleys shall be adjustable for final system balancing. A disconnect switch shall be factory installed and wired from the fan motor to a junction box installed within the motor compartment. A conduit chase shall be provided through the base to the motor compartment for ease of electrical wiring.
- D. All fans shall bear the AMCA Certified Ratings Seal for sound and air performance.
- E. All components to be of same manufacturer unless specified or approved otherwise.
- F. Advise and/or confirm with general trades actual size requirements of roof curb opening.
- G. Manufacturer:
 - 1. Design basis on Greenheck.
 - 2. Acceptable alternate manufacturers are Greenheck, Hartzell, or Cook.

2.3 SIDEWALL PROPELLER FAN:

- A. Sidewall propeller exhaust fan as per the drawing schedule, AMCA performance and sound certified to AMCA Standards 210 and 300, and complete with:
- B. Fan shall be aluminum with one-piece drawn venture construction. Provide wall weather hood, aluminum wall collar with heavy gauge mounting flanges, backdraft damper, and OSHA motor side protective guard.
- C. Disconnect Switches NEMA 3R.

D. Acceptable Manufacturers: Acceptable fan Manufacturers are:

1. Greenheck Fan Corp.
2. Loren Cook
3. Twin City Fan and Blower
4. New York Blower

2.4 EXHAUST FAN SCHEDULE:

A. Refer to contract drawings for Exhaust Fan Schedule including fan selection and design criteria.

2.5 THERMOSTAT:

A. Single stage heavy duty line voltage room thermostat White Rodgers Model 1A65--610 double-pole disconnected model with tamperproof setting, summer-winter sub-base switch, and guard with locking cover.

PART 3 - EXECUTION

- A. Install fans of the capacities and sizes shown in the locations shown on the schedules on the contract drawings, and install in the location shown on the contract drawings.
- B. Fans shall be installed with vibration isolators as recommended by the manufacturer and as approved by the Engineer.
- C. Install flexible duct connections where indicated on the contract drawings between the fan and the main duct connected to the fan.
- D. Install fan per detail as shown on the contract drawings.
- E. Connect duct from inside the building to the fan
- F. Provide spare belt for each belt driven fan.

END OF SECTION

SECTION 15890

DUCTWORK

PART 1 - GENERAL

1.1 SCOPE OF THE WORK

- A. The work required under this Section of the Specifications shall consist of furnishing all labor, materials, tools, equipment and services to perform all operations in connection with Sheet Metal Ductwork and Specialties to the full extent of the Drawings and Specifications.
- B. The principal items of work are as follows:
 - 1. Work consists of all heating, ventilating and exhaust ducts and specialties shown on the drawings, specified or required to complete the Buildings as shown. The work includes providing the equipment and services in various sections of "Air Distribution" specified in Sub-heading 1.2 hereinafter.
 - 2. Ductwork for this project is defined as low pressure and all construction shall conform to this designation.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 09900: Finish Painting
- B. Section 15250: Mechanical Insulation
- C. Section 15910: Ductwork Accessories
- D. Section 15990: Testing, Balancing and Controls
- E. Division 16: Electrical Work

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIAL

- A. All ductwork unless specifically noted otherwise shall be of galvanized sheet steel. The galvanizing shall be carefully done and the sheets shall be of such quality that they may be bent flat on themselves with no fracture to the coating or the base metal.
- B. Supply and return air ducts, fresh air intake ducts, room air exhaust ducts to suction side of exhaust fans, or supply side of fans, except where otherwise noted, shall be zinc coated galvanized steel sheets conforming to the latest ASTM Specification A 93.
- C. Ductwork construction shall conform to specifications herein and standard drawings attached to this section along with details and standard drawings shown on the contract drawings.

PART 3 - EXECUTION

3.1 SHEET METAL CONSTRUCTION AND INSTALLATION

- A. General ductwork construction as follows:
1. Unless otherwise specified or shown on the Drawings, sheet metal construction to conform to the recommendations of the current issue of ASHRAE Guide, and the "Duct Manual and Sheet metal Construction for Ventilating and Air Conditioning Systems" published by the Sheet metal and Air Conditioning National Association Inc. (SMACNA) in a manner acceptable to the Engineer.
 2. Make all laps in the direction of air flow. Use no sheet metal screws in the duct where it is possible to use rivets and bolts. Hammer down all edges and slips so as to leave smooth finished surface inside the ducts.
 3. All ducts shall be braced and stiffened and shall be tight so that they will not drum, breathe, rattle, vibrate or sag. Cross-break all rectangular ducts with heights or widths of 12" or larger.
 4. Where rectangular ducts are shown, round ducts may be substituted at the Contractor's option and with the Engineer's written approval, provided there is sufficient room. Conversion from rectangular to round duct sizing shall be as shown on charts in ASHRAE or equipment monographs.
 5. Where ductwork passes through a wall or floor, other than when a fire damper is required, pack around the duct using a fire resistant material to ensure a sound and air-tight joint.
 6. Access panels shall be installed for all ducts containing airflow stations, fire dampers, smoke dampers, pressure switches, etc.
 7. Clear access from the occupied space shall be provided to apparatus within ducts (dampers, sensors, CAV/VAV boxes, etc) without requiring personnel to step on ductwork.
 8. Seal and inspect ductwork per SMACNA prior to insulating or otherwise concealing ductwork.
 9. Visually inspect all ductwork: Place fan system in operation, or pressurize ductwork with portable fan. Inspect ductwork for audible leaks, and leaks perceptible to hand 2" from duct. Reseal all perceptible leaks.
 10. Locate all sheet metal ducts where shown and size as shown. If changes of size or location of duct is found necessary because of building construction, the following conditions shall be fulfilled:
 11. For change of duct size:
 - a. Maintain the same circular equivalent for the new size. Ratio of the longest side of the duct to the least shall not exceed 4 to 1 unless specifically authorized by the Engineer.
 - b. Select the gauge of metal and method of construction for the new size.

- c. Notify Engineer of any change before such changes are incorporated into the work.
- 12. For change of duct location, consult Engineer before the locations indicated are changed in any way.
- 13. Provide all necessary reinforcements, bracing, framing and gasketing for such construction, whether or not they are specifically called for or detailed on the Drawings.
- 14. Install all sheet metal clean and free of oil, grease and other foreign substances particularly where insulation adhesive or sealer is to be applied.
- 15. Be responsible for all cleaning required to bring sheet metal to such condition.
- 16. Touch up duct welds with zinc chromate primer paint to prevent corrosion.

B. Ductwork supports:

- 1. Hang all horizontal rectangular ductwork and horizontal round ductwork securely and in a rigid manner. For mounting into concrete, all anchors shall be S. S. epoxy set anchors by Hilti.
- 2. Provide hangers as follows:

a. Rectangular Duct :

Max. Duct Dimension (Inches)	Hanger Construction Dimensions (Inches)
up to 60	Two 1 x 16 U.S. gauge straps on 96 centers with two screws on side of duct, one on bottom
61 to 120	2 x 2 x 1/4 trapeze hanger with two 3/8 ø S.S. rods on 96 centers
121 to 240	2 1/2 x 2 1/2 x 3/16 trapeze hanger with two 3/8 ø Rods on 48 centers

Round Duct Duct Diameter (inches)	Hanger Construction, Dimensions (inches)
up to 18	One 1 x 6 U.S. gauge hanger ring supported from one 1 x 16 U.S. gauge hanger strap on 96 centers
19 to 36	One 1 x 12 U.S. gauge hanger ring supported from 1 x 12 U.S. gauge hanger strap on 96 centers
37 to 50	One 1 1/2 x 12 U.S. gauge hanger ring supported from one 1 1/2 x 12 U.S. gauge hanger strap on 96 centers
51 to 84	Two 1 1/2 x 12 U.S. gauge hanger connected to the 1 1/4 x 1 1/2 x 1/8 angle girth reinforcing of duct, hangers on 96 centers

Note:
For mounting into concrete, all anchors shall be S.S. epoxy set anchors by Hilti.

- C. Vertical ductwork shall be as follows:
1. Support all vertical rectangular ductwork and vertical round ductwork with structural grade galvanized steel angles, riveted to the ducts, or as approved by the Engineer.
 2. Angles shall be secured to concrete walls w/ S.S. epoxy set anchors by Hilti.
- D. Ductwork pressure divisions shall be as follows:
1. Pressure divisions for the various thicknesses of ductwork shall conform to the following ranges of static pressures in the duct systems (and are not total pressures at the fan):

Low Pressure	=	up through 2 inch W.G.
Medium Pressure	=	over 2 inch through 6 inch W.G.
High Pressure	=	over 6 inch through 8 inch W.G.
- E. Low pressure rectangular ductwork construction shall be as follows:
1. Low pressure rectangular ducts which are defined as 2000 FPM or less velocity and less than 2" W.G. pressure shall be constructed as follows:
 - a. Assemble longitudinal seams on rectangular ducts with Pittsburgh lock closed for tightness and appearance.
 2. Form elbows and transformation sections with Pittsburgh lock on all corners. Make turns with these elbows as conditions necessitate in the following order of preference (unless otherwise shown on the Drawings):
 - a. Standard radius elbow, the throat radius equal to the duct width.
 - b. Short radius elbow, with airfoiled vanes or splitter vanes throat radius not less than 0.25 x duct width.
 - c. Square elbow with 3" throat radius and vaned as herein specified.
 3. Determine location of vanes in short radius elbows in accordance with latest recommendation of the Sheet Metal and Air conditioning Contractors National Association Inc. (S.M.A.C.N.A.).
 4. Install factory fabricated airfoiled turning vanes of approved manufacture in all square corner elbows.
 5. Provide all necessary offsets and transformations required in the sheet metal work whether specifically shown on the Drawings or not, as may be necessary, to avoid interference with the building construction or building services.
 6. Construct ducts and fittings so as to be properly reinforced and airtight. The Engineer reserves the right to reject any ductwork which is not properly reinforced or airtight in the sense of the best current practice.
 7. Joints in all ducts and plenum ducts to be sealed airtight by applying duct sealer after assembly.

8. Joints in all ductwork shall be sealed with Duro-Dyne type "S 2" High Velocity Duct Sealer, "DW" water based sealant or equal. Where ducts are exposed and uninsulated all joints are to be sealed with Duro-Dyne Type "DW" water based sealant, brush or tube application. Apply in strict accordance with manufacturer's instructions, in a neat manner.
9. Fabricate rectangular ductwork from galvanized sheets conforming to the following table unless otherwise shown on the drawings.
10. Provide insulated flexible connections between fan openings and sheet metal work and in ductwork at building expansion joints. Refer to Section 15910 for products.

F. Easements shall conform as follows:

1. Provide necessary easements in sheet metal work for pipes, conduit, equipment, building construction and headroom even though not specifically shown. Transformations shall maintain the equivalent duct area and shall have good aerodynamic proportions. Where an obstruction absolutely cannot be avoided and must penetrate the duct, a streamlined collar shall be formed around the obstruction. When the duct area is reduced more than 10% by the collar, the duct size must be increased to maintain the original duct area.

FABRICATION AND REINFORCEMENT

Dimension of Longest Side (Inches)	Steel Sheet Metal Gauge (S/ST & Alum)	Reinforcing Between Joints (Angle)	Joints & Reinforcing at Joints	Height of Standing Leg (Inches)
Thru 12	26 (24)	None	Drive slip (sides only) plain "S" slip	1
13 to 18	24 (22)	None	As above	1
19 to 30	24 (22)	1 x 1 x 1/8 at 5 ft. CC	Hemmed "S" slip bar slip 10 ft. C-C	1
31 to 41	22 (20)	1 x 1 x 1/8 at 5 ft. CC	Alternate or reinforced 1x1/8 bar slip 10 ft. C-C	1
43 to 54	22 (20)	1 1/2 x 1 1/2 x 1/8 at 4 ft. C-C	Alternate or reinforced 1 1/2 x 1/8 bar slip 8 ft. C-C	1 1/2
55 to 50	20 (18)	1 1/2 x 1 1/2 x 1/8 at 4 ft. C-C	Reinforced 1 1/2 x 1/8 bar slip 8 ft. C-C	1 1/2
61 to 84	20 (18)	1 1/2 x 1 1/2 x 1/8 at 2 ft. C-C	Reinforced 1 1/2 x 1/8 bar slip 4 ft. C-C	1 1/2
85 to 96	18 (16)	1 1/2 x 1 1/2 x 3/16 at 2 ft C-C	Companion angles 1 1/2 x 1 1/2x 3/16 at 4 ft. C-C	1 1/2
97 to 120	18 (16)	2 x 2 x 1/4 at 4 ft. C-C	Companion angles 2 x 2 x 1/4 at 4 ft. C-C	2

NOTES:

1. Flat areas of duct over 18" wide shall be stiffened by cross-breaking or beading unless duct is insulated or sound lined.
2. Where aluminum construction is shown on the drawings or specified, aluminum alloy sheets 3S type alloy, half hard temper shall be used.

END OF SECTION

SECTION 15910

DUCTWORK ACCESSORIES

PART 1 - GENERAL

1.1 SCOPE OF THE WORK

- A. The work required under this Section of the Specifications shall consist of furnishing all labor, materials, tools, equipment and services to supply and install all Ductwork Accessories.

1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Section 09900: Finish Painting
- B. Section 15250: Mechanical Insulation
- C. Section 15890: Ductwork
- D. Section 15990: Testing, Balancing and Controls
- E. Division 16: Electrical Work

PART 2 - PRODUCTS

2.1 DAMPERS

- A. General:
 - 1. Dampers shall be provided at the locations and of the sizes and quantities as shown on the drawings and in the Schedules herein and/or in the contract drawings.
- B. Back Draft Dampers:
 - 1. Dampers shall be heavy gauge, corrosion resistant, welded frame channel (aluminum, formed for rigidity, and heavy gauge blades (aluminum), press formed and installed to overlap and interlock to minimize air leakage when closed.
 - 2. Locate spring loaded back-draft dampers in ductwork below roof of exhaust fans.
 - 3. Provide felt edges and all spring loaded back-draft dampers for quiet operation. Rotate damper blades in bronze bearings when damper is motor or spring operated.
 - 4. Mount frames for back-draft in opening through roof and fasten before roof exhauster is set in place and place back draft damper in rack for wall exhaust fans before fan is mounted in place or in tray for roof exhaust fans before fan is placed on curb.

5. Backdraft dampers for new exhaust fans shall be provided as shown in detail on contract drawings.
 6. Manufacturer:
 - a. Tamco Series 7000 aluminum back draft dampers.
 - b. Approved equal.
- C. Volume Control Dampers (VCD):
1. Provide and install single blade volume dampers with Duro-dyne Specseal/Quad Seal air-tight, rattle proof, self forming silicone gasket and locking quadrant where shown on the plans and wherever else required to balance the system properly.
 2. Dampers above plaster ceilings shall be complete with Duro-dyne concealed type regulator cast of alloy chrome plated or approved equal.
 3. Single blade dampers shall be as supplied by Arrow in galvanized steel (Type 150VCD) or aluminum (Type SB-28) or Type 304 Stainless steel to match ductwork materials or approved equal.
 4. Dampers for ducts of greater depth than 12" shall be multiblade opposed-acting type and shall have blades mounted in 1½" channel frame, and interconnected for operation from one locking type hand quadrant.
 - a. Provide Duro-dyne spec Seal/Quad Seal etc. same as above.
 5. Dampers for right angle take-off of branch from riser shall be similar to Hart and Cooley Vectrol on supply.
 6. For externally insulated ducts, mount quadrant on a bracket, clear of the insulation.
- D. Motorized and Automatic Dampers:
1. Motorized Dampers:
 - a. Low leakage proportioning multiple blade volume control dampers shall be parallel blade type, 16 gauge aluminum Type 6063 T5 construction with interlocking leaves, nylon bushed bearings.
 - b. Dampers for outside air shall have extruded vinyl sealed edge at the tip of the blade and sealed at frame top and bottom and blade edge and end.
 - c. Dampers operated by two-position damper motors shall be of 16 gauge parallel blade design, unless otherwise specified on the drawings. Proper number of damper motors and operators shall be used to efficiently transmit force of motor motion full length of damper blades.
 - d. Provide all linkage rods and brackets, etc., to operate the dampers from the wall or duct mounted motor. Each damper blade shall have a

connecting link in the mid-span of the blade on the room side of the damper.

- e. All dampers shall be 4" in depth (min.) equipped with aluminum welded single flange frames and oilite-bushed machined trunnion bearings.
- f. All linkages shall have machined non-ferrous pivots; linkage ball may be aluminum, cadmium-plated steel, or stainless steel. Construction shall be such as to guarantee permanently free rattleproof operation.
- g. Blades for all dampers shall be fabricated from aluminum (gauge minimum), and so designed and/or reinforced as to be perfectly rigid under all operating conditions. Damper shaft shall be ½" ø minimum or 7/16" hexagon for spans up to 48" and ¾" diameter minimum for spans up to 6'. Shafts shall be continuous and shall be stainless steel. Crankarm or Jack shaft assemblies shall be exposed type mounted on the back surface of the damper and interconnected with a common linkage rod.
- h. Blades shall be insulated with minimum of ½" polystyrene and have a maximum of 10" width and 60" length. Blades shall have a double thermal break.
- i. Refer to drawing and attached schedule for damper sizes, locations and orientation of damper operators. Provide all necessary sectional supports as recommended by manufacturers when multiple damper sections are required due to size restrictions.
- j. Manufacturer:
 - 1. Tamco Series 9000.
 - 2. Approved equal.

2. Damper Operators:

- a. All automatic dampers shall be equipped with motor operators of power and design to control the dampers without flutter or hunting located outside the airstream wherever possible.
- b. Damper operator shall be fully electric damper motor as indicated and sized to suit the damper size. Provide sufficient number of operators necessary to ensure required output force for damper size. Opening time shall be 150 seconds.
- c. Motorized damper operators shall be 120 volt line voltage powered, industrial grade, two position, spring return to open or close on power failure, 20 sec. opening or closure time, motor with 90 degree angular stroke; Min. 130 in/lb torque complete with control transformer as required for control voltage of 120/240 V, mounting brackets, screws, couplings, linkages and shafts for control of dampers. Spring return force must be strong enough to tightly close the damper blades to prevent air leakage.
- d. Provide built-in adjustable auxiliary switch where required. Rotation limitors shall be used to set minimum closure points so as not to over torque the damper blades. Local indication shall also be provided to

identify the actuator position. Manual over ride capability shall be included in the actuator assembly.

- e. Damper operator(s) and dampers shall be provided where and as indicated on the contract drawings and schedules.
- f. Manufacturer:
 - 1. Belimo Air Controls, AF Series.
 - 2. Approved equal.

E. Generator Exhaust Pipe:

- 1. Interior:
 - a. Manufacturers to ASTM A53 continuous weld, ASTM A135 ERW or ASTM-120. Schedule 40, black steel plain end, Grade B.
 - b. Joints: Welded and flanged. Flanged joints to have 3 mm (1/8") thick, full faced black gaskets with 1100°F service temperature rating.
 - c. Fittings:
 - 1. Welded -Standard wall, 150 lb. B.W. seamless ASTM A234, lack steel, ANSI-B16.9.
 - 2. Flanged -150 lb. R.F. or F.F. S.O., W.N. or blind, forged steel to ASTM A105 and drilled to ANSI B16.1
Flanged -150 lb. R.F. or F.F. S.O., W.N. or blind, forged steel to ASTM A105 and drilled to ANSI B16.1
 - d. Pipe Support:
 - 1. Provide roller stand, adjustable style at structural support locations. Yatt Figure No. 266 and Grinnel equal. Include saddles for insulation installation.
 - 2. Provide standard roller hangers, Myat Figure No. 258 c/w pipe saddles where shown on drawings for full size of insulated pipe O.D. or Grinnell equal
 - e. Provide metallic expansion joint pressure rating 50 psig and 1100°F service temperature rating with 10 convolutions Plate Flange.
 - f. Provide wall/roof thimble as shown on drawings where exhaust penetrates wall.
- 2. Exterior
 - a. Manufacture to ASTM A-774 and 778, type 304L stainless steel meeting NSF61 standards for sizes greater than 50 mm (2"). Class Schedule 40

2.2 INSTRUMENT TEST PORTS

- A. Heavy duty 16 gauge zinc plated steel, aluminum or stainless steel with neoprene gasket c/w cam action handle, cover plate and integral chain, Duro-Dyne Model 1P.1 for rectangular or round duct or approved equal.
- B. Test ports are to be provided on the suction and discharge duct of all ductwork systems suitable for an air balance traverse based on the size of duct.

2.3 DUCT FLEXIBLE CONNECTIONS:

- A. Furnish and install in an airtight manner glass-fabric reinforced neoprene flexible connections between sheet metal work and vibrating equipment such as fans, generators and air handling units. Install flexible connector loosely without tension at any point and suitable for temperatures and pressures encountered.
- B. Fabric shall be a minimum of 6" exposed connector double hemmed or clenched by double lock seam into a sheet metal strap, high temperature rated, fastened airtight to the ductwork.
- C. Fasten flexible connection securely to the equipment and ductwork by a galvanized iron band provided with tightening screws.
- D. Connections shall be of length specified or long enough, whichever is greater; to ensure that there is no contact between fan and duct due to movement of units on the anti-vibration mountings.
- E. Manufacturer:
 - 1. Duro-Dyne.
 - 2. Vent fabrics Inc. equivalent.
 - 3. Approved Equal.

2.4 ACCESS DOORS

- A. Access panels or doors at all fire dampers, gravity dampers, motorized dampers, coils, heaters, fan bearings or similar equipment requiring occasional maintenance or inspection.
- B. Panels shall be 24" x 18" or full width of duct if less than 18" width or as shown in drawings. Panels shall be of double wall construction and shall be internally insulated on insulated ducts.
- C. Frames shall be of structural angle with welded corners, gasketed to receive the panel. Panel shall be held in place with 4 window sash locks.
- D. Access doors shall be standard construction with concealed hinges and screwdriver cam lock.
- E. Ceiling access doors shall be 24" x 24" in size and factory prime coated.
- F. Where labelled fire dampers are to be installed in existing ductwork, access doors are to be added for access to the damper. Access doors shall be of the hinged type and of the size noted or as required for proper access to dampers or for cleaning. These doors shall be constructed of (No. 22 gauge) galvanized iron or approved design.

2.5 GAS VENTS

- A. Provide Type "B" double wall exhaust vents and Type "C" single wall vents from unit heaters and duct heaters to discharge to atmosphere as shown or identified on the drawings.
- B. Vent through walls and roof shall have metal flashings and be sealed from the weather supplied with inlet air guard and screened exhaust cap.
- C. Vents which discharge through roof shall be Type "B" double wall vent with proper C.O. fittings, deck plates, tall cone flashing and storm collar.
- D. Manufacturer:
 - 1. Selkirk vent and accessories.
 - 2. Van Packers equivalent.
 - 3. Approved equal.

PART 3 - EXECUTION

Not Applicable

END OF SECTION

SECTION 15990

MECHANICAL TESTING AND BALANCING

PART 1 – GENERAL

1.1. DESCRIPTION

- A. This section specifies the testing and balancing requirements concerning air and hydronic systems.

1.2. RELATED DOCUMENTS

- A. General and Supplementary Conditions and requirements of Division 1 apply to Work of this Section.
- B. Related work specified in other Division 15 Sections:
 - 1. 15010 – Mechanical Basic Materials and Methods
 - 2. 15621 – Gas Fired Unit Heaters
 - 3. 15782 – Electric Rooms AC Units
 - 4. 15861 – Fans
 - 5. 15910 – Ductwork Accessories

1.3. INTENT

- A. The intent of this section is to call for finished work, tested and ready for operation.
- B. Furnish all materials, supplies, equipment, tools, transportation and facilities, and perform all labor and services necessary for the complete testing and balancing of the mechanical air and hydronic systems as shown on the Drawings, as herein specified, and as required to make complete and operating systems.
- C. The work shall also include the completion of such details of mechanical work not mentioned or specifically shown, but which are necessary for the successful operation of all mechanical systems.
- D. Adjust and balance the following mechanical systems:
 - 1. Supply air systems
 - 2. Exhaust air systems
- E. Conduct the following mechanical systems testing:
 - 1. Sound testing
 - 2. Vibration testing
 - 3. Verification of temperature control system operation

- F. Air Balancing shall include as a minimum all devices for which a CFM is indicated in the plans, schedules or specifications.
- G. Testing, Adjusting and Balancing Reports, as detailed in Part 3.

1.4. QUALITY ASSURANCE

- A. The Contractor shall obtain the services of an independent Test and Balance Contractor
- B. Testing and balancing shall be performed in accordance with standards of either AABC ("National Standards for Field Measurement and Instrumentation - Total System Balance", Current Volume and Supplements,) or NEBB ("Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems").
- C. Testing and Balancing Contractor shall be a current member in good standing of AABC, NEBB and SMACNA.

1.5. SEQUENCING AND SCHEDULING

- A. Where performance testing is specified, equipment and systems must be tested under conditions that are near design conditions. Various components and systems shall be tested in summer or winter design conditions to accurately reflect specified conditions.

1.6. WARRANTY

- A. For a period of 90 days after the acceptance of the balancing report, the balancing subcontractor shall recheck or reset any part of any system to meet the Owner's needs, where these variations are within the capabilities of the equipment.

PART 2 – PRODUCTS

Not used in this section.

PART 3 – EXECUTION

3.1 PREPARATION

- A. Testing and Balancing (TAB) Contractor shall meet with Mechanical Contractor during early phase of construction to point out location of taps and dampers to allow TAB Contractor to conduct tests.
- B. Phased Construction: Coordinate TAB procedures with any phased construction requirements for the project so that usable increments of finished work may be accepted for beneficial occupancy. Systems serving partially occupied phases of the project may require balancing for each phase prior to final balancing.

3.2 TESTING AND BALANCING - GENERAL REQUIREMENTS

- A. Conduct final TAB after system has been completed and is in full working order. Prior to completing balancing, inspect and test systems and components to verify proper installation and operation, including but not limited to:

1. Verify motor and equipment rotation, lubrication and alignment.
 2. Align belts and pulleys. Adjust tension.
 3. Check operation of all automatic dampers.
 4. Check position of dampers.
- B. In cooperation with other Contractors, correct deficiencies.
 - C. Field testing and balancing shall be performed under the direct supervision of journeyman technician.
 - D. TAB Contractor shall report all deficiencies discovered in work by other trades that result in flow rate inadequacies or elevated noise.
 - E. Immediately notify the Engineer when any deficiencies are detected, whether associated with design, installation or equipment.
 - F. TAB Contractor shall provide all required tools and equipment necessary to perform TAB services. Take measurements with certified and calibrated devices. Do not rely on field installed sensors and gauges.
 - G. Measure motor and equipment speed (RPM) with strobe tachometer. Record full load and part load slippage, and calculate motor brakehorsepower (BHP) using $BHP = \text{nameplate HP} \times (\text{part load slip}/\text{full load slip})$.

3.3 AIR BALANCING - GENERAL REQUIREMENTS

- A. Place systems in operation with filters installed and control systems complete and operating. Balance systems to design ratings. Adjust each air terminal unit, inlet and outlet within plus or minus 10 percent of design requirements, but total air for each system shall be not less than shown.
- B. Check flow rates for all factory set air terminal units and reset if not correct.
- C. Adjust fan speeds by adjusting or replacing sheaves and belts. If required, Mechanical Contractor shall furnish new sheaves and belts, for installation by TAB Contractor. V-belt drives, including fixed pitch requirements.
- D. Set supply fan static pressure as low as practicable while maintaining required pressure at the most aerodynamically remote terminal units.
- E. Record pressure drop readings across all major system components and significant drops within duct systems.
- F. Label all diffusers, registers and grilles with clear plastic adhesive labels indicating number and outlet number corresponding to the balance report.

3.4 AIR BALANCING - CONSTANT VOLUME SYSTEMS

- A. Balance system to achieve design system flow with filter artificially loaded at the midpoint between clean and dirty condition.
- B. Adjust fan speed to minimize wasted horsepower and noise at throttled balancing dampers.

3.5 AIR BALANCING - AIR HANDLING EQUIPMENT AND SYSTEMS

- A. Test air handling units, exhaust and return fans, and associated automatic dampers in all modes of operation. Determine the most restrictive operating mode and balance systems in this mode.
- B. In addition to values listed in ASHRAE Standard 111-1988, the following shall also be measured and reported.
 - 1. Minimum and maximum outdoor air quantities. (Include setting minimum outside air.)
 - 2. Power factor or watts for motors larger than 10 HP.
 - 3. Component pressure drops.
- C. Record actual motor amps, volts, and rpm, and fan flow, static pressure and rpm.
- D. Check all equipment motors, belts, drives, bearings, filters.
- E. Check supply and return fan tracking to assure compliance with design requirements.
- F. For new air handling units and above ceiling fan coil units: Test cooling coil condensate drain and trap performance. Artificially load filters to simulate dirty filter conditions. Verify drain pan does not overflow, and air does not blow by trap.

3.6 VIBRATION TESTING

- A. Furnish instruments and perform vibration measurements for all rotating equipment, including compressors, pumps, fans and motors.
- B. Inspect vibration isolation system and alignment and report deficiencies.
- C. Allowable Vibration Tolerances: Self-excited, vibration maximum velocity shall not exceed the following limits, measured in inches per second RMS (not in mils peak to peak), filter in. Measure vibration at bearing caps of machine in vertical, horizontal and axial directions or at equipment mounting feet if bearings are concealed.
 - 1. Except where noted otherwise: 0.20
 - 2. Pumps: 0.13
 - 3. Fans: 0.09
- D. For variable speed equipment, inspect at full range of speeds. Test at full speed and intermediate speed that indicate possible harmonic vibrations.
- E. Include in the report a summary sheet indicating pass/fail for each unit. For each unit of equipment, record detailed initial measurements, corrections made, retest measurements, and suggested course of action for equipment that still fails limits after Contractor correction.

3.7 COMPLETION SERVICES

- A. Final Check: Make final checks and do any testing as directed.

- B. Acceptance: Final acceptance of the project will not be made until a satisfactory report is received. Owner reserves the right to spot check the report by field verification prior to final acceptance.

3.8 CERTIFIED TEST REPORT

- A. For each system tested, provide a certification testifying that the system has satisfactorily tested measurements required under previous sections of this specification:

- B. General

1. Date tested.
2. Measurements and checks used to ensure accuracy of data obtained and that tolerances were met.
3. Media used for testing, calibration and certification dates.
4. Performance data sheets shall be furnished for all equipment including curves and operating information.
5. List of necessary repairs made before system passed the test.
6. Methods or formulas and references used for correcting measured readings.
7. Report shall include table of contents, index, tests, results, summary and comments.
8. Final report shall include a one line diagram of each measured air and water system with equipment nomenclature as defined in construction documents. Correlate all devices to the balance report.
9. Submit one copy of balancing report to the Owner.

- C. Air System Data: Include for each air-handling system the data listed below:

1. Equipment:

- a. Installation data:

- 1) Identification number.
- 2) Manufacturer and model.
- 3) Size.
- 4) Service.
- 5) Arrangement, discharge and class.
- 6) Motor hp, rated voltage, phase, cycles and rated full load amps.
- 7) Full load amperes.
- 8) Location and local identification data.

- b. Design data: Data listed in schedules on Drawings and Specifications or submittals.
- c. Fan recorded (test) data:
 - 1) CFM
 - 2) Static pressure: Suction, discharge, total.
 - 3) Fan rpm.
 - 4) Motor rpm.
 - 5) Motor sheave diameter: adjustable or solid.
 - 6) Fan sheave diameter.
 - 7) Outlet velocity.
 - 8) Motor operating amperes.
 - 9) Motor operating BHP.
 - 10) Actual voltage.

2. Duct system:

- a. Duct air quantities-main, submains, branches, outside air, total supply air, return and exhaust:
 - 1) Duct size(s).
 - 2) Number of pitot tube (pressure) measurements.
 - 3) Sum of velocity measurement, excluding pressure measurement.
 - 4) Average velocity.
 - 5) Recorded (test) CFM and FPM.
 - 6) Design CFM and FPM.
 - 7) Outside air minimum and maximum CFM, design and test valves.
- b. Individual air terminals:
 - 1) Terminal identification (supply, return or exhaust, location and number designation).
 - 2) Type, size, manufacturer and catalog identification.
 - 3) Design and recorded quantities-CFM, including minimum and maximum air flows even when factory calibrated.

- 4) Deflector vane or diffusion cone settings.
 - 5) Applicable factor for application, velocity, area, etc.
 - 6) Design and recorded velocities-FPM (state "core", "inlet", etc., as applicable).
3. Filter and coil data as specified; scheduled on Drawings or as required.
- D. Room temperatures.
 - E. Vibration Testing
 1. Measured vibration.
 2. Corrective measures taken.

3.9 ADJUSTMENT TOLERANCE

- A. Establish an Adjustment Tolerance Schedule with permissible tolerances as follows:
 1. Supply, return and exhaust fans +5% to 10%
 2. Diffusers and supply grilles 0% to +10%
 3. Return and exhaust grilles 0% to -10%
 4. Heating and cooling GPM 0% to -10%

3.10 ACCEPTABLE T&B CONTRACTORS

- A. Airflow Testing, Inc.
- B. Absolut Balancing Co., Inc.
- C. Enviro Aire Total Balance Co.
- D. Owner approved equal.

END OF SECTION

SECTION 16010

ELECTRICAL SYSTEM GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Work Included
- B. Codes and Standards
- C. Drawings
- D. Record Drawings
- E. Operation and Maintenance Manuals
- F. Site Examination
- G. Utilities
- H. Temporary Power
- I. Storage at Site
- J. Equipment and Materials
- K. Workmanship and Completion of Installation
- L. Cutting and Patching
- M. Coordination
- N. HVAC Equipment Wiring and Control
- O. Miscellaneous

1.2 RELATED SECTIONS

- A. The requirements set out in the contract documents, contract forms, general conditions, supplementary general conditions and general requirements apply to all work specified herein.

1.3 WORK INCLUDED

- A. Refer to the entire set of contract documents to become familiar with the project. Contractor is responsible for all equipment mounting, conduit routing and incidental work which may be necessary because of construction requirements, whether or not they are shown on the electrical drawings.

- B. The Contractor shall furnish all materials, labor, transportation, tools, permits, fees and incidentals necessary for the installation of a complete electrical system.
- C. It is the intent of the contract documents to provide an installation complete in every respect. In the event that additional details or special construction are required for work indicated or specified, it shall be the responsibility of the Contractor to provide all materials and equipment which are usually furnished with such systems in order to complete the installation, whether mentioned or not.

1.4 PAYMENT RESTRICTIONS

- A. Electrical equipment included in Division 16 shall be paid for in the following payment sequence:
 - 1. Upon equipment delivery – 30% of the contract amount.
 - 2. Upon completion of equipment installation – 30% of the contract amount.
 - 3. Upon successful startup and testing – 30% of the contract amount.
 - 4. Upon completion of system validation – 10% of the contract amount.
- B. Retainage shall apply to the payment sequence.

1.5 CODES AND STANDARDS

- A. All work shall be in compliance with all applicable portions of the edition recognized by the Authority Having Jurisdiction (AHJ) of the National Electrical Code (NEC), the National Electrical Safety Code (NESC) and all city and county codes and ordinances, which may or may not be specifically referenced in these contract documents. None of the terms or provisions of these contract documents shall be construed as waiving any of the rules, regulations or requirements of these authorities.
- B. In any instance where these contract documents call for construction materials of a better quality or larger size than required by the codes, the provisions of the contract documents shall take precedence. The codes shall govern where violations are indicated in the construction documents. In any instance where there is a conflict between the drawings and specifications, the larger size, higher quantity or better quality shall be provided, unless the Owner's Representative directs otherwise.

1.6 DRAWINGS

- A. The accompanying drawings are intended to show the general arrangement and extent of the work. The exact location and arrangement of all parts shall be determined as the work progresses to conform in the best possible manner with the surroundings and as directed by the Owner and/or Engineer.
- B. If any departures from the drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore shall be submitted to the Owner's Representative for review. No departures shall be made without prior written acceptance of the Owner and/or Engineer.

- C. Figured dimensions shall be followed without reference to scale. Where dimensions are not shown, measurements shall be scaled.

1.7 RECORD DRAWINGS

- A. The Contractor shall maintain a set of electrical drawings at the job site neatly marked with all changes from the original contract drawings. This set of drawings shall not be used for construction purposes and shall be available to the Owner and/or Engineer at all times. Drawings shall be kept up to date as the job progresses and shall be delivered to the Owner and Engineer at the completion of the contract.
- B. The Contractor shall maintain record drawing per the requirements of Division 1.

1.8 OPERATION AND MAINTENANCE MANUALS

- A. The Contractor shall furnish of operation and maintenance manuals to the Owner and and/or Engineer per the requirements of Division 1.

1.9 SITE EXAMINATION

- A. The Contractor shall be responsible for the coordination and proper relation of his work to the building structure and to the work of all trades. The Contractor shall visit the premises and thoroughly familiarize himself with all details of the work and working conditions, and verify all dimensions in the field. The Contractor shall advise the Owner's Representative of any discrepancy at least seven days prior to bidding. The submission of bids shall be deemed evidence of the Contractor's site visit, the coordination of all existing conditions and the inclusion of all considerations for existing conditions.

1.10 UTILITIES

- A. The contract documents reflect the general location, voltage, capacity, size and manner of routing for all utilities known to be required on this project. It shall be the responsibility of the Contractor to visit the site and to meet with the local utility companies in order to coordinate and confirm the exact requirements for all electrical utilities, including, but not limited to, all facilities required to provide complete and operative electrical power and telephone services. The bid submitted by the Contractor shall include costs for all such coordinative work as well as any and all utility company charges and/or fees.

1.11 TEMPORARY POWER

- A. The Contractor shall coordinate with the Owner, and other trades involved to determine requirements for temporary power on this project. No additional charges shall be made to the Owner for wiring, connections, poles, fixtures or devices required to facilitate construction.
- B. The Contractor shall provide the necessary wiring, connections, service switches, poles, wiring protective devices, lighting fixtures, lamps, outlet devices, disconnect switches, etc., as required for temporary lighting. In addition, a similar system shall be provided for the distribution of single- and three-phase power of voltage levels and adequate ampacity as required to facilitate the construction of the project. These services shall be installed in accordance with requirements of the NEC and OSHA.

1.12 STORAGE AT SITE

- A. The Contractor shall not receive material or equipment at the job site until ready for installation or until there is suitable space provided to properly protect equipment from rust, weather, humidity, dust and physical damage.
- B. Store major electrical equipment (switchboards, panelboards, lighting fixtures, dry type transformers, VFDs, etc.) sealed in original factory wrapping in a clean, dry and conditioned environment protected from the weather. Storage outdoors is not acceptable.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIAL

- A. All materials shall be new and of high quality. All materials of a type for which the Underwriters' Laboratories, Inc. (UL) has established a standard shall be listed by UL and shall bear the UL label.

PART 3 - EXECUTION

3.1 WORKMANSHIP AND COMPLETION OF INSTALLATION

- A. All work shall be performed by competent electricians, skilled in their trade, and shall be executed in a thorough and substantial manner.
- B. The Contractor shall be held responsible for transportation of his materials to and on the job, and for their storage and protection until the final acceptance of the job.
- C. The Contractor shall be held responsible for timely placing of all conduit and outlet boxes, cabinets and other wiring devices in the walls, ceilings, slabs, beams, etc., as construction progresses.
- D. Contractor shall furnish all necessary scaffolding, tackle, tools and appurtenances of all kinds, and all labor required for the safe and expeditious execution of his contract.
- E. All equipment shall be installed in a manner to permit access to parts requiring service. All electrical equipment shall be installed in such a manner as to allow removal for service without disassembly of other equipment, and shall have working clearances as required by NEC. Any large piece of apparatus which is to be installed in any space in the building, and which is too large to fit through finished openings, shall be placed before enclosing structure is completed. Following placement, such apparatus shall be completely protected from damage.
- F. The Contractor shall, at all times, keep the premises free from accumulations of waste material and packaging debris. This debris shall be removed daily from the construction site.

3.2 CUTTING AND PATCHING

- A. Where it becomes necessary to drill or cut through any floors, walls or ceilings to permit the installation of any work under this contract, or to repair any defects that may appear prior to the expiration of the warranty, such cutting shall be done under the supervision of the

Owner's Representative by the Contractor. After the necessary work has been completed, the damage shall be repaired by the Contractor, who shall pay all costs of such cutting and repairing.

- B. No joists, beams, girders or columns shall be cut by the Contractor without first obtaining written permission from the Owner's Representative.
- C. All drilling for expansion bolts, hangers and other supports shall be done by the Contractor, subject to the approval of the Owner's Representative. Labor and materials required to replace or rebuild parts cut or injured shall be furnished at the Contractor's expense, subject to the satisfaction of the Owner's Representative.
- D. All openings made in fire-rated walls, floors and ceilings shall be patched by the electrical contractor in a manner maintaining the original fire rating.

3.3 COORDINATION

- A. The Contractor shall coordinate the work of the different trades so that interferences between piping, equipment, structural and architectural work shall be avoided.
- B. The Contractor is responsible for ensuring that all conduit sleeves are timely installed and are sealed, flashed or caulked to the satisfaction of the Owner's Representative.

3.4 HVAC EQUIPMENT WIRING AND CONTROL

- A. In general, the Contractor shall provide the low-voltage (less than 120 volts) control wiring from the heating, ventilation and air conditioning equipment (HVAC) to the mechanical furnished device (T-STAT, temperature control system, etc.). The electrical drawings will indicate only branch circuit power supplies to serve the HVAC equipment.
- B. If substitution of controls or mechanical equipment for that specified requires any changes in the electrical work, any extra cost of the equipment or electrical work will be the responsibility of the Contractor.

3.5 MISCELLANEOUS

- A. Each piece of floor-mounted equipment, such as switchboards, transformers, etc., shall be set on a concrete base. Bases shall not be less than 4 inches high and shall be pinned to the floor.
- B. The Contractor shall furnish and install vibration isolation means for all equipment and materials furnished under this contract which may transmit perceptible noise or vibration, structure borne or air borne, to occupied areas.
- C. All transformers and other equipment indicated shall be mounted on 1-inch-thick cork rib or rubber pads or steel spring isolator units properly sized, spaced and loaded, as specified herein, which in turn shall rest on a 4-inch minimum concrete base.
- D. Electrical conduit shall be isolated from all dry type transformers and rotating or reciprocating machinery with flexible metal conduit. Use lengths approximately 10 diameters in length.

END OF SECTION

SECTION 16013

STANDBY GENERATOR

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Under this Section, the Contractor shall provide all materials, labor, and services necessary for furnishing and installing one (1) natural gas standby generator set as shown on the Plans for the purpose of delivering emergency power to the facilities in case of utility power failure.

PART 2 - PRODUCTS

2.1 ELECTRICAL CHARACTERISTICS

- A. The generator set shall consist of a natural gas engine directly coupled to an electric generator, together with the necessary controls and accessories for automatic start/stop control and automatic transfer switch. The generator shall have the following electrical characteristics:

29 kw/36 kva	Barton Pump Station
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2.2 REQUIREMENTS

- A. All materials and parts of the generator set shall be new. Each component shall be of current manufacture from a firm regularly engaged in the production of such equipment. The complete unit shall be supplied by a single manufacturer. The unit shall be a standard series of the manufacturer and not a one-of-a-kind fabrication.
- B. The Contractor shall specify the nearest location of permanent parts outlets from which parts may be obtained.
- C. The Contractor shall furnish three (3) sets of operation, maintenance and parts manuals covering all components of the generator set and equipment. The Contractor shall also instruct the Owner in the operation and maintenance of the unit.
- D. Complete operating instructions shall be installed in a suitable form and mounted on the unit.
- E. The performance tests of the generating set series shall be in accordance with procedures certified by an independent testing laboratory. The manufacturer shall have successfully tested a prototype of the generating set series offered which shall include:
 - 1. Maximum power level.
 - 2. Maximum motor starting capacity.
 - 3. Transient response and steady state governing.
 - 4. Generator temperature rise per NEMA MG122.40.
 - 5. Single step load pickup per NFPA 76A-822.
 - 6. Harmonic analysis and voltage waveform deviation per MIL-STD-705B.
 - 7. Three phase short circuit test for mechanical and electrical strength.
 - 8. Fuel consumption.
 - 9. Structural soundness.
 - 10. Engine-generator cooling air flow.

- F. The complete standby electric power system shall be warranted for a period of two (2) years minimum or fifteen hundred operating hours, whichever occurs first, from the date of initial start-up. The warranty must be provided by the system manufacturer. Multiple warranties for individual components will not be acceptable. Satisfactory warranty documents must be provided.

2.3 MANUFACTURER

- A. The standby generator shall be as manufactured by Onan, Kohler or MTU Energy.

2.4 ENGINE

- A. The engine shall be natural gas fueled, 4-cycle, water-cooled type. The engine shall be equipped with oil filter and an air cleaner with replaceable elements, fuel filter, and engine mounted radiator, fan and coolant pump.
- B. The engine isochronous governor shall maintain generator frequency within .025% from no load to full load generator output.
- C. The rated net horsepower of the engine at the generator synchronous speed with all accessories attached shall not be less than that required to produce the kw specified. The horsepower rating shall take into account generator efficiency losses. The engine shall be capable of producing this rated power and the generator set shall be capable of producing the specified kw for a continuous standby rating.
- D. The engine shall be liquid cooled with an engine-mounted radiator with fan and shall be sized to maintain safe operation at 100°F maximum ambient temperature.
- E. The engine cooling system shall be filled with anti-freeze protection to -40°F.
- F. The exhaust line shall be of such size that back pressure on the system shall not exceed the back pressure that permits the engine to produce the maximum power required for this application. A flexible connection shall be mounted between the engine exhaust manifold and the exhaust line and an approved rain cap shall be installed at the discharge end of the exhaust line. Piping within reach of personnel shall be protected by screening or covered with lagging.
- G. The muffler shall be a critical-type silencer. Exhaust silencer shall provide a maximum DBA level of 70 at a distance of 23 feet when installed in sound reducing enclosure. Silencer shall be supplied by generator manufacturer, or approved equivalent.
- H. A thermostatically controlled engine coolant heater (block heater) shall be furnished.

2.5 GENERATOR

- A. The generator shall be a synchronous type and be built to NEMA standards.
- B. The frequency regulation shall not exceed 0.15 Hz from no load to rated load. Voltage regulation shall be within 2% of rated voltage from no load to full rated load. A rheostat shall provide a minimum of +5% voltage adjustment from rated value. Temperature rise shall be within NEMA MGI 22.40 standards
- C. The generator shall be equipped with 120 volt electric strip heaters to help prevent condensation in the generator windings. The heaters shall be de-energized while the generator is running.

2.6 STARTING SYSTEM

- A. A 12-volt DC electric starting system with positive engagement drive shall be furnished.
- B. Fully automatic generator set with local start-stop controls in the generator control panel shall be provided. Controls shall provide shutdown for low oil pressure, high water temperature, over speed, over-crank, and one auxiliary contact for activating remote alarm. Controls shall include 30 second single-cranking cycle limit with lockout.
- C. A 24-volt lead-acid storage battery set of the heavy-duty starting type shall be provided. The battery set shall be of sufficient capacity to permit starting of the generator engine a minimum of three (3) times without recharging. A battery rack and necessary cables and clamps shall be provided. A thermostatically controlled battery box heater(s) shall be furnished.
- D. A current-limiting battery charger shall be furnished to automatically recharge batteries. Charge shall float at 2.17 volts per cell. It shall include over voltage protection, silicon diode full wave rectifiers, voltage surge suppressors, DC ammeter, and fused AC input. The AC input voltages shall be 120 VAC, single phase. Charger rating shall not be less than 10 amps. The battery charger shall be factory mounted within the generator enclosure. Wiring between charger and batterie(s) shall be factory installed.
- E. The unit shall be provided with an engine driven 12 volt DC alternator with voltage regulatory designed to keep the 12 volt battery set properly charged.

2.7 GENERATOR CONTROL PANEL

- A. A generator-mounted, vibration isolated deadfront 14 gauge steel control panel shall be provided. Top of the generator control panel shall not exceed six (6) feet above ground level.
- B. The panel shall contain, but not be limited to the following equipment:
 - 1. Engine Pre-Heat Switch
 - 2. Voltmeter, 2% accuracy
 - 3. Voltmeter Phase Selector Switch
 - 4. Ammeter, 2% accuracy
 - 5. Ammeter Phase Selector Switch
 - 6. Frequency Meter
 - 7. Manual/Auto Starting Controls
 - 8. Running Time Meter
 - 9. Panel Illumination Lights and On/Off Switch
 - 10. Voltage Level Adjustment Potentiometer
 - 11. Engine Oil Pressure Gauge
 - 12. Engine Water Temperature Gauge
 - 13. Automatic engine shutdown for the following conditions: Low Oil Pressure, High Water Temperature, Over speed, and Overcrank
 - 14. Fault Indicators for Low Oil Pressure, High Water Temperature, Low Coolant Level, Low Fuel Supply, Overspeed, and Overcrank, High Battery Voltage and Low Battery Volts w/Individual Fault Lamps and Test and Reset Switches
 - 15. Contacts for Remote Alarms Wired to Terminal Strips (one for each fault) to include a Charge Rate Ammeter
 - 16. Manual Reset Field Breaker (not used with permanent magnet field exciters)

2.8 MAIN LINE CIRCUIT BREAKER

- A. A generator-mounted totally enclosed main line molded case circuit breaker shall be installed as a load circuit interrupting and protection device. It shall operate both manually for normal switching function and automatically during overload and short circuit conditions.
- B. The trip unit for each pole shall have elements providing inverse time delay during overload conditions and instantaneous magnetic tripping for short circuit protection. The circuit breaker shall meet standards established by the Underwriters' Laboratories, National Electric Manufacturer's Association, and National Electrical Code.

2.9 STATIONARY BASE

- A. The unit shall be equipped with a structural steel sub-base. The base shall be a box-type frame construction consisting of a channel-iron perimeter and wide flange beam cross members for engine support. The base shall contain vibration isolators.

2.10 AUTOMATIC TRANSFER SWITCH

- A. The CONTRACTOR shall furnish and install where indicated an automatic transfer switch having ratings, accessories, etc., as indicated on the Plans or noted herein. The automatic transfer switch shall be fully rated, to protect all types of loads, inductive and resistive, from loss of continuity of power. The switch shall be rated as suitable for all classes of loads without derating, either open or closed.
- B. The transfer switch shall automatically transfer its load circuit to an emergency power supply upon failure of its normal supply. Upon restoration of the normal supply, the transfer switch shall automatically retransfer its load circuits to the normal supply.
- C. The transfer switch shall be interlocked so that it shall not be possible for load circuits to be connected to normal and emergency sources simultaneously.
- D. Voltage sensing relays shall be provided to monitor each phase of the normal supply. A drop in voltage in any phase below the predetermined drop-out value of the relay shall initiate load transfer. The relay(s) shall initiate retransfer of the load to the normal supply as soon as the voltage is restored in all phases beyond the predetermined pickup value of the relay. Voltage sensing relays shall be of the completely solid state type and shall have field adjustable pickup and dropout values from approximately 52 to 115% of nominal line voltage. These values shall be set for 70% dropout and 90% pickup.
- E. All accessories and equipment shall be front accessible for ease of maintenance or removal. The CONTRACTOR shall provide the following control accessories.
 - 1. Adjustable time delay on engine starting;
 - 2. Adjustable time delay emergency to normal;
 - 3. Breaker auxiliary contacts for operation of normal source and emergency source lights as follows:
 - Green - normal source
 - Red - emergency source
 - 4. Time delay for engine cool-off;
 - 5. Frequency/voltage relay for emergency source to prevent transfer from normal to emergency until the generator has reached operating voltage and frequency;

6. Solid ground bar and solid neutral bar;
 7. Engine start auxiliary contact;
 8. Test pushbutton to simulate a loss of normal power;
 9. Adjustable time delay for switching in both directions, during which time the load is isolated from both power sources to allow residual voltage of motors to decay before completing the switching cycle.
 10. Auxiliary contacts for normal and emergency source (one NO and one NC of each source);
 11. NEMA 12 enclosure;
 12. Pilot devices/relays shall be of the industrial type rated 10 amperes;
 13. Transfer mechanism shall be energized only momentarily during transfer;
 14. Underwriters Laboratory Certified;
 15. Transfer switch shall have ratings equal or greater than shown on the Plans.
 16. Seven day LOAD/NO-LOAD transfer exerciser with two-position selector switch and override feature.
- F. Transfer switch and all pertaining accessories shall be supplied by the supplier of the engine generator set and shall be manufactured by ASCO, Onan, or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The generator unit shall be installed as shown on the Plans and meet the manufacturer's installation recommendations.

3.2 CONDUITS

- A. Separate conduits shall be installed in the concrete slab for the following systems if installed:
1. Power Conductors;
 2. DC start circuit and discrete signals for a remote annunciator;
 3. Branch circuit conductors for heaters, 120 volts for the battery charger, 120 volt lights, and 120 volt receptacles;
 4. Data cable for remote monitoring.

3.3 CONCRETE PAD

- A. The generator and enclosure shall be anchored to a concrete pad.

3.4 GROUNDING

- A. Four 5/8-inch diameter x 10 ft long ground rods shall be installed. The rods shall be copper-clad steel rods.
- B. Connect the four rods together with 2/0 stranded, soft drawn bare copper.
- C. Supply two conductors up through the concrete slab. One near the main circuit breaker and the other in the opposite corner.
- D. All ground connections made underground shall either have exothermic welds or use the Burndy Hyground irreversible compression system.

3.5 PAINTING

- A. The engine, generator set, and control panel shall be painted with factory standard paints.

3.6 FIELD ACCEPTANCE TEST

- A. Following installation and initial adjustment of the standby generator, the unit will be tested as set forth below. All special equipment necessary for conducting the tests shall be provided by the Contractor. The tests shall be performed by the Contractor in the presence of the Engineer and the manufacturer's technical representative. Prior to beginning the tests the manufacturer's technical representative shall inspect the installation, make such initial adjustments as he deems necessary, and provide written certification that the installation meets the manufacturer's approval. A copy of the written certification shall be provided to the Engineer for record purposes. The Contractor will allow in his bid price the cost of the trip to the field site by the manufacturer's representative. The manufacturer's representative shall instruct the Owner's personnel on the operation and maintenance of the unit.

3.7 TEST

- A. The generator set and equipment shall be operated for a 2-hr period to show that it will pickup and carry load within voltage and frequency tolerances as specified under steady state, transient load, and motor starting operation.
- B. If, during the tests, the generator fails to meet the specified performance requirements, the manufacturer's representative shall be permitted to readjust the unit, in which case the entire series of tests will be repeated to the satisfaction of the Engineer. Failure of the generator to meet performance specification will be cause for rejection of the entire unit.

END OF SECTION

SECTION 16030

EQUIPMENT INSTALLATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section specifies receiving, unloading, storing, installing, connecting electrical circuits, and placing in operation all electrical equipment, including but not limited to the following:
 - 1. Disconnect switches.
 - 2. Dry-type transformers.
 - 3. Low voltage motor controllers.
 - 4. Panelboards.
 - 5. Switchboards.

1.2 RECEIVING, STORAGE, AND HANDLING

- A. Receiving: Receive, uncrate, and inspect equipment for defects or damage. If defective or damaged equipment is discovered take necessary action to repair or replace equipment. Notify Owner/Engineer if project schedule will be affected.
- B. Storage: Store equipment in dry, clean, and secure area until time of installation.
- C. Handling: Handle equipment in accordance with manufacturer's instructions. Use lifting points where provided to move equipment. Protect painted and machined surfaces where exposed.

PART 2 - PRODUCTS

Not applicable

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION

- A. Grounding: Comply with Section 16450 for grounding requirements in addition to specific grounding methods covered in the following articles.
- B. Identification: Comply with Section 16195.
- C. Cleaning: Clean interior of enclosures prior to installation of components or pulling conductors.
- D. Supports and Fastenings: Comply with Section 16190.
- E. Enclosure Application:
 - 1. NEMA 12 for indoor locations unless indicated otherwise on Drawings.

2. Alum NEMA 3R or stainless steel NEMA 4X for outdoor installations.

3.2 FLOOR OR PAD MOUNTED EQUIPMENT

- A. General: Install floor sills, anchor bolts, shims, and hardware required to level, align, secure, and connect equipment components in accordance with manufacturer's instructions. Make electrical connections in accordance with Section 16121 for supply and load circuits and leave items in operating condition.

3.3 WALL MOUNTED EQUIPMENT

- A. General:
 1. Enclosures:
 - a. Mount enclosures plumb, level, and rigidly attached to structure.
 - b. Mount 1 inch off structure with top 6'-6" above finished floor.
 - c. Install supports in a manner to permit vertical flow of air behind enclosure.
 - d. Use steel supports fabricated from standard rolled structural steel shapes specified in Section 16190.
 2. Wiring: Make electrical connections in accordance with Section 16121 for supply and load circuits.
- B. Disconnect Switches: Install properly rated fuses.
- C. Dry-Type Transformers:
 1. Mounting: Refer to Section 16190 for proper support and anchorage.
 2. Raceway Connections: Connect raceways to transformer enclosure using flexible conduit specified in Section 16111. Use lengths of flex approximately 10 diameters in length.
- D. Panelboards:
 1. Enclosure: Close unused circuit positions with blanking plates.
 2. Wiring: Check buses for proper insulation resistance prior to energizing.
 3. Circuit Breakers: Set circuit breaker instantaneous trip adjustments to minimum setting unless designated otherwise on Drawings.
 4. Fusible Units: See section 16416 for fuse requirements.
 5. Flush Mounted Panelboards: From each flush mounted panelboard extends into an accessible location a 3/4 inch empty conduit for every three spare branch circuits and spaces or as shown on Drawings.
 6. Application:

- a. Power and Lighting and Receptacle Type Panelboards: As designated by Panelboard Schedules on Drawings.
 - b. Ground Fault Circuit Interrupters: Provide for 120 volt circuits supplying 15 and 20 ampere receptacles installed outdoors or as shown on Drawings.
- E. Molded Case Circuit Breakers: Set adjustable instantaneous trips to minimum, unless indicated otherwise on Drawings. On magnetic breakers in combination with starters, set trips at lowest value that will permit motor starting, but not higher than 13 times motor nameplate full-load current.
- F. Low Voltage Motor Controllers and Contactors in Individual Enclosures:
- 1. On motor circuits, connect power circuits for proper phase rotation.
 - 2. Set circuit breaker instantaneous trips at proper value and install correct size fuses and thermal overload heater elements.
 - 3. Check interconnection and operation of control devices, interlocks, indicating lights, and control relays. Set timers and time delay relays for correct intervals. Check controller-operating coil for correct voltage rating. Program relay settings for exterior lighting controls per manufacturer's specification and coordinate time schedules with owner.
 - 4. See Specification Section 16481 – Motor Starters
- G. Self-Contained Emergency Power Pack: Connect each unit to equipment ground conductor by means of a crimped ring-type terminal connector secured to housing with a self-tapping screw.

END OF SECTION

SECTION 16111

METALLIC CONDUIT AND FITTINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Rigid metal conduit (RMC).
- B. Flexible metal conduit.
- C. Liquidtight flexible metal conduit.
- D. Associated fittings.

1.2 QUALITY ASSURANCE

- A. Furnish conduit and fittings bearing UL labels.
- B. Furnish conduit and fittings bearing label of a Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.
- C. All exposed conduits shall be RMC.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. RMC: ANSI C80.1 and UL 6, hot dipped galvanized, zinc metalized or sheradized, heavy wall, steel.
- B. Flexible Conduit: Provide flexible conduit sized 1-1/4 inches and smaller that is UL approved for use as a grounding conductor.
 - 1. Flexible Metal (Greenfield): UL 1, hot dipped or electro-galvanized steel.
 - 2. Liquidtight Flexible Metal Conduit (Sealtite): UL 360, hot dipped or electro-galvanized steel with thermoplastic outer covering.

2.2 FITTINGS

- A. Fittings: UL 514B. Provide fittings of same type by same manufacturer.
- B. Conduit Bodies:
 - 1. Zinc coated, cast malleable, ferrous metal, threaded fittings, Appleton "Form 35 Unilets" or Crouse-Hinds "Form 7 Condulets."
 - 2. Conduits 1-1/4 Inch and Larger: Cast malleable or aluminum "Mogul" size bodies.
 - 3. Gaskets: Where installed outdoors or in areas with gasketed enclosures, furnish neoprene cover gasket.

- C. Insulated Bushings:
 - 1. Thermoplastic: Appleton "BBU," O-Z/Gedney "IB," or Thomas & Betts "510" Series.
 - 2. Thermosetting Phenolic: O-Z/Gedney "A."
 - 3. Grounding: O-Z/Gedney "BLG."
- D. Flexible Connectors: Flexible conduit fittings sized 1-1/4 inches and smaller shall be UL approved for use as a grounding device.
 - 1. Metal: Thomas & Betts "3100" series "Tite Bite," insulated.
 - 2. Liquidtight Metal: Thomas & Betts "5200/5300" series or Appleton "ST" series, insulated.
- E. Sealing Hubs: Appleton "HUB" or "HUB-U" series or Thomas & Betts "370" series.
- F. Expansion Fittings:
 - 1. Exposed: O-Z/Gedney type "AX" or "EX" or Appleton type "XJ" with bonding jumper.
 - 2. Concrete Embedded: O-Z/Gedney "DX."
- G. Unions: Appleton type "EC" or Thomas & Betts "670/680" series "Erickson" coupling.
- H. Seals: Provide seals with interior cross section to allow 40% wire fill capacity.
 - 1. Enclosure Termination and Stub-ups Into Switchboards, Distribution Panels, and Other Similar Locations: O-Z/Gedney "CSB" series sealing bushing.
 - 2. "In-Line": Gasketed "C" conduit body, filled with Dow Corning "Fire Stop" sealant.
 - 3. Hazardous Area Seals: Appleton type "EYSEF", "EYDEF", "ESU" or "SF" or Crouse-Hinds type "EYSX", "EZS" or "EYDX" with manufacturer's recommended fiber filler and cement.
 - 4. Miscellaneous Fittings: Locknuts, caps, plugs, reducers, elbows, and other accessories required for a complete installation.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. Do not make unnecessary bends or offsets.
 - 2. Do not heat conduits for making bends or bend conduit through more than 90 degrees of arc.

3. Install conduits so that vertical runs are plumb and horizontal runs are level and parallel or perpendicular to principal structural features.
 4. Maintain 6-inch clearance from steam lines, hot water lines, flues, and other heat producing lines or devices where practicable.
 5. Make up joints tight and do not use running threads.
 6. Clean inside of conduits and swab dry before installing conductors.
 7. Support conduits 2-1/2" and smaller in accordance with NEC. For conduits 3" and larger support at intervals of 10'-0" or less.
- B. Bending Radius: Comply with NEC 344.24 for minimum bending radius on both field bends and factory bends.
- C. Concrete Embedded: Anchor conduit to reinforcing in concrete; plug or cap open ends until concrete and masonry operations are completed.
- D. Below Grade: Encase conduits installed below grade in a 2-inch concrete envelope unless noted otherwise on Drawings.
- E. Conduit Terminations (RMC):
1. NEMA 1 Areas: one interior and one exterior locknut with thermoplastic bushing.
 2. Gasketed Enclosure Areas: One interior locknut and one exterior-sealing locknut with appropriate type bushing.
 3. Outdoor Areas: Use sealing hubs in top and sides of enclosures. Use an exterior locknut, interior sealing locknut, and bushing in bottom of enclosures.
 4. Service Entrances and Circuits above 600 Volts: Same as specified for NEMA 12 areas except use grounding bushing.
- F. Expansion Fittings: Furnish for building expansion joints where conduit is rigidly attached to building structure or rod supported within 18 inches of structure.
- G. Seals:
1. Install seals where conduit passes from a conditioned space into an unconditioned space, in enclosures mounted outdoors, and in conduits entering structures from outside or underground.

3.2 APPLICATION

- A. RMC :
1. Below grade, under load bearing concrete slabs and asphalt roadways unless concrete encased.
 2. Below grade sweeps up to finish floor or grade.
 3. Above-grade areas subject to physical damage.
 4. Do not use RMC conduit smaller than 3/4 inch.

- B. Flexible Metal Conduit: Use for final connection to vibrating equipment, enclosed transformers, lay-in lighting fixtures, lighting fixtures with flexible supports, and equipment or devices requiring adjustment, such as motors and limit switches.
1. Greenfield:
 - a. Indoor areas where gasketed enclosures are not required.
 2. Liquidtight:
 - a. Outdoor areas.
 - b. Where gasketed enclosures are required.

END OF SECTION

SECTION 16112

PLASTIC CONDUIT AND FITTINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Schedule 80 (Sch. 80) poly-vinyl chloride conduit.

1.2 QUALITY ASSURANCE

- A. Furnish conduit and fittings bearing UL labels.
- B. Furnish conduit and fittings bearing label of a Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.
- C. PVC conduit is only approved below grade and enclosed in concrete.

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Sch. 80: NEMA TC 2 and UL 651 rigid poly-vinyl chloride rigid conduit.

2.2 FITTINGS

- A. Plastic Fittings:
 - 1. Sch. 80: NEMA TC 3 and UL 651.
- Seals:
 - 1. Enclosure Termination and Stub-ups Into Switchboards, Distribution Panels, and Other Similar Locations: OZ/Gedney "CSB" series sealing bushing.
 - 2. "In-Line": Gasketed "C" conduit body, filled with Dow Corning "Fire Stop" sealant.
- B. Sealing Hubs: Appleton "HUB" series or Thomas & Betts "370" series.
- C. Miscellaneous Fittings: Locknuts, caps, plugs, reducers, rigid galvanized steel elbows, and other accessories required for a complete installation.
- D. Conduit Cement: Conduit manufacturer's recommended solvent cement.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. Do not make unnecessary bends, offsets, or bend conduit through more than 90 degrees.

2. Use manufacturer's recommended heating units for making PVC field bends.
 3. Clean inside of conduits and swab dry before installing conductors.
 4. Support conduits in accordance with NEC.
 5. Install conduits so that vertical runs are plumb and horizontal runs are level and parallel or perpendicular to principal structural features.
 6. Maintain 6-inch clearance from steam lines, hot water lines, flues, and other heat producing lines or devices.
 7. Provide PB max 200' in all UG ducts.
- B. Bending Radius: Comply with NEC for minimum bending radius on field bends and factory bends.
- C. Expansion Fittings: Install across building expansion joints where conduit is rigidly attached to building structure or rod supported within 18 inches of structure and where required to meet thermal expansion in accordance with NEC.
- D. Conduit Terminations:
1. NEMA 12 Areas, Sizes 1 inch and below: PVC terminal adapter with one interior locknut and thermoplastic bushing.
 2. NEMA 12 Areas, Sizes above 1 Inch: PVC terminal adapter with one interior locknut and thermosetting phenolic bushing.
 3. Gasketed Enclosure Areas: PVC terminal adapter with one interior-sealing washer with appropriate type locknut and bushing.
 4. Outdoor Areas: Use sealing hubs in enclosures.
- E. Conduits Below Grade:
1. Circuits of 600 Volts or less: Direct burial not under load bearing concrete slabs and asphalt roadways.
 2. Circuits of 600 Volts or less: 2-inch minimum concrete encasement under load bearing concrete slabs and asphalt roadways.
 3. Conduit Bends: Make a transition to rigid steel conduit for elbows, offsets, and stub ups.
 4. Long radius for Comm. Ducts.
- F. Concrete Embedded: Anchor conduit to reinforcing in concrete; plug or cap open ends until concrete and masonry operations are completed.
- G. Seals: Install seals where conduit passes from a conditioned space into an unconditioned space and in conduits entering structures from outside or underground.

3.2 APPLICATION

- A. Sch. 80:
1. Below grade, under load bearing concrete slabs and asphalt roadways.
 2. Do not use Sch. 80 conduit smaller than $\frac{3}{4}$ inch.
 3. In concrete slabs and walls.
 4. Duct banks.

END OF SECTION

SECTION 16121

LOW VOLTAGE COPPER WIRE AND CABLE

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section specifies copper wire, cable, associated connectors, and termination hardware used on systems operating at 600 volts or less.

1.2 QUALITY ASSURANCE

- A. Furnish wire, cable, associated connectors, and termination hardware bearing UL label.
- B. Furnish wire, cable, associated connectors, and termination hardware bearing the label of, or listed by a Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Soft drawn, annealed copper, Class "B" stranding.

2.2 POWER WIRE AND CABLE

- A. Acceptable Manufacturers: Single source manufacture is required for power wire and cable specified in this Section.
- B. General: Conform to UL 83 and NEMA WC 5.
 - 1. Single Conductor: Type THWN-THHN (75°C wet/90°C dry) or XHHW (75°C wet/90°C dry) cable rated 600 volts.

2.3 SIGNAL CABLE

- A. Type PLCC (Power Limited Control Cable):
 - 1. General: Rated 300 volts, 90 deg. C, single pair (Pr.), triad (Tri.) or quad (Qd.).
 - 2. Single Pr., Tri. Or Qd.: No. 16 AWG, stranded copper conductors, twisted and covered with a 100% aluminum-mylar shield, with drain wire and overall PVC jacket.
 - 3. Multiple Pr., Tri. Or Qd.: Same as single construction except No. 20 AWG conductors and an overall aluminum-mylar shield in addition to individual shields.
 - 4. Direct Burial Cable: Same as single or multiple constructions with addition of aluminum sheath and weatherproof outer jacket.

2.4 CONNECTORS AND TERMINALS

- A. Insulated Crimp Type Connectors and Terminals: Nylon insulated, Burndy "INSULINK" and "INSULUG," or Thomas & Betts "Sta-Kon."
- B. Split Bolts: High-conductivity copper alloy, Burndy "SERVIT" or Thomas & Betts "Split-Bolt."
- C. Compression Terminals: Copper long barrel, Burndy "HYLUG" or Thomas & Betts "Color-Keyed," or aluminum alloy Buchanan "Cytolok CL500" series.
- D. Bolted Terminals: Cast copper alloy, Burndy "QIKLUG" or Thomas & Betts "Locktite."

2.5 MISCELLANEOUS COMPONENTS

- A. Tape:
 - 1. Vinyl Plastic: 3M "Scotch 33+" or "Scotch 88."
 - 2. Varnished Cambric (VC): 3M "Irvington 2920."
 - 3. Friction: Black friction tape.
 - 4. Color Coding: 3M "Scotch 35."
 - 5. Fireproofing: 3M "Scotch 77."
 - 6. High Temperature Glass Cloth: 3M "Scotch 69" (180°C).
 - 7. Electrical Insulation Putty: 3M "Scotchfil."
- B. Splice Kits: 3M "Scotchcast 82 Series".
- C. Pulling Lubricants: Ideal "Yellow 77" or Polywater "Type J."
- D. Wire Markers:
 - 1. Individual Wires: Write-on type with self-laminating vinyl overwrap, 3M "ScotchCode," Ideal "Write-On," or Thomas & Betts "WSL."
 - 2. Multi-Conductor Cables or Groups of Wires as a Cable: Nylon tie on marker, Thomas & Betts "Nylon I.D. Ties Ty-Raps."
- E. Wire and Cable Ties: Thomas & Betts "Ty-Raps."

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Wire and Cable:
 - 1. General:

- a. Limit pulling tension to maximum values recommended by manufacturer.
 - b. Do not pull through boxes, fittings, or enclosures where a change of raceway alignment or direction occurs. Use of shieves is acceptable.
 - c. Do not cut strands from conductors to fit lugs or terminals.
 - d. Do not splice control or signal wiring.
- B. Compression Connectors and Terminals: Install on wire and cable with approved tool and die to recommended compression pressure.
- C. Bolted Connectors and Terminals:
1. Torque to manufacturer's recommended foot-pounds for size and class of connector.
 2. Where manufacturer's published torquing requirements are not indicated, tighten connectors and terminals to comply with UL 486A torque values.
 3. Use plated bolts and lock washers on terminal connections.
- D. Wiring in Enclosures:
1. Form and tie conductors in panelboards, cabinets, control panels, motor controllers, wireways, and wiring troughs in a neat and orderly manner.
 2. Use Thomas & Betts wire and cable ties of appropriate size and type.
 3. Limit spacing between ties to not more than 6 inches.
- E. Taping:
1. Above Ground and Dry Locations: Fill voids and irregularities with half-lapped layers of VC (two minimum) or electrical insulation putty. Insulate with three half-lapped layers of vinyl plastic and one half-lapped layer of friction tape.
 2. Below Ground and Wet Locations: In lieu of taping protect connection with resin splicing kit.
 3. Fireproofing: Same as specified for above ground and dry locations plus one half-lapped layer of fireproofing.
- F. System Separation:
1. Control and Signal Wiring: Provide separate raceways or barriers in raceways to separate each of the following systems from other wiring:
 - a. 120 volt control wiring.
 - b. Analog 4-20 Milliamp.
 - c. Digital (Pulse).

3.2 APPLICATION

A. Wire and Cable:

1. THWN-THHN or XHHW for power wiring through No. 2 AWG, and control wiring in conduit. XHHW for sizes above No. 2 AWG in conduit.
2. Bare copper for ground conductors, which penetrate finished floor or grade and ground loops.
3. No. 12 AWG minimum for power circuits and No. 14 AWG minimum for control circuits unless noted otherwise on Drawings.

B. Connectors and Terminals:

1. Motor Terminations (Single Conductor Circuits): Insulated ring tongue crimp type connectors or compression terminals, connected back-to-back with plated bolt, nut and lockwasher, and then taped. Where strap screw devices are present use split tongue connectors in lieu of ring tongue connectors.
2. Motor Terminations (Parallel Conductor Circuits): Gang compression terminals on a 1/4-inch-thick copper bar.
3. Transformer Terminations: Split bolt connectors for pigtail connections. Compression terminals for all other connections.

C. Multiconductor Control Cable: 14 AWG conductors except 16 AWG may be used in control enclosures.

3.3 COLOR CODING

A. Power Wiring: Provide color coding for single and multi-conductor power circuits as follows:

<u>Voltage</u>	<u>ØA</u>	<u>ØB</u>	<u>ØC</u>	<u>Neutral</u>
240 volts and below	Black	Red	Blue	White
250 - 600 volts	Brown	Orange	Yellow	Natural Gray

1. For specified insulations and jackets not manufactured with integral colors, use conductors with black insulation or jacket and color coding tape.
2. Color code conductors entering boxes, troughs, cabinets, and other enclosures.
3. Color code conductors in wireways, trenches, and other locations where conductors are continuously accessible at intervals not exceeding 5 feet.

B. Insulated Equipment Ground: Green.

C. Control Cables:

1. Single Conductors: Red (AC), Blue (DC).
 2. Multi-conductor: Comply with ICEA S-66-524, "Method 1", Table K-2.
- D. Signal Cables: Comply with ICEA S-82-552, "Method 9", Table E-2. In addition, number multiple pairs, triads, and quads.

3.4 IDENTIFICATION

- A. Cables: Attach nylon tie on markers on both ends of cable denoting cable type and number as noted on Drawings. Where a number of 1/C wires are identified as a single cable, group conductors using "Ty-Raps" and attach markers.
- B. Conductor Identification: Attach conductor markers on both ends of wire and label as indicated on Drawings.

END OF SECTION

SECTION 16123

PRIMARY WIRING - 15KV NOMINAL

PART 1 - GENERAL

1.1 REFERENCES

- A. ICEA S-68-516/NEMA WC-8 Ethylene-Propylene Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.
- B. AEIC CS-6 Specifications for Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 through 69KV.
- C. UL 1072 Medium-Voltage Power Cables.
- D. IEEE 48 Standard Test Procedures and Requirements for High-Voltage Alternating-Current Cable Termination.

1.2 SUBMITTALS

- A. Submittals Package: Submit the data specified below for preliminary approval all at the same time as a package. After preliminary approval, submit the data and samples specified below for final approval all at the same time as a package.
- B. Submit the following for preliminary approval:
 - 1. Complete manufacturer's construction details and specifications for the cables, including physical and electrical characteristics of insulation, shields and jackets.
 - 2. Overall dimension and ampacity of cable.
 - 3. Splicing and termination data, including the following
 - a. List of materials.
 - b. Method of connecting conductors.
 - c. Details of cable preparation.
 - d. Method of applying materials (including quantities and recommended tools).
 - e. Precautionary measures.
 - f. Drawings showing method of splicing, complete with dimensions.
 - f. Approved splicing and termination equipment for the specific cable manufacturer.
 - g. Specific splices and terminations equipment suitable for the proposed application.

4. If ethylene-propylene rubber insulated cable is proposed for use, furnish cable manufacturer's certified copies of the AEIC qualification test for the cable being proposed, unless these documents are currently on file with the organization reviewing the submittals.
- C. Final Approval: After preliminary approval, submit the following for final approval:
1. Independent testing organization certified test data from tests performed on the completed cable.
 - a. For ethylene-propylene rubber insulated cable, furnish cable manufacturer's certified copies of AEIC electrical tests required for completed cables (ac and dc voltage withstand, partial discharge, jacket spark test, and insulation resistance). Plot results of partial discharge test (apparent discharge characteristics and partial discharge extinction voltage) on an x-y recording.
 2. Two foot samples of each cable, taken from reel at jobsite prior to installation. Reseal cable on reel. Include the following additional information on the sample labels, required by Section 01330:
 - a. The maximum voltage at which the conductor is designed to be used.
 - b. Date of manufacture.
 3. Samples of splicing and termination materials if requested (complete kits will be returned and, if approved, may be used in the Work). Include:
 - a. Full roll of all tapes in original box or container, with the date of manufacture indicated thereon.
 - b. Other materials in sufficient quantity to construct a complete splice and labeled for identification.
 - c. Entire factory packaged kit if splice or termination is of the kit type.
 4. Specific pulling compounds for type and conditions of the installation.
 5. Resume of each cable splicer's experience. Include:
 - a. Details of type of high voltage splicing and terminations performed.
 - b. Types of cables which were spliced.
 - c. Job locations.
 - d. Number of years performing splices and terminations.
 - e. Certificate of training from the splice/termination manufacturer for heat-shrinkable products, if used.

6. Catalog sheets, specifications and installation instructions for all products.
 - a. Field Advisor Data / Independent Inspection Agency:
 - b. Name, business address, email address, and telephone number of Company Field Advisor/Independent Inspection Agency secured for the required services.
 - c. Certified statement from the Company, listing the qualifications of the Company Field Advisor / Independent Inspection Agency.
- D. Contract Closeout Submittals:
 1. Test Report: High voltage after installation test report.
 - a. Certificates:
 - b. Affidavit, signed by an Independent Inspection Agency, certifying that the cable has been installed in accordance with the manufacturer's recommendations and is operating properly.
 - c. Affidavit, signed by the splice and termination manufacturer's an Independent Inspection Agency, certifying that the splices and terminations were constructed in accordance with the manufacturer's recommendations and are operating properly.

1.3 DELIVERY, STORAGE AND HANDLING

- A. Cable Delivery:
 1. No insulated cable over one year old when delivered to the site will be acceptable.
 2. Keep ends of cables sealed at all times, except when making splices or terminations. Use soldered seals for lead sheath cables. For other type cables use heat shrinkable plastic end caps with sealant as produced by Raychem Corp., or Thomas & Betts Corp., or other methods approved by cable manufacturer.
 3. Include the following data durably marked on each reel:
 - a. Facility name and address.
 - b. Contractor's name.
 - c. Project title and number.
 - d. Date of manufacture.
 - e. Cable size and voltage rating.
 - f. Manufacturer's name.
 - g. Linear feet of cable.

- B. Cable Storage: Store where cable will be at optimum workability temperature recommended by cable manufacturer.

1.5 MAINTENANCE

- A. Special Tools: Furnish one set of special tools for the assembly of premolded splices (if used). Store them at the Site where directed.

PART 2 - PRODUCTS

2.1 CABLES

- A. Cable Configuration: Multiple conductors.
- B. Cable Configuration: Single conductors.
- C. Conductors: Annealed uncoated copper or annealed coated copper in conformance with the applicable standards for the type of insulation on the conductor.
- D. Ethylene-Propylene Rubber Insulated/Lead Cables: By Okonite Cable Co., Pirelli Cables of North America, or Rome Cable Corp. in accordance with:
 - 1. ICEA S-68-516/NEMA WC-8 Standards Publication "Ethylene-Propylene Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy".
 - 2. The following specific cable parameters:
 - a. Rated 15KV between phases at an insulation level of 133 percent.
 - b. Rated 90 degrees C (normal operation), 130 degrees C (emergency operation), 250 degrees C (short circuit operation).
 - c. Conductor shield, insulation, and insulation shield extruded by a triple-tandem extrusion process.
- E. Ethylene-Propylene Rubber Insulated Cables: - by Okonite Co., Pirelli Cables of North America, or Rome Cable Corp. in accordance with:
 - 1. ICEA S-68-516/NEMA WC-8 Standards Publication "Ethylene-Propylene Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy".
 - 2. The following specific cable parameters:
 - a. Rated 15KV between phases at an insulation level of 133 percent.
 - b. Rated 90 degrees C (normal operation), 130 degrees C (emergency operation), 250 degrees C (short circuit operation).
 - c. Conductor shield, insulation, and insulation shield extruded by a triple-tandem extrusion process.

2.2 TERMINATIONS

- A. Materials: All materials required for a complete termination the standard product of one manufacturer, designed specifically for the type of cable and conductor to be terminated.
- B. Ampere Rating: Not less than ampere rating of cable.
- C. Voltage Rating: Not less than voltage rating of cable.
- D. Manufacturer: Furnish terminations by one of the manufacturers listed below, if acceptable to the cable manufacturer.
 - 1. IEEE 48 Class 1 Terminations:
 - a. For Cables With Lead Sheath: Capnut type pothead, cast iron, aluminum, bronze body or bell, wiping sleeve type, with insulating compound, - by; Adalet-PLM, G & W Electric Co., or Mac Products Inc.
 - b. For Cables Without Lead Sheath: Adalet PLM's Overroll FSDW, Elastimold's 16THG, or 35MTG, with cable shield adapter, G & W Electric Co.'s Slip-On II Terminator or Slip-On Terminator with adapter, Kerite Co.'s Outdoor Terminal OT, Minnesota Mining & Mfg. Co.'s 3M Cold-Shrink Terminations, or Raychem Corp.'s Heat-Shrinkable High Voltage Termination System. Equip terminations with or without skirts as recommended by manufacturer.
 - 2. IEEE 48 Class 3 Terminations:
 - a. For Cables Without Lead Sheath: Adalet-PLM's Overroll FSDT, Elastimold's 35MSC or 35MTGI, with cable shield adapter, G & W Electric Co.'s Termination Kit, Kerite Co.'s Indoor Terminal IT, Mac Products Inc.'s Terminating Kit, Minnesota Mining & Mfg. Co.'s 3M Tape Termination Kit or Cold-Shrink Terminations, Plymouth Rubber Co.'s Plymouth Bishop Plypak or Stress Wrap Terminating Kit, or Raychem Corp.'s Heat-Shrinkable High Voltage Termination System.

2.3 SPLICES

- A. Materials: All materials required for a complete splice the standard product of one manufacturer, designed specifically for the type of cable and conductor to be spliced.
- B. Ampere Rating: Not less than ampere rating of cable.
- C. Voltage Rating: Not less than voltage rating of cable.
- D. Splices Installed in Wet Locations: Waterproof and submersible.
- E. Manufacturer: Furnish splices by one of the manufacturers listed below, if acceptable to the cable manufacturer (field made epoxy-resin unit not acceptable):
 - 1. For Cables With Lead Sheath:
 - a. Wiped Joint Splices: Adalet-PLM's LP Series Cable Splicing Kit, or Mac Products Inc.'s Cable Splicing Kits.
 - b. Heat-Shrinkable Splices: Raychem Corp.'s High Voltage Splice HVS.

2. For Cables Without Lead Sheath:
 - a. Tape Splices: Adalet-PLM's S Type Cable Splicing Kits, Kerite Co.'s Splice S, Mac Products Inc. Cable Splicing Kits, Minnesota Mining & Mfg. Co.'s 3M Splicing Kits or Plymouth Rubber Co.'s Plymouth Bishop Plypak or Stress Wrap Splicing Kits.
 - b. Premolded Splices: Elastimold's Premolded Splices or Minnesota Mining & Mfg. Co.'s 3M Molded Quick Splice.
 - c. Heat-Shrinkable Splices: Raychem Corp.'s High Voltage Splices HVS.

2.4 CABLE DEAD ENDS (FULL VOLTAGE)

- A. For Cables with Lead Sheath:
 1. Wiped Joint Type: G & W Electric Co.'s Caps for Live Cables, or Mac Products Inc.'s Live End Caps.
 2. Heat-Shrinkable Type: Raychem Corp.'s Live End Seals HVES.
 3. Mechanical Type: G & W Electric Co.'s Universal Splicing System with sealing caps.
- B. For Cable Without Lead Sheath: Elastimold's Premolded Splice with Dead-End Plug, G & W Electric Co.'s Universal Splicing System with sealing caps, or Raychem Corp.'s Live End Seals HVES.

2.5 ACCESSORIES

- A. Pulling Compounds: As recommended by cable manufacturer.
- B. Arc Proofing Tapes:
 1. Arc Proofing Tape: Mac Products Inc.'s AP30-30 or AP, Minnesota Mining & Mfg. Co.'s 3M 77, Plymouth Rubber Co.'s Plymouth Bishop 53 Plyarc, or Quelcor Inc.'s Quelpyre.
 2. Glass Cloth Tape: Mac Products Inc.'s TAPGLA 5066, Minnesota Mining & Mfg. Co.'s 3M 69, or Plymouth Rubber Co.'s Plymouth Bishop 77 Plyglas.
 3. Glass-Fiber Cord: Mac Products Inc.'s MAC 0527, or Quelcor Inc.'s QTC-250.
- C. Tags: Precision engrave letters and numbers with uniform margins, character size minimum 3/16 inches high.
 1. Phenolic: Two color laminated engraver's stock, 1/16 inch minimum thickness, machine engraved to expose inner core color (white).
 2. Aluminum: Standard aluminum alloy plate stock, minimum .032 inches thick, engraved areas enamel filled or background enameled with natural aluminum engraved characters.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Cables:

1. Install cables in conduit after conduit system is completed.
2. Keep ends of cables sealed watertight at all times, except when making splices or terminations.
3. No grease, oil, lubricant other than approved pulling compound may be used to facilitate the pulling-in of cables.
4. Use pulling eye attached to conductor(s) for pulling-in cables. Cable grip will not be allowed. Seal pulling eye attachment watertight.
5. Pull all cables with a dynamometer or strain gage incorporated into the pulling equipment. Do not pull cables unless the Owner/Engineer representative is present to observe readings on the dynamometer or strain gage during the time of actual pulling. Do not exceed pounds total strain on size cable for a 3 conductor pull (3 conductor cable or 3 single conductor cables).

B. Terminations and Splices:

1. General: Splice and terminate cable in accordance with manufacturer's approved installation instructions, employing specific tools recommended by the manufacturer.
2. For Cables With Lead Sheath:
 - a. Use potheads to terminate lead sheath cables.
 - b. Ground lead sheath at splices and terminations.
3. For Cables Without Lead Sheath:
 - a. Use IEEE 48 Class 1 terminations to terminate cable in wet locations.
 - b. Use IEEE 48 Class 1 terminations to terminate cable inside of outdoor equipment which is not equipped with space heaters (pad mounted switches, pad mounted transformers, etc). Class 1 or Class 3 terminations may be used to terminate cable inside of outdoor switchgear cubicles which are equipped with space heaters (metal-clad switchgear, metal-enclosed interrupter switchgear, etc.).
 - c. Use IEEE 48 Class 1 or Class 3 Terminations to terminate cable in dry locations.
 - d. Ground shield at splices and terminations.
 - e. Incorporate solder dam or use other approved method to prevent moisture from entering splices through grounding conductor.

- C. Arc Proofing: Arc proof feeders installed in a common pullbox or manhole as follows:
1. Arc proof new feeders.
 2. Arc proof existing feeders that are spliced to new feeders
 3. Arc proof each feeder as a unit with half-lapped layer of 55 mils thick arc proofing tape, random wrapped or laced with glass cloth tape or glass-fiber cord. For arc proofing tape less than 55 mils thick add layers to equivalent of 55 mils thick arc proofing tape.
- D. Identification of Feeders: Identify feeders in manholes, pullboxes and in equipment to which they connect:
1. Install tags on each insulated conductor indicating phase leg. Attach tags with non-ferrous metal wire. Install phase leg tags under arc proofing tapes.
 2. Install tags on each feeder indicating feeder number, date installed (month, year), type of cable, voltage rating, size, and manufacturer. Attach tags to feeders with non-ferrous metal wire or brass chain. Install tags so that they are easily read without moving adjacent feeders or require removal of arc proofing tapes.
- E. Phase Relationship: Connect feeders to maintain phase relationship through system. Phase legs of feeders shall match bus arrangements in equipment to which the feeders are connected.

3.2 FIELD QUALITY CONTROL

- A. High Voltage After Installation Test:
1. Have the cable installation tested by the Independent testing company.
 2. Perform test after cable has been installed complete with all splicing, bonding, etc., and prior to placing cable into service.
 3. Perform test on new cable after it has been installed complete with splicing, bonding, etc., but prior to splicing to existing cable. Do not splice new cable to existing cable until new cable test has been completed. Do not perform test on existing cable.
 4. Perform test on feeders comprised of new cable after cable has been installed complete with all splicing, bonding, etc., and prior to placing cable into service. For feeders comprised of new and existing cable, perform test on new cable after it has been installed complete with splicing, bonding, etc., but prior to splicing to existing cable. Do not splice new cable to existing cable until new cable test has been completed. Do not perform test on existing cable.
 5. Perform test with potential and duration specified by the Independent testing company after approval of manufacturer's certified test data. Follow test procedure summarized on Test Record-Power Cable Proof Test and applicable test methods in ICEA and AEIC Specifications. Do not make tests until test voltages and duration have been specified in writing by the Owner/Engineer.
 6. List results of the tests on form supplied by the Independent testing company Representative.
 7. Perform test in the presence of the Independent testing company Representative.

3.3 CABLE SCHEDULE

- A. Use either of the following for primary wiring:
 - 1. Kerite insulated/lead cable.
 - 2. Ethylene-propylene rubber insulated/lead cable.
 - 3. Kerite insulated cable.
 - 4. Ethylene-propylene rubber insulated cable.
- B. For primary wiring within transformer vaults use either of the following:
 - 1. Kerite insulated cable.
 - 2. Ethylene-propylene rubber insulated cable.

END OF SECTION

SECTION 16130

BOXES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section specifies electrical outlet, device, pull, junction boxes and wireways and installation.

1.2 DEFINITIONS

- A. Outlet Box: A box used as a wiring enclosure that may be used as a device box with the addition of a plaster ring or special cover.
- B. Device Box: A box designed to house a switch, receptacle or other wiring devices.

1.3 QUALITY ASSURANCE

- A. Furnish boxes bearing label or listing of a Nationally Recognized Testing Laboratory (NRTL), as defined in OSHA Regulation 1910.7.

PART 2 - PRODUCTS

2.1 OUTLET AND DEVICE BOXES

- A. General:
 - 1. UL 514A and 514B for all boxes.
 - 2. NEMA OS 1 for sheet steel boxes.
- B. Cast Iron Boxes: Crouse-Hinds or Appleton "FS/FD" and "ALC" series.
- C. Cast Aluminum Boxes: Crouse-Hinds "FS-SA"/"FD-SA" or Appleton "FS-A"/"FD-A" Series.
- D. Sheet Steel Boxes: Pressed steel, galvanized, 4 inch octagonal or 4 inch square (or "gang") boxes, depth as needed to accommodate devices and associated wiring.
- E. Accessories: Provide fixture studs, plaster rings, extension rings, and covers as required for application. Galvanized steel indoors and galvanized cast ferrous metal or cast aluminum with neoprene gaskets outdoors.
- F. Floor Boxes;
 - 1. Acceptable Products:

	<u>Hubbell</u>	<u>Steel City</u>
Single-gang box	B-2436	641
Two-gang box	B-4233	642

Three-gang box	B-4333	643
Duplex receptacle trim	S3625	P-64-DU
Telephone/Signal trim	S2425	P-64-3/4-2

2. Accessories: Provide necessary floor covering adapters, plugs, gaskets, nipples and sealing compound.

2.2 JUNCTION AND PULL BOXES

- A. Boxes (6 Inch Minimum Dimension):
 1. Welded galvanized sheet steel, of sizes required by NEC, without knockouts.
 2. 14 gauge metal for boxes with maximum dimension of less than 24 inches, 12 gauge for boxes with maximum dimension of 24 to 35 inches, and 10 gauge for boxes with any dimension greater than 35 inches.
 3. Provide removable, flame retardant, insulating cable supports in boxes with any dimension greater than 42 inches.
 4. Comply with UL 50 for boxes over 100 cubic inches volume.
 5. Provide screwed or bolted covers of same gauge as box.
- B. Boxes (4-11/16 Inch Maximum Dimension): Pressed steel, galvanized, 4 or 4-11/16 inches square, 1-1/2 or 2-1/8 inches deep.
- C. Weatherproof Boxes: NEMA 3R, continuously welded-seam, galvanized sheet steel enclosures with gasketed covers.
- D. Watertight Boxes: Galvanized cast iron with gasketed, bolt-on covers, tapped holes in bosses or hubs for conduit entrances, and integrally cast mounting lugs.

2.3 WIREWAYS

- A. Provide hinged cover NEMA 1 lay-in steel wireway assemblies of sizes indicated on Drawings.
- B. Provide special lengths, telescope fittings, box connectors, elbows and other fittings as required for a complete system.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 1. Mount boxes plumb and level and rigidly attach them to the structure.
 2. Clean interiors before installing trim and cover.
 3. Close unused openings with blanking devices or threaded plugs.

4. Install surface mounted units at least 1 inch off of walls with supports placed in such a manner to permit vertical flow of air behind the enclosure.
- B. Wireways:
1. Assemble and erect system so that access covers are on top of horizontal runs
 2. Do not mount wireways directly to building structure or machinery. Use a trapeze assembly to install wireways.

3.2 APPLICATION

- A. NEMA 3R for outdoor installations.
- B. NEMA 1 for all other areas unless indicated otherwise on the Drawings.
- C. Cast iron "FS/FD" for use with surface mounted steel conduit unless noted otherwise on the Drawings or in other Specification Sections.
- D. One-piece stamped steel boxes for installation in partitions, walls, and suspended ceilings.
- E. Tile box, 3-½ inch deep for installation in poured concrete walls and concrete columns. 4-inch octagonal box with removable back cover for installation in overhead concrete slabs.

END OF SECTION

SECTION 16136

CLEANING UNDERGROUND CONDUITS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Clean all new underground conduits following conduit installation and prior to the installation of conductors
 - 2. Clean all existing conduits for which existing conductors are to be removed as indicated in the Drawings.
- B. Related Sections:
 - 1. Section 16010 Electrical System General Requirements
 - 2. Section 16111 Metallic Conduit and Fittings

1.2 SUBMITTALS

- A. Comply with the provisions and requirements of Section 01330, Submittal Procedures.
- B. Following the cleaning of the existing and new underground conduits, provide the following Submittals:
 - 1. Cleaning Report, to include the following information:
 - a. List locations, types and sizes of conduits successfully cleaned.
 - b. Status of conduits which cannot be successfully cleaned (type of conduits, problems encountered, cause of problem, and exact locations measured from 2 adjacent manholes).
 - c. Report general conditions of the ducts (rusting steel, fiber delaminating, etc.).
 - d. Report of Conditions Within Manholes:
 - (1) Unracked cables.
 - (2) Missing or broken parts on cable racks.
 - (3) Equipment that is not grounded to a rod electrode (manhole frame, channel racks, metal ladders, splice shields).
 - (4) Cable arc-proofing damaged or missing.
 - (5) Conduits without end bells.

- (6) Broken manhole covers.
- e. Comments on any items that require future corrections.

1.3 QUALITY ASSURANCE

- A. Qualifications of Supervisor: The person supervising the Work of this Section shall be personally experienced in this type of Work and shall have been regularly employed by a company engaged in underground pipe or conduit cleaning for a minimum of 2 years.
- B. Furnish to the Owner and Engineer the names and addresses of 3 similar projects which the supervisor has worked on.

1.4 PROJECT CONDITIONS

- A. Existing Conditions: The spare conduits are to be cleaned with all high voltage cables within the manholes and vaults energized.
- B. Protection:
 - 1. Provide electrical insulating blankets, sleeves, gloves, etc., to protect workmen from electrical hazards.
 - 2. Provide heavy blankets, plywood or other devices to protect cables and equipment from physical damage.

PART 2 - PRODUCTS

2.1 DRAG LINE

- A. Minimum 1/8" polypropylene monofilament utility rope:
 - 1. American Synthetic Ropes' Flotorope.
 - 2. Greenlee Tool Co.'s 2 ply Rope 431.
 - 3. Ideal's Pro-Pull Rope 3/16.
 - 4. Thomas Industries/Jet Line Products Rope 232.

2.2 CONDUIT SEALS

- A. Wood or plastic plugs designed for the purpose or a contrasting color cement/sand mixture. Seals shall be removable for future use of conduits. Seals shall include waterproof tag stating "CONDUIT CLEANED" and date (month, year).

PART 3 - EXECUTION

3.1 PREPARATION

- A. Dewater manholes.
- B. Remove all debris from manholes.
- C. Install protective devices on cables and equipment.
- D. Methods used for performing the Work shall have prior approval from the Owner and Engineer.

3.2 PERFORMANCE

- A. Remove all dirt, scale, debris and projections by flushing, rodding, scrapping, wire brushing and swabbing the conduits with hand tools and power equipment designed for the purpose.
- B. Demonstrate to the Owner and Engineer the condition of the cleaned conduits.
 - 1. Use mandrel 1/2" less in diameter than the conduit. Paint sheath of mandrel with black lacquer. Pull mandrel through conduit. Conduit will be considered successfully cleaned if there are no roller marks or scratches on the mandrel.
 - 2. Other methods may be used to determine the status of cleaned conduits, if approved.
- C. Demonstrate to the Owner and Engineer any defect found in the conduits that cannot be satisfactorily eliminated.
- D. Provide a drag line in each cleaned conduit.
- E. Provide conduit seals at both ends of each cleaned conduit.
- F. Remove all debris from conduits and manholes resulting from the work of this Project.

END OF SECTION

SECTION 16140

WIRING DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. The Contractor shall provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install receptacles.
- B. Related Sections: The Contractor shall coordinate the requirements of this Section with the requirements of the Sections listed below.
 - 1. Section 16130, Boxes.
 - 2. Section 16121, Low Voltage Copper Wire and Cable.

1.2 QUALITY ASSURANCE

- A. Comply with applicable provisions and recommendations of the following:
 - 1. National Electrical Code.
 - 2. UL Standard No. 1010, Electrical Receptacle - Plug Combinations for Use in Hazardous Locations.

1.3 SUBMITTALS

- A. Comply with the provisions and requirements of Section 01330, Submittal Procedures.
- B. Provide submittals for all Receptacles proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Receptacles for Non-Hazardous Locations:
 - 1. Duplex grounding receptacle, two pole, three wire, 125 volt AC, 20 amperes.
 - a. Product and Manufacturer: Provide one of the following:
 - (1) Catalog No. 5362, for dry indoor locations and Catalog No. 53CM62, for wet and corrosive locations, by Harvey Hubbell Incorporated.
 - (2) Catalog No. 5362, for dry indoor locations and Catalog No. 5362-CR, for wet and corrosive locations, by Arrow-Hart Incorporated.
 - (3) Or equal.

2. Single grounding receptacle, two pole, three wire, 125 volt AC, 20 amperes.
 - a. Product and Manufacturer: Provide one of the following:
 - (1) Catalog No. 53CM61, by Harvey Hubbell Incorporated.
 - (2) Catalog No. 5361-CR, by Arrow-Hart Incorporated.
 - (3) Or equal.

- B. Ground Fault Receptacles:
 1. Duplex receptacle, two pole, three wire, 125 volt AC, 20 amperes.
 2. Product and Manufacturer: Provide one of the following:
 - a. Catalog No. GF5362, by Harvey Hubbell Incorporated.
 - b. Catalog No. GF5342, by Arrow-Hart Incorporated.
 - c. Or equal.

- C. Surge Suppression Receptacles:
 1. Duplex grounding, surge suppression receptacle, two pole, three wire, 125 volt AC, 20 amperes, capable of absorbing a transient surge 6,000 volts minimum. Receptacle to include power on indicator light:
 - a. Product and Manufacturer: Provide one of the following:
 - (1) Catalog No. 5350S by Harvey Hubbell Inc.
 - (2) Catalog No. 5380-GY by Leviton Manufacturing Company.
 - (3) Or equal.

- D. Power Receptacles: 480 volt interlocked receptacle with enclosed safety switch service outlet: Provide service outlets, quantity as shown on the Drawings for portable equipment.
 1. Material: Copper free aluminum enclosure with operating handle, NEMA 4 with gasketed hinged door.
 - a. Switch: Heavy duty, three pole, with visible blades, a quick make and break mechanism with reinforced, positive pressure type blade and fuse clips. Switch shall be mechanically interlocked with the receptacle. The switch cannot be closed until the plug is fully inserted and the plug cannot be withdrawn or inserted, unless the switch is open.
 - b. Receptacle: As indicated on the drawings. Provide two matching plugs.
 - c. Type WSR, and Type APS plugs by Crouse-Hinds Company or equal.

- E. Power and Special Receptacles: Provide receptacles with number of poles and voltage and current rating as shown on the Drawings. Coordinate with equipment plugs. Provide matching plug for each receptacle.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install receptacles at locations as shown on the Drawings in outlet or device boxes in accordance with Section 16130, Boxes, in non-hazardous locations.
- B. Install receptacles in PVC coated galvanized rigid steel conduit systems in hazardous locations.
- C. Install receptacles with ground pole in the down position.
- D. Mount receptacles 18-inches above finished floor, or in accordance with local building codes, in non-hazardous locations and 4 feet-6 inches above finished floor in hazardous locations, unless otherwise noted.
- E. Identify each conductor with the circuit number and the lighting panel number. Identification shall conform to the requirements of Section 16121, Low Voltage Copper Wire and Cable.
- F. Identify each receptacle with a permanent phenolic tag. The tags shall include the circuit number and the lighting panel number.
- G. Installation shall conform to the National Electrical Code.

END OF SECTION

SECTION 16150

SNAP SWITCHES

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Scope:
 - 1. Contractor shall provide all labor, materials, equipment and incidentals as shown on the Drawings, specified and required to furnish and install snap switches for lighting and other systems.
- B. Related Sections: Contractor shall coordinate the requirements of the work in this section along with the requirements of the sections listed below which include, but are not necessarily limited to, work that is directly related to this Section.
 - 1. Section 16130, Boxes.
 - 2. Section 16121, Low Voltage Copper Wire and Cable.

1.2 QUALITY ASSURANCE

- A. Comply with applicable provisions and recommendations of the following, except where otherwise shown or specified.
 - 1. National Electrical Code.
 - 2. UL Standard No. 20, General Use Snap Switches.

1.3 SUBMITTALS

- A. Comply with the provisions and requirements of Section 01330, Submittal Procedures.
- B. Provide Submittals for all switches proposed for use.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Switches for Non-Hazardous Locations:
 - 1. Single pole AC toggle switch, quiet type, 120/277 volt AC, 20 amperes, Ivory, specification grade.
 - a. Product and Manufacturer: Provide one of the following:
 - (1) Catalog No. 1221-I, by Harvey Hubbell Incorporated.
 - (2) Catalog No. 1991-I, by Arrow-Hart Incorporated.
 - 2. Single pole, 3-way AC toggle switch, quiet type, 120/277 volt AC, 20 amperes, Ivory, specification grade.

- a. Product and Manufacturer: Provide one of the following:
 - (1) Catalog No. 1223-I, by Harvey Hubbell Incorporated.
 - (2) Catalog No. 1993-I, by Arrow-Hart Incorporated.
- 3. Two pole AC toggle switch, quiet type, 120/277 volt AC, 20 amperes, Ivory, specification grade.
 - a. Product and Manufacturer: Provide one of the following:
 - (1) Catalog No. 1222-I, by Harvey Hubbell Incorporated.
 - (2) Catalog No. 1992-I, by Arrow-Hart Incorporated.
- B. Switch Covers:
 - 1. Indoor covers shall be Type 304, stainless steel.
 - 2. Outdoor or wet location covers shall be weatherproof and corrosion resistant.
- C. Key Operated On-Off Switches:
 - 1. Key operated switches shall be complete with legend plate and NEMA 4 enclosure and two keys for each switch.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install switches at locations as shown on the Drawings in outlet or device boxes in accordance with Section 16130, Boxes, in non-hazardous locations.
- B. Mount wall switches 4 feet-6 inches above finished floor unless otherwise noted.
- C. Identify each conductor with the circuit number and the lighting panel number. Identification shall conform to the requirements of Section 16121, Low Voltage Copper Wire and Cable.
- D. Install switches in conformance with National Electrical Code.

END OF SECTION

SECTION 16190

SUPPORTS AND FASTENERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Supports and hangers, anchors, and fastenings for mounting and anchoring electrical raceways, equipment, and fixtures.
- B. Related Sections: Additional support requirements for specific items are specified elsewhere in Division 16.

PART 2 - PRODUCTS

2.1 FIELD FABRICATED SUPPORTS

- A. Structural steel shapes and plates as specified in Division 05000. Hot-dipped galvanized for outdoor locations.
- B. 3/8 inch minimum, continuous thread, plated or galvanized hanger rod.
- C. Prefabricated structural systems manufactured by American Electric Kindorf, Power-Strut, or Unistrut.

2.2 CONDUIT SUPPORTS

- A. Clamps: Steel City or American Electric Kindorf "RC" and "PC" clamps.
- B. Straps:
 - 1. Conduit Straps: Plated steel or hot-dipped galvanized, "two-hole" straps.
 - 2. Channel Straps: American Electric Kindorf "C-105," Power-Strut "PS-1300," or Unistrut "P1100" and "P1400."
- C. Hangers:
 - 1. Conduit Hangers: Steel City Series "6H" or Erico Products, Inc. Caddy "CD" series.
 - 2. Lay-In Pipe Hangers: American Electric Kindorf "C-149," Power-Strut "PS-3200," or Unistrut "J1200."
- D. Clips: Erico Products, Inc. "Caddy M" Series snap-lock conduit clip in combination with a "Caddy Universal" drive-on beam clamp or threaded rod.

2.3 ANCHORS

- A. Toggle Bolts: Star "3000" series.
- B. Plastic Anchors: Star "06" series with appropriately sized metal screws.

- C. Lead Shields and Lag Bolts: ITW Ramset/Red Head "LS" series or Star "1800" series.
- D. Hollow Wall Anchors: ITW Ramset/Red Head "WA" series or Star "2700" series.
- E. Threaded Expansion Anchors: ITW Ramset/Red Head "J," "S" or "JS" series, or Star "3400" series.
- F. Wedge Anchors: ITW Ramset/Red Head "WS" series or Star "3500" series.

2.4 FASTENERS

- A. Bolts and Nuts: ASTM Grade 2, low carbon, plated or galvanized, hex head.
- B. Beam Clamps: American Electric Kindorf "E-160" or "E-231," Power-Strut "PS800" and "PS2000," or Unistrut "P2600" or "P2700" clamps with retainers.
- C. Channel/Angle Clamps: American Electric Kindorf "E-177" or equal.

2.5 GALVANIZING REPAIR PAINT

- A. ASTM A 780.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 - 1. Fabricate and install supports so that supported installation does not weaken or overload structure.
 - 2. Do not impose weight of electrical equipment, raceways, or fixtures on supports provided for non-electrical systems unless indicated otherwise on Drawings.
 - 3. Secure steel supports to structure by bolting or welding.
 - 4. Use retaining device when making connections with setscrew-type beam clamps or C-clamps.
 - 5. Maximum diameter of drilled holes in beam flanges shall not exceed 15% of width of flange.
 - 6. Drill holes to leave minimum of 1/2 inch of steel from edge of member to edge of hole.
 - 7. Support loads from bottom chord member of trusses or steel joists only where diagonal members attach to bottom chord.
 - 8. Do not support loads from metal roof or floor decking.
 - 9. Do not weld to steel joist.
- B. Outdoor Supports: Coat bolted and field welded supports with galvanizing repair paint.

3.2 APPLICATION

- A. Supports for Single Conduits:
 - 1. Conduit in Direct Contact with Steel Framing: "RC" and "PC" clamps.
 - 2. EMT, 1 Inch and Smaller in Direct Contact with Steel Framing: Conduit clips.
 - 3. Suspended Conduit 1-1/4 Inch and Below: Hanger rod and conduit hanger.
 - 4. Suspended Conduit 1-1/2 Inch and Above: Hanger rod and lay-in pipe hanger.
 - 5. On Walls: Steel "one-hole" straps.
- B. Supports for Multiple Parallel Conduits:
 - 1. In Direct Contact with Steel Framing: Attach prefabricated 1-1/2 inch wide channel, of sufficient depth to support the load, directly to framing and attach conduits to channel straps.
 - 2. Suspended: Assemble a "trapeze" hanger using prefabricated 1-1/2 inch wide steel channel of sufficient depth to support load, and two or more hanger rods. Attach conduits to channel using channel straps.
- C. Wall Anchors:
 - 1. Hollow Masonry Units: Support light loads such as one and two-hole straps, and outlet boxes with plastic anchors and screws. Support heavy loads such as panelboards, safety switches, and multiple conduit runs with toggle bolts.
 - 2. Solid Masonry Units: Lead shields and lag bolts; use through-bolts for tension loads.
 - 3. Gypsum Board: Hollow wall anchors.
- D. Concrete Floor and Overhead Slabs:
 - 1. For overhead equipment loads less than 400 lbs., use at least two (2) 3/8-inch minimum diameter threaded expansion anchors. For equipment loads in excess of 400 lbs., but less than 1,000 lbs., use at least two (2) 3/8-inch minimum diameter wedge anchors.

END OF SECTION

SECTION 16195

IDENTIFICATION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes: Identification and information signs and warning signs for electrical equipment.
- B. Related Sections: Additional identification requirements for specific items are specified elsewhere in Division 16. See Specification Section 16121, Low Voltage Copper Wire and Cable for wire identification.

1.2 APPLICABLE STANDARDS

- A. OSHA Subpart S.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Identification and Information Signs:
 - 1. Rigid laminated phenolic, per owner specific color requirements.
 - 2. Text size for equipment designations shall be as large as space allows, up to 1-1/2" maximum.
 - 3. 1/2-inch minimum text size.
 - 4. Contractor shall submit proposed lettering for approval by Owner.
 - 5. The Contractor shall coordinate names, abbreviations, and other designations used in the electrical identification work with the corresponding designations shown, specified and scheduled. Provide numbers, lettering, and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of the electrical systems and equipment.
- B. Warning Signs:
 - 1. OSHA Subpart J - General Environmental Controls, Section 1910.145.
 - 2. Signs provided with equipment are acceptable provided all necessary signs are issued with equipment.
 - 3. Provide identical signs for each application.
 - 4. High voltage warning signs to read "DANGER - HIGH VOLTAGE - KEEP OUT."
- C. Panelboard Directories: Refer to Section 16470.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Identification and Information Signs:
 - 1. Location: Place signs on the following equipment:
 - a. Power distribution switchboards.
 - b. Power distribution panels.
 - c. Panelboards.
 - d. Dry-type transformers.
 - e. Individually mounted motor controllers.
 - f. Control panels.
 - g. Safety/disconnect switches.
 - h. Junction boxes
 - 2. Minimum Information on Sign: Include the following information:
 - a. Equipment Designation.
 - b. Operating Voltage.
 - c. Served From equipment designation.
 - d. For branch circuit panelboards, include color coding for phase, neutral, and ground conductors for each voltage system used in accordance with NEC paragraph 210-5(c).
 - 3. Equipment Served Identification: Include Equipment Served on identification and information signs for the following equipment:
 - a. Dry-type transformers.
 - b. Individually mounted motor controllers.
 - c. Safety/disconnect switches.
- B. Panelboard Directories. Provide fully completed typewritten circuit directory cards. Identify each circuit using descriptions contained in panelboard schedules on Drawings.
- C. Mounting: Mount signs to clean, dry equipment surface with an epoxy adhesive.

END OF SECTION

SECTION 16200

LIGHTING SYSTEM

PART 1 - GENERAL

1.1 SCOPE

- A. Furnish and install all lighting fixtures as shown and scheduled.
- B. The Contractor shall furnish and install lighting fixtures complete with lamps for every lighting outlet scheduled on the accompanying drawings. Where a fixture type designation may have been omitted from the plans, it shall be the responsibility of the electrical bidder to contact the Owner's Representative prior to the bid opening and determine which fixture type is intended at the location in question. No allowance will be made on behalf of the Contractor who fails to comply with this requirement.
- C. In general, if fixtures are being relocated, Contractor shall ascertain the number of new fixtures to be purchased, if any

1.2 SUBMITTALS

- A. Comply with the provisions and requirements of Section 01330, Submittal Procedures.
- B. Submit product data in accordance with Section 16010 for all fixtures scheduled on the plans, all lamps, ballasts, emergency battery pack ballasts, lighting poles and all associated mounting equipment related to this project. For all lighting system Submittals, include the manufacturer's name, catalog number, ballast type, type and size of lamp, and all ordering data.

1.3 RELATED WORK

- A. The requirements of Section 16010, General Requirements for Electrical Work, and other sections govern the work specified in this section, where applicable.

1.4 SECTION INCLUDES

- A. Fixtures
- B. Fluorescent Ballasts
- C. HID Ballasts
- D. Emergency Battery Pack Ballasts
- E. Lamps
- F. Time Switches
- G. Photocells
- H. Lighting Contactors

- I. Dimmers
- J. Site Lighting Luminaries
- K. Lighting Poles

PART 2 – PRODUCTS

- 2.1** All lighting fixtures shall be furnished complete with mounting accessories to suit the specific service intended. See architectural and structural plans for ceiling and construction details where fixtures are to be mounted. Coordinate final location with architectural and mechanical features.
- 2.2** Fixtures shown in the schedule to be recessed shall be complete with any accessories required to fit the fixture to the ceiling construction. See architectural plans for type of ceilings. Locate fixtures in regard to ceiling patterns, unless otherwise indicated on drawings.
- 2.3** Fixtures scheduled to be surface mounted shall be furnished and installed employing supports, toggle bolts and any other accessories which, in the opinion of the Owner's Representative, are required to adequately support the fixtures.
- 2.4** Fluorescent fixtures in continuous rows shall be supplied with all fixture couplings, chase nipples and/or other accessories recommended by manufacturer for continuous row installation.
- 2.5** Fluorescent fixtures purchased new shall be field installed with T-8 energy-efficient rapid start lamps as manufactured by Westinghouse, General Electric or Sylvania. Lamps shall produce 2,850 lumens and consume only 28 watts. All fluorescent lamps shall be color corrected 3500°K unless otherwise indicated in fixture schedule. All fluorescent lamps shall be cool white unless otherwise indicated in fixture schedule.
- 2.6** Prismatic diffusers for troffer fixtures shall be acrylic with a minimum thickness of 0.125 inch.
- 2.7** Wherever fluorescent fixtures are to be dimmed, the fixture supplier shall coordinate the type of dimming ballast to be used with the dimmer supplier to ensure compatibility. Lampholders shall be the circuit interrupting type.
- 2.8** Incandescent fixtures shall be furnished complete with lamps of the size called for. All incandescent lamps used during construction shall be replaced prior to occupation of the building by the Owner. All incandescent lamps shall be inside frosted unless otherwise specified in the light fixture schedule.

2.9 FLUORESCENT BALLASTS

- A. Ballasts for fluorescent lamps shall be rapid start electronic (no hybrids shall be permitted) and shall consist of a rectifier, high frequency inverter, and power control and regulation circuitry. The ballasts shall be UL listed, Class P, with a Class A sound rating, and shall contain no PCBs. Ballasts shall meet 47 CFR 18 for electromagnetic interference and shall not interfere with the operation of other electrical equipment. Design shall withstand line transients per IEEE C62.41, Category A. Unless otherwise indicated, the minimum number of ballasts shall be used to serve each individual fixture, using one, two, three or four lamp ballasts. A single ballast may be used to serve multiple fixtures if they are continuous mounted, factory manufactured for that installation with an integral wireway and are identically controlled.
- B. Light output regulation shall be $\pm 10\%$.

- C. Voltage input regulation shall be $\pm 10\%$.
- D. Lamp current crest factor shall be less than 1.7.
- E. Ballast factor shall be not less than 75% or more than 118%, unless otherwise indicated.
- F. A 60 Hz filter shall be provided. Flicker shall be no more than 15% with any lamp suitable for the ballast.
- G. Ballast case temperature shall not exceed 25 degree Celsius rise above 40 degree Celsius ambient, when tested in accordance with UL 935.
- H. Input current third harmonic shall not exceed 20% total harmonic distortion or 27.5% of the third triplens.
- I. Power factor shall not be less than .94.
- J. Ballasts shall operate at a frequency of 20 KHz or more.
- K. Operating filament voltage shall be 2.5 to 4.5 volts.
- L. Warranty. Five-year full warranty including a \$10 labor allowance.
- M. Total harmonic distortion shall be equal to or less than 10%.

2.10 HID BALLASTS

High Intensity Discharge (HID) ballasts shall be thermally protected, high power factor (minimum 90%), core and coil ballasts, manufactured by a certified ballast manufacturer, approved by ETL, and guaranteed for two years. HID ballasts for exterior applications shall have Class "H" insulation. HID ballasts for interior applications shall be fully encapsulated with a "B" Sound Rating and Class "A" insulation. Ballasts that produce excessive noise will be replaced at no additional cost to the Owner.

2.11 EMERGENCY BATTERY PACK BALLAST

Emergency battery pack ballasts for fluorescent lighting fixtures shall consist of an automatic power failure device, test switch, pilot light and fully automatic solid-state charger in a self-contained power pack furnished by the fixture manufacturer as an integral part of the fixture. Charger shall be either trickle, float, constant current or constant potential type, or a combination of these. Battery shall be no maintenance nickel cadmium type with capacity to supply power to one lamp for each fixture for 90 minutes minimum at 1,400 lumens. Parallel units shall not be accepted. Battery pack ballast shall be Bodine or equal as manufactured by Radiant or Emergi-Lite. Emergency battery pack ballasts shall be guaranteed for five-year full warranty including a \$10 labor allowance.

2.12 LAMPS

- A. Four foot fluorescent lamps shall be 28 watt T-8 rapid start as indicated on plans and be manufactured by Philips, General Electric, or Sylvania with a color temperature of 3500° K, 4100° K, or as indicated on the drawings and shall be rated for a minimum of 20,000 hours.
- B. Fluorescent lamps shall have a minimum CRI of 85.

- C. Compact fluorescent lamps shall be four pin, triple tube 42, 32 or 26 watt with color temperature of 3500° K, 4100° K, or as indicated on the drawings, or as indicated on the drawings and be manufactured by Philips, General Electric, or Sylvania.
- D. Biax fluorescent lamps shall be 38 (40) watt with color temperature of 3500° K, 4100° K, or as indicated on the drawings and be manufactured by Philips, General Electric, or Sylvania.
- E. High Pressure Sodium lamps shall be color corrected type as manufactured by Philips, General Electric, or Sylvania
- F. Metal Halide lamps shall be Pulsearc or Pulsestart type as manufactured by Venture or General Electric, and have a CRI of 75 or greater. Metal halide lamps shall rate for open fixture applications and contain no mercury.
- G. Compact halogen lamps (MR-16 and PAR 30) shall be constant color type with a minimum 6000-hour lamp life. Beam pattern for lamps shall be as indicated on the plans.
- H. High output fluorescent lamps shall be T-5HO, programmed start, 54 watt with color temperature of 3500° K, 4100° K, or as indicated on the drawings and be manufactured by Philips, General Electric, or Sylvania.
- I. All fluorescent lamps shall be burned in for 100 hours prior to final acceptance by owner.

2.13 TIME SWITCHES

Provide and install where shown on the drawings programmable electronic time clocks. Time clocks provided shall be two-channel, 16 ON/OFF events per channel, 24-hour clock format, 365-day calendar and daylight savings changeover capability. Time clocks shall operate on 120 volts, have two form "C" single pole, double throw, output relays and battery-operated power outage carry-over of 100 hours. Time clocks shall be wall mounted at +48 inches above finished floor to the top of the clock enclosure. Time clocks shall be Paragon Cat. No. EC72-D or approved equal.

2.14 PHOTOCELLS

- A. Shall be Paragon, minimum 2,000 watts, 15 amperes at 120 volts, model PJ-201 or 1,800 watts model CW201, (or approved equivalent). Die-cast aluminum housing for 3/4-inch conduit threaded hub nipple. Directional lens. Photocell shall be mounted on roof facing north.
- B. For 208- or 277-volt circuits, use locking type control, 1,800 watts. Provide Paragon Model PN-201-71 or CW-201-71 (or approved equivalent), respectively.
- C. All photocells shall fail in the ON position.

2.15 LIGHTING CONTACTORS

- A. Provide and install ASCO Bulletin 920, Square D, Class 8903 or General Electric, mechanically held, electrically operated contactors of capacities as shown on the drawings. All units shall be suitable for two-wire control. These contactors may be incorporated in various distribution or individual panels as shown on the drawings.
- B. Lighting contactors shall be provided and installed with HOA switch in cover.

2.16 DIMMERS

- A. Provide Lutron, Ideal, or Hunt solid-state dimmers flush wall-mounted or remote, at locations shown on the drawings, of the ratings required for connected loads and properly directed when ganged. All dimmers and/or exposed parts shall be matching and of one manufacturer.
- B. All unites, unless otherwise noted or specified on the drawings, shall be UL listed and furnished with positive ON-OFF positions. Mount at wall switch height or as shown or directed by the Architect/Engineer. Slide type operation is preferred.

2.17 SITE LIGHTING LUMINAIRES:

- A. Luminaires shall be mounted on poles as shown on the drawings and shall be of the type and manufacturers shown in the schedule, or equal. Luminaires shall be mounted flat and level, with no tilt or cant. Luminaires of one type shall be of one manufacturer and of identical finish and appearance.
- B. Provide ballasts and mounting hardware required for a complete installation. Mounting hardware shall be completely compatible with, and designed for use with, the proposed pole.
- C. Fixture finish shall match poles with no detectable difference under normal viewing conditions. Any minor damages to paint after delivery shall be touched up with paint provided by the manufacturer. Any major paint damage shall be repaired in the factory by the original process.
- D. HID lamps shall be by General Electric, Philips, Sylvania or equal, and shall conform to ANSI Standard C78 when tested in conformance to ANSI Standard C78.388.
- E. Submit a computer-generated layout of the site showing the illumination levels in footcandles that will result using all proposed fixtures, luminaires and poles. If designed lighting levels are not met, Contractor shall provide additional fixtures as necessary to meet these levels, at no additional cost to the Owner.
- F. Submit catalog cuts and data sheets for each type and wattage proposed. Submittals shall be bound with the pole submittals and shall include complete information on all ballasts, lenses and mounting hardware. Submit photometrics for each site lighting fixture. Site lighting fixture shall be full cut-off type with no light emitted above horizontal.

2.18 LIGHTING POLES:

- A. Poles shall be of the type, configuration and height shown on the drawings.
- B. Poles 10 feet or longer shall be designed to withstand when installed a wind load of 100 MPH with a gust factor of 1.3. Submittal shall include a statement or other evidence of compliance.
- C. Luminaire mounting provisions shall be designed for complete compatibility with the luminaire to be installed.
- D. Poles shall be one-piece square, steel with anchor bases welded to the shaft inside and out. Manufacturer shall furnish galvanized steel anchor bolts having an "L" bend. Bolts shall be complete with washers and hex nuts for leveling. Provide a base cover. Hardware up to 8

feet from the base shall be tamperproof. A gasketed handhole or access plate shall be located near the base and shall be reinforced as necessary.

- E. Poles shall be painted to match luminaires as closely as possible if luminaires are anodized and shall be painted with the same color exactly if the luminaires are painted. Prime poles before painting and touch up as necessary after installation. Paint shall be two coats of exterior enamel either shop-applied by the manufacturer or furnished by the manufacturer for field application. Touch-up paint shall be furnished by the manufacturer for field application.
- F. Finish shall be electrostatically applied baked-on black enamel prime coat. Finish shall match luminaires with no detectable difference under normal viewing conditions. Any minor damages to paint after delivery shall be touched up with paint provided by the manufacturer. Any major paint damage shall be repaired in the factory by the original process.
- G. Concrete foundations shall be round, of the size shown on the drawings. Concrete shall be cast at 3,000 psi with reinforcement steel conforming to ASTM A615. Concrete shall conform to ASTM C-33, and shall have a troweled finish with 1-inch chamfered edge.
- H. Poles shall be aligned vertically true with luminaires installed and while no wind is blowing. Base nuts shall be tightened in this position. Bolts in foundations shall be installed in such a way that luminaires on the poles will be facing in the direction shown on the drawings. Luminaires shall be bolted to the poles and adjusted so that the luminaire's lens will be perfectly horizontal or tilted to the exact angle specified.
- I. Take all necessary precautions against damaging existing and new surfaces, structures and other work on the site during handling and erection of poles. Provide barriers to keep others at a safe distance during excavation, erection and assembly.

PART 3 - EXECUTION

3.1 CLEANING

- A. All fixtures shall be cleaned and left free of any dirt, dust, grease, etc., at the completion of the job.

3.2 WIRING

- A. Where bodies of fluorescent fixtures are used as raceways for branch circuit wiring, the wire shall be approved for such location, 90 degrees C and carefully and securely clamped within the fixture body to positively prevent contact of the wires with the ballast case.

3.3 ORDERING

- A. Contractor shall not order any fixtures until submittals are approved.

3.4 COORDINATION

- A. Contractor shall coordinate with other crafts for final location and openings for all recessed fixtures.

- B. Coordinate exact location of all lighting fixtures in mechanical/electrical rooms with the work of the other trades to avoid conflicts.

3.5 FIXTURES

- A. All exterior lighting fixtures shall be furnished complete with gaskets, cast aluminum weatherproof outlet boxes, labeled approved for damp locations, have lamp bases coated with a rust inhibitor to prevent base from corroding to the socket, and be solidly grounded.

3.6 EXTERIOR

- A. All exterior grade-mounted fixtures shall be furnished and installed complete with concrete base, boxes, grounding, wire, conduit, control (photocell/time switch), trenching and backfilling, necessary for a finished installation.
- B. All exterior lighting standards are to be grounded through a separately driven ground rod at the pole and through the system ground.
- C. All exterior directional type light fixtures shall be aimed at night for maximum effective coverage of areas to be lighted.

3.7 AIR HANDLING FIXTURES

- A. Air Handling Fixtures: Duct connectors shall be included with all air handling fixtures. Final connections shall be per Division 15 work.

3.8 SUPPORT

- A. All fixtures shall be securely supported from the building structure. Fixtures in T-bar grid ceilings shall be supported from the structure with #12 ceiling wire at opposite corners, and shall be securely fastened to the grid with factory provided clips. All lighting fixture installations shall comply with NEC Article 410.

END OF SECTION

SECTION 16211

DIGITAL PANEL METERS

PART 1 – GENERAL

1.1 SCOPE

- A. Provide digital panel meters as described in this section.

1.2 SUBMITTALS

- A. Comply with the provisions and requirements of Section 01330, Submittal Procedures
- B. Submit all Digital Panel Meter product data at the same time in one package. Product data shall include:
 - 1. Catalog sheets, specifications and installation instructions.
 - 2. Drawings showing installation details including current transformers and all accessories to be provided with the meter.
- C. Upon successful completion of testing submit a test report bearing the signatures of the personnel who performed the test, the Owner's Representative, and any witnesses present during the test.
- D. Submit operation and maintenance manuals as required in Section 16010, Electrical General Requirements.

PART 2 – PRODUCTS

2.1. APPROVED MANUFACTURERS

- A. Provide digital panel meters complete with all associated current transformers and accessories from Siemens, General Electric, Square D or Electro Industries.

2.2. DIGITAL PANEL METERS

- A. Provide UL listed panel-mount meters suitable for operation at ambient temperatures ranging from -20°C to 60°C.
- B. Meters shall be capable of measuring or calculating true RMS three phase and per-phase values (including the neutral) for voltage, current, power, reactive power, power factor, energy consumed and peak 15-minute average demand.
- C. Meters shall be capable of recording all channels simultaneously and storing the maximum, minimum, average and instantaneous values for each.
- D. Provide meters with the proper voltage ratings and transformers necessary for the use intended.
- E. Meters shall have a display with at least three lines and support RS485 Modbus RTU

communication.

- F. Meter accuracy shall not exceed $\pm 0.6\%$ for measured values and $\pm 1.5\%$ for calculated values.
- G. 512 samples per cycle waveform recorder.
- H. Historical logs.
- I. 4 megabytes of storage
- J. 100 base T Ethernet capability.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Individually test each meter installation and demonstrate to the Owner and Engineer that the meters are operating properly. Testing shall be in accordance with the requirements of Section 01810, Commissioning.

END OF SECTION

SECTION 16221

ELECTRIC MOTORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. All motors for equipment or products specified in the individual technical specifications, expressly referring to this section.
- B. A total of three (3) motors shall be replaced: one (1) 300HP, one (1) 400 HP and one (1) 600 HP at Barton Drive Pump Station.

1.2 RELATED SECTIONS

- A. Section 16010 – General Requirements for Electrical Work.

1.3 SUBMITTALS

- A. Comply with the provisions and requirements of Section 01330, Submittal Procedures
- B. Submit manufacturer's Operations and Maintenance Manuals for each motor under provisions of Section 16010, General Requirements for Electrical Work.
- C. For critical tolerances/balances as outlined herein, submit certification of motor bearing vibration testing and the results thereof.
- D. Certificate of compatibility: for each motor controlled by an adjustable/variable frequency drive, furnish a certificate stating that the motors are compatible with the adjustable/variable frequency drive and the equipment loads to be driven.
- E. Test Reports: provide test reports for motors as follows;
 - 1. Provide certified standard industrial test reports for motors 5HP through and including 750HP.
 - 2. Provide witnessed test reports as specified.

1.4 QUALITY ASSURANCE

- A. Performance: Manufacturer shall guarantee performance when operating under the specified or indicated conditions. Manufacturer shall repair or replace equipment found deficient in field testing.
- B. Codes and Standards: Comply with requirements of the following, as referenced herein:
 - 1. Electric motors shall meet NEMA and/or IEEE standards for torque, current, insulation, frame size, nameplate, life, bearings, power factor, service factor and efficiency.
 - 2. Electric motors shall be designed, selected and applied in accordance with NEMA Standard MG1.

- C. Motor torque shall meet or exceed locked rotor (starting) and minimum breakdown torques specified in NEMA standard for Design B for ratings specified. Applications requiring greater starting or breakdown torque will require a special design motor.
- D. Locked rotor (starting) currents shall not exceed NEMA Design B maximum values for the specified rating.
- E. Service factor rating of 1.15 in a 50 degree C ambient shall be standard rating. Motor service factor shall not be included in determining motor size.
- F. Power factor shall be a minimum of 85 percent for all 1180 and 1800 RPM motors (3 through 75 HP), minimum of 88 percent for all 1180 and 1800 RPM motors (100-300HP) at full load and voltage. Smaller motors may have power factor less than 85 percent, provided that they comply with all other requirements.
- G. Motors for equipment located in "critical areas" for vibration shall be manufactured to critical balance tolerances specified in related sections.
- H. All motors specified to be connected to the load side of any variable frequency drive, (VFD), shall be "inverter duty" rated.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. U.S., G.E., Baldor.

2.2 ELECTRIC MOTORS

- A. Unless otherwise specified:
 - 1. Integral HP Motors: Vertical, open drip-proof, three phase, squirrel cage induction type.
 - 2. Three-quarter (3/4) HP and larger motors: Three phase type.
 - 3. Motors smaller than three-quarter (3/4) HP: Single phase type.
 - 4. Motors smaller than one-eighth (1/8) HP: Permanent split capacitor type.
 - 5. Motors exposed to weather or installed downstream of humidifiers, air washers, etc.: Totally enclosed fan cooled (TEFC) type.
 - 6. Motors specified for connection to the load side of any variable frequency drive, (VFD), shall be "inverter duty" rated.
- B. Voltage ratings, in general, shall be:
 - 1. 115 volt or 11/230 volt for use on nominal 120/240 volt single phase systems.
 - 2. 200 Volt for use on nominal 208 volt three phase systems.
 - 3. 230/460 volt for use on nominal 240 volt or 480 volt three phase systems.

4. Voltage of all motors shall be as indicated or specified in the various technical sections or scheduled on the drawings.
- C. Full class B insulation systems shall be incorporated in all standard motors.
 - D. Frame/HP relationship shall meet NEMA standards for "T" frame motors.
 - E. Motor Mounting: Mount motor to well head as recommended by motor and well pump manufacturers recommendations.
 - F. Nameplates: Stainless steel or aluminum and stamped with NEMA standard information including nominal efficiency per MC1-12.53b, bearing identification, lubrication instructions and thermal protector type.
 - G. Integral horsepower motors shall have sealed or double shielded ball bearings, fractional horsepower motors shall have ball or sleeve type bearings. All bearings shall be anti-friction type sized for L-10 life of at least:
 1. 20,000 hours under minimum V-belt sheave sizes for maximum loading conditions per NEMA standard MG1-14.41.
 2. 125,000 hours for a direct connected belt.
 3. Motors over 5HP shall be factory lubricated for operation at normal load and normal ambient temperature. Provide inlet and outlet grease connections ("Zerk" fittings) in motor housings for each bearing.
 4. Motors 5HP and under shall have factory-sealed, permanently lubricated bearings.
 5. Provide vibration tolerances stated herein.
 - H. Provide special hazard enclosures where indicated or specified. Such enclosures may include, but are not limited to:
 1. Open splashproof.
 2. Totally enclosed fan cooled (TEFC).
 3. Totally enclosed air over (TEAO).
 4. Totally enclosed explosion-proof (TEEP), UL classified for Class I Groups A, B, C and D vapors and flammable liquids.
 5. Totally enclosed dust ignition proof, UL classified for Class II and III Groups E, F and G combustible dust and ignitable fibers.
 - I. Nominal efficiency under full load conditions shall meet or exceed the values listed in table below when tested in accordance with NEMA test standard MG1-12.53a, IEEE Test Procedure 112, Method B. The guaranteed minimum efficiency shall be within the range of deviation allowed in the above standards.
 1. Motor efficiency shall be a high rated determination in the award of contract.

2. Percent Nominal Efficiency at Full Load shall meet or exceed the values in the following table:

HP	Synchronous Speed RPM		
	1200	1800	3600
1	81.5	82.5	81.5
2	83.7	82.0	80.7
3	85.0	83.5	82.1
5	88.5	88.5	86.5
7.5	89.5	90.2	90.2
10	90.2	90.2	90.2
15	90.2	91.7	90.2
20	91.7	91.7	91.7
25	91.7	93.0	91.7
30	92.4	93.0	91.7
40	93.0	93.0	92.4
50	93.0	94.1	92.4
60	93.0	94.1	93.4
75	93.6	94.1	93.6
100	94.1	94.1	93.6
125	94.1	94.1	94.1
150	94.1	95.0	94.1
200	94.1	95.0	94.1

- J. Construction shall include cast iron or steel end bells on all motors. Aluminum end bells are unacceptable.
- K. Heaters: Provide outdoor ODP motors with integral single-phase space heaters to prevent condensation.
- L. Rotors on integral horsepower motors provided for equipment located in "critical areas" for vibration shall be statically and dynamically balanced to within 0.1 mil peak-to-peak tolerance measured radially or axially on either motor bearings. Manufacturer shall document and submit with the delivery of the motor, proof that the motor bearing balance has been confirmed.

2.3 THERMAL OVERLOAD PROTECTION

- A. Provide motors with automatic resetting thermal cutouts compatible with insulation class specified, sized for full load plus service factor.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All factory installed motors shall be installed in full compliance with the national Electrical Code and Division 16 requirements.

3.2 FIELD TESTING

- A. Each motor (whether factory or field-installed) shall receive and insulation resistance ("Meggar") test. Submit results of field test to Engineer in accordance with Section 01810, Commissioning.

- B. All motor above 250HP shall be fully tested per manufacturer/NEMA requirements. This includes vibration testing as a minimum.

3.3 ALIGNMENT AND MOUNTING

- A. On factory installed motors, ensure that motor shaft or sheave is properly aligned with the driven device or sheave.
- B. All motors are to be mounted horizontally or vertically as noted on plans.
- C. Motors shall be installed in a manner which permits ease of removal without dismantling equipment in which the motor is installed.

END OF SECTION

SECTION 16271

MEDIUM VOLTAGE TRANSFORMERS

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 transformers with medium-voltage primaries:
 - 1. Pad-mounted, liquid-filled transformers.
 - 2. All transmitters shall be compliant with DTE Energy primary services requirements.

1.3 SUBMITTALS

- A. Comply with the provisions and requirements of Section 01330, Submittal Procedures
- B. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, location of each field connection, and performance for each type and size of transformer indicated.
- C. Shop Drawings: Wiring and connection diagrams including power, signal, and control wiring.
- D. Coordination Drawings: Floor plans drawn to scale and coordinating floor penetrations and floor-mounted items. Show the following:
 - 1. Underground primary and secondary conduit stub-up location.
 - 2. Dimensioned concrete base, outline of transformer, and required clearances.
 - 3. Ground rod and grounding cable locations.
- E. Qualification Data: For testing agency.
- F. Source quality-control test reports.
- G. Field quality-control test reports.
- H. Follow-up service reports.

1.4 O&M MANUALS

- A. Comply with the provisions and requirements of Section 01781, Operation and Maintenance Data.

1.5 REFERENCES

- A. Refer to Section 16010, Electrical System General Requirements for Codes and Standards.
- B. In addition to the Codes and Standards summarized in Section 16010, transformers shall comply with the requirements of IEEE C2, ANSI C57.12.28, IEEE C57.12.10, IEEE C57.12.70, and IEEE C57.12.80, and NFPA 70.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent testing 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. Product Options: Drawings indicate size, profiles, and dimensional requirements of transformers and are based on the specific system indicated.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store transformers protected from weather and] so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

1.8 PROJECT CONDITIONS

- A. Service Conditions: IEEE C37.121, usual service conditions except for the following:
 - 1. Unusual space limitations.

1.9 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate installation of louvers, doors, spill retention areas, and sumps. Coordinate installation so no piping or conduits are installed in space allocated for medium-voltage transformers except those directly associated with transformers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Industries; Cooper Power Systems Division.
 2. General Electric
 3. Siemens Energy & Automation, Inc.
 4. Square D/Groupe Schneider NA.
 5. ABB

2.2 PAD-MOUNTED, LIQUID-FILLED TRANSFORMERS

- A. Insulating Liquid: Less flammable, dielectric, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.
- B. Insulation Temperature Rise: 65 deg C when operated at rated kVA output in a 40 deg C ambient temperature. Transformer shall be rated to operate at rated kilovolt ampere in an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C without loss of service life expectancy.
- C. Basic Impulse Level: 95 kV.
- D. Full-Capacity Voltage Taps: Four 2.5 percent taps, 2 above and 2 below rated high voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
- E. High-Voltage Switch: Refer to drawings for amperage rating. Make-and-latch rating of 10-kA RMS, symmetrical, arranged for radial feed with 3-phase, 2-position, gang-operated, load-break switch that is oil immersed in transformer tank with hook-stick operating handle in primary compartment.
- F. Primary Fuses: 150-kV fuse assembly with fuses complying with IEEE C37.47.
1. Bay-O-Net liquid-immersed fuses that are externally replaceable without opening transformer tank.
- G. Surge Arresters: Distribution class, one for each primary phase; complying with IEEE C62.11 and NEMA LA 1; support from tank wall within high-voltage compartment. Transformers shall have three arresters for radial-feed circuits.
- H. High-Voltage Terminations and Equipment: Dead front with universal-type bushing wells for dead-front bushing-well inserts, complying with IEEE 386 and including the following:
1. Bushing-Well Inserts: One for each high-voltage bushing well.
 2. Surge Arresters: Dead-front, elbow-type, metal-oxide-varistor units.
 3. Parking Stands: One for each high-voltage bushing well.
 4. Portable Insulated Bushings: Arranged for parking insulated, high-voltage, load-break cable terminators; one for each primary feeder conductor terminating at transformer.

- I. Accessories:
 1. Drain Valve: 1 inch (25 mm), with sampling device.
 2. Dial-type thermometer.
 3. Liquid-level gage.
 4. Pressure-vacuum gage.
 5. Pressure Relief Device: Self-sealing with an indicator..
 6. Busway terminal connection at low-voltage compartment.
 7. Alarm contacts for gages and thermometer listed above.

2.3 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 16 Section Electrical Identification.

2.4 SOURCE QUALITY CONTROL

- A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to ANSI C57.12.50, ANSI C57.12.51, IEEE C57.12.90, IEEE C57.12.91.
- B. Factory Tests: Perform the following factory-certified tests on each transformer:
 1. Resistance measurements of all windings on rated-voltage connection and on tap extreme connections.
 2. Ratios on rated-voltage connection and on tap extreme connections.
 3. Polarity and phase relation on rated-voltage connection.
 4. No-load loss at rated voltage on rated-voltage connection.
 5. Excitation current at rated voltage on rated-voltage connection.
 6. Impedance and load loss at rated current on rated-voltage connection and on tap extreme connections.
 7. Applied potential.
 8. Induced potential.
 9. Temperature Test: If transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kilovolt-ampere Class OA or Class AA rating and highest kilovolt-ampere Class OA/FA or Class AA/FA rating.
 - a. Temperature test is not required if record of temperature test on an essentially duplicate unit is available.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for medium-voltage transformers.
- B. Examine roughing-in of conduits and grounding systems to verify the following:
 - 1. Wiring entries comply with layout requirements.
 - 2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and that requirements in Division 16 Section "Grounding and Bonding" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install transformers on concrete bases.
 - 1. Anchor transformers to concrete bases according to manufacturer's written instructions
 - 2. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit and 4 inches (100 mm) high.
 - 3. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete".
 - 4. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
 - 5. Install epoxy-coated anchor bolts, for supported equipment, that extend through concrete base and anchor into structural concrete floor.
 - 6. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 7. Tack-weld or bolt transformers to channel-iron sills embedded in concrete bases. Install sills level and grout flush with floor or base.
- B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 IDENTIFICATION

- A. Identify field-installed wiring and components and provide warning signs as specified in Division 16 Section Identification.

3.4 CONNECTIONS

- A. Ground equipment according to Division 16 Section Grounding.
- B. Connect wiring according to Division 16 Section Low Voltage Copper Wiring.
- 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.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Testing Agency: Contractor will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- C. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
 - 1. After installing transformers but before primary is energized, verify that grounding system at substation is tested at specified value or less.
 - 2. After installing transformers and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. Perform electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.2. Certify compliance with test parameters.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove malfunctioning units, replace with new units, and retest as specified above.
- E. Test Reports: Prepare and submit written reports in accordance with the requirements of Section 01810, Commissioning, 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 actions taken to achieve compliance with requirements.

3.6 FOLLOW-UP SERVICE

- A. Voltage Monitoring and Adjusting: Perform the following voltage monitoring after Substantial Completion but not more than six months after Final Acceptance:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at secondary terminals of each transformer. Use voltmeters with calibration traceable to National Institute of Science and Technology standards and with a chart speed of not less than 1 inch (25 mm) per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.
 2. Corrective Actions: If test results are unacceptable, perform the following corrective actions, as appropriate:
 - a. Adjust transformer taps.
 - b. Prepare written request for voltage adjustment by electric utility.
 3. Retests: After corrective actions have been performed, repeat monitoring until satisfactory results are obtained.
 4. Report: Prepare written report covering monitoring and corrective actions performed.
- B. Infrared Scanning: Provide a baseline infrared scan when it is initially energized and at the end of commission. Follow the applicable NETA standard.

END OF SECTION

SECTION 16416

FUSES

PART 1 - GENERAL

1.1 SUBMITTALS

- A. Product Data: Catalog sheets, specifications and installation instructions. Comply with the provisions and requirements of Section 01330, Submittal Procedures

1.2 MAINTENANCE

- A. Spare Parts:
 - 1. Six spare fuses of each size and category, including any accessories required for a complete installation.
 - 2. Special tools if required for installation or removal of fuses.

PART 2 - PRODUCTS

2.1 FUSEHOLDERS

- A. Equipment provided shall be furnished with fuseholders to accommodate the fuses specified.

2.2 FUSES RATED 600V OR LESS

- A. Fuses for Safety Switches (Motor Circuits) and Service Disconnects:
 - 1. Cartridge Type (250 Volts, 600 Amperes or Less): Dual element time-delay, UL Class RK-5, 200,000 amperes R.M.S. symmetrical interrupting capacity:
 - a. Cooper Industries Inc.'s/Bussman Div. Type FRN-R.
 - b. Gould Inc.'s/Circuit Protection Div. (Shawmut) Type TR-R.
 - c. Littlefuse Inc.'s Type FLN-R.
 - 2. Cartridge Type (600 Volts, 600 Amperes or Less): Dual element time-delay, UL Class RK-5, 200,000 amperes R.M.S. symmetrical interrupting capacity:
 - a. Cooper Industries Inc.'s/Bussmann Div. Type FRS-R.
 - b. Gould Inc.'s/Circuit Protection Div. (Shawmut) Type TRS-R.
 - c. Littlefuse Inc.'s Type FLS-R.
 - 3. Cartridge Type (600 Volts or Less - Above 600 Amperes): Current limiting, UL Class L, 200,000 amperes R.M.S. symmetrical interrupting capacity:

- a. Cooper Industries Inc.'s/Bussmann Div. Type KTU.
 - b. Gould Inc.'s Circuit Protection Div. (Shawmut) Type A4BY.
 - c. Littlefuse Inc.'s Type KLP-C.
- B. Fuses for Safety Switches (Lighting and Heating Circuits):
- 1. Cartridge Type (250 Volts): Single element, UL Class RK-1, 200,000 amperes R.M.S. symmetrical interrupting capacity:
 - a. Cooper Industries Inc.'s/Bussmann Div., Type KTN-R.
 - b. Gould Inc.'s/Circuit Protection Div. (Shawmut) Type A2K-R.
 - c. Littlefuse Inc.'s Type KLN-R.
 - 2. Cartridge Type (600 Volts): Single element, UL Class RK-1, 200,000 amperes R.M.S. symmetrical interrupting capacity:
 - a. Cooper Industries Inc.'s/Bussmann Div. Type KTS-R.
 - b. Gould Inc.'s/Circuit Protection Div. (Shawmut) Type A6K-R.
 - c. Littlefuse Inc.'s Type KLS-R.

2.3 FUSES RATED OVER 600V

- A. Fuses for Metal Enclosed Interrupter Switchgear:
 - 1. Current Limiting, Silver-Sand Type: General Electric Co.'s Type EJ, or Westinghouse Elec. Corp.'s Type CLE.
 - 2. Boric-Acid Type: S & C Electric Co.'s Type SM with snuffler, or Westinghouse Elec. Corp.'s Type RBA with condenser.
- B. Fuses for 35KV Service Switch and Fuse Assembly: S & C Electric Co.'s Type SM-5.
- C. Fuses for Pad Mounted High Voltage Switch and Fuse Assembly: S & C Electric Co.'s Type SML.
- D. Fuses for Fused Load Break Interrupter Switches: General Electric Co. Type EJ, S & C Electric Co.'s Type SM, or Westinghouse Electric Corp.'s Type CLE.
- E. Fuses for Distribution Oil Cutouts: General Electric Co.'s Fuse Links 9F57CAA, or G & W Electric Co.'s Type FL.
- F. Fuses for Primary Cutouts:

1. Cutouts Rated 5.2KV: EEI-NEMA standard Type K (fast) distribution fuse links; Westinghouse Electric Corp.'s Universal Cable Type Fuse Links Series 632AO--A01.
2. Cutouts Rated 14.4KV: EEI-NEMA standard Type K (fast) distribution fuse links; S & C Electric Co.'s 265000 Series, or Westinghouse Electric Corp.'s Universal Cable Type Fuse Links Series 632A0--A01.
3. Cutouts Rated 38KV: EEI-NEMA standard Type K (fast) distribution fuse links, to suit primary cutouts.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install fuses in respective equipment.

END OF SECTION

SECTION 16425

SWITCHBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section specifies multiple section, low voltage, dead front, free standing power distribution and service entrance switchboards.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of contract, including general and supplementary conditions and Division 1 specifications, apply to the work of this section.

1.3 RELATED SECTIONS

- A. Section 16010 Electrical System General Requirements
- B. Section 16011 Submittal Procedures
- C. Section 16012 Electrical Product Substitution Procedures
- D. Section 16030 Equipment Installation
- E. Section 16111 Metallic Conduit and Fittings
- F. Section 16121 Low Voltage Copper Wire and Cable
- G. Section 16190 Supports and Fasteners
- H. Section 16195 Identification
- I. Section 16440 Disconnect Switches
- J. Section 16450 Grounding
- K. Section 16475 Molded Case Circuit Breakers
- L. Section 16955 Electrical Equipment Testing and Adjustment

1.4 QUALITY ASSURANCE

- A. Refer to Section 16010, Electrical System General Requirements for Codes and Standards.
- B. In addition to the Codes and Standards summarized in Section 16010, switchboards shall comply with the requirements of NEMA PB-2, UL 891
- C. UL Labeling or Listing: Furnish switchboards bearing UL label.

- D. NRTL Labeling or Listing: Furnish switchboards bearing the label of a Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.

1.5 SUBMITTALS

- A. Product Data and Shop Drawings: Submit manufacturer's data on Switchboards in accordance with Section(s) 01300 and 16010 including but not limited to:
1. Exterior plans and elevations.
 2. Foundation or anchor bolt plan
 3. Representative section views
 4. Single line diagram
 5. Elementary control diagrams
 6. Wiring diagrams
 7. Bill of material
 8. Nameplate schedule
 9. Dimensions, weights, capacities, and ratings
 10. Customer's switchboard designation
- B. Test Reports: Refer to Section 16955

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. General: Where switchboards are used as service entrance equipment, they shall comply with all National Electrical Code and UL requirements for service entrance equipment and a UL service entrance label shall be provided. Provide switchboards fabricated as follows:
1. Internal components individually mounted and removable from front.
 2. Front accessible line and load connections.
- B. Housing: Dead front, free standing self supported independent of wall supports, open bottom, metal enclosed housing constructed in such a manner to permit rolling in place individual sections using conduit or pipe. Provide switchboard section(s) with adequate lifting means.
1. Vertical sections bolted together to form one rigid switchboard.
 2. Formed steel shapes welded and bolted together to form rigid framework.
 3. Cover sides, top, and rear with removable, gasketed, screw fastened steel plates.

4. Provide cable pull sections or top cable pull boxes, where required or shown on the drawings, complete with cable tie down supports. When cable pull sections or pull boxes contain utility service cables, provide utility acceptable sealing means.
 5. Sectionalized removable front plates with hinged doors with catch locks for the open position.
 6. Openings for natural ventilation designed to prevent entry of rodents and to guard against accidental contact with energized parts.
 7. Manufacturer's standard finish.
- C. Nameplates
1. Engraved nameplates shall be furnished for all mains and feeder circuits with designation and circuit numbers as indicate on the drawings or as directed by the Owner's Representative in accordance with Section 16195 - Identification
- D. Buses: High conductivity electrical grade copper bars with silver plated contact surfaces. Use Belleville washers on bolted connections.
1. Rigidly mount buses on supports of high impact non-tracking material.
 2. Insulate or provide barrier for load side runbacks to feeder cable connection terminals where they pass through main bus area
 3. 100% rated isolated neutral bus.
 4. Uninsulated ground bus entire length of switchboard assembly.
 5. A-B-C type bus arrangement throughout, left-to-right, top-to-bottom, and front-to-rear, as viewed from front.
 6. Provide all previsions required for future extension of all buses.
 7. Termination lugs shall be provided for the size and quantity of each phase, neutral and ground conductor as indicated on the drawings.
- E. Internal Devices:
1. Molded Case Circuit Breakers for feeder protective devices: Refer to Section 16475.
- F. Insulated Case Power Circuit Breaker for main protective device per UL489. Drawout Type Power Circuit Breaker for main protective device per ANSI/IEEE C37.13, UL1066 and NEMA SG-3. Main protective device shall have 100 percent continuous ampere rating.
1. Rated 600 volts, 60 Hz. with frame size and trip rating as designated on Drawings.

2. Solid state trip devices with current sensors as required for ground sensing functions for all main breakers rated 1,000A and larger on systems rated greater than 150V to ground or as designated on Drawings.
3. Minimum short-circuit interrupting capacity as designated on Drawings.
4. Breaker shall be provided with a true, two-step stored energy mechanism providing a maximum of five-cycle closing. All the energy required for closing the breaker shall be completely stored and held in readiness pending a release to close action. Manual operated breakers shall be convertible to motor operation by insertion of an internally mounted motor operator without voiding the UL label. As a safety feature, provisions shall be available to manually discharge the stored energy without closing the breaker. Antipump provisions shall be provided as standard for motor operated breakers and optional for manual breakers with spring release solenoids.
5. The breaker control face plate shall include color coded visual indicators to indicate contact "open" and "closed" positions as well as mechanisms "charged" and "discharged" positions. Manual control pushbuttons shall be provided for "opening" and "closing" the breaker.
6. The breaker shall have high endurance characteristics being capable of a minimum of 4,000 interruptions at rated current followed by 4,000 operations at no load without maintenance. The breaker shall be equipped with field replaceable contacts.
7. Provide one test kit for testing breaker.

G. Standard Analog Trip Unit

1. Provide plug-in analog trip devices for insulated case circuit breakers, which are interchangeable between compatible breaker frames. The continuous ampere rating of the breaker shall be determined by the insertion of an interchangeable plug of the rating indicated on the drawings. The rating plug shall be interlocked with the tripping mechanism to automatically "open" the breaker when the plug is removed. The breaker shall remain "trip free" with the plug removed. Rating plugs shall be keyed to prevent incorrect application between different frame ratings.
2. Complete system selective coordination shall be provided by the addition of the following time/current curve shaping solid state elements. Provide:
 - a. Ampere setting and long time delay settings.
 - b. Short time pick-up and short time delay settings.
 - c. Instantaneous pick-up.
 - d. Ground fault pick-up and ground fault time delay.
 - e. Adjustments shall be made using nonremovable, discrete step, highly reliable switching plugs for precise settings. A sealable transparent cover shall be provided over the adjustments to prevent tampering.

3. Trip devices shall be provided with up to three visual indicators to indicate the automatic tripping mode of the breaker including:
 - a. Overload
 - b. Short circuit
 - c. Ground fault
 - d. Ground fault trip where shown on the drawings shall be provided as an integral part of the breaker. The fault pick-up shall be adjustable with a maximum setting of 1,200 amperes in compliance with the 2002 National Electrical Code article 230-95(A). The time delay shall be adjustable in three discrete bands for maximum system selective coordination. A memory circuit shall be provided to compensate for the erratic nature of arcing ground faults to provide positive tripping actions. A residual scheme shall be used a standard for detecting ground fault currents.
 4. A separately mounted test panel shall be provided for use with trip devices. The test panel shall test the ground fault circuit in either of two methods.
 - a. By tripping the breaker.
 - b. By not tripping the breaker.
 5. Each breaker shall be equipped with integral externally accessible test points to be used with a hand held portable test kit for field testing the functioning of that portion of the long time, instantaneous and ground fault trip circuitry contained within the breaker itself.
- H. Bolted Pressure Contact Switches: UL 977. Provide fusible bolted pressure contact switches with ratings as designated on Drawings which have the following features.
1. Line terminal shields.
 2. Visible blades when switch is in "OPEN" position and door is open.
 3. Bolted pressure contacts made by firmly bolting switch blades to stationary contact terminals and to hinge terminals.
 4. Handle whose position is easily recognizable and can be multiple padlocked in "OPEN" position.
 5. Defeatable door interlocks that prevent door from opening when operating handle is in "CLOSED" position.
 6. Manually operated, non-teasible, positive, quick make, quick break interrupter operating mechanism.
 7. Operating Handle Height: Position internal devices with operating handles so that center of operating handle grip does not exceed 6'-6" above finished floor or working platform.

- I. Small Conductors: All groups of control wires leaving the switchboard shall be provided with terminal blocks with suitable numbering strips.
- J. Feeders: All feeders shall enter, exit and be routed within each switchboard in full compliance with the 2002 edition of the National Electrical Code article 408.3(A).(3).
- K. Accessories: Provide floor sills, anchor bolts, and hardware in accordance with manufacturer's installation instructions.
- L. Control Power Transformers (CPTs): All required CPTs shall be provided with primary and secondary protection and shall be adequately sized for required loads plus twenty percent spare.
- M. Utility Metering: Where indicated on the drawings, furnish a separate barriered utility metering compartment complete with hinged sealable door. Bus work shall include provisions for mounting utility company current transformers and potential transformers or potential taps as required by utility company. Provide service entrance label and provide necessary applicable service entrance features per NEC, local code and utility company requirements. Provide metering switchboard section with minimum short-circuit interrupting capacity as designated by the utility company.
- N. Kirk Key Automatic Transfer, Manual Re-Transfer: The Switchboard will be configured with a Main-Main configuration. Each main will be provided with a kirk key system to allow isolation from the generator. Four (4) Kirk Key receivers will be provided, two (2) in the Switchboard and two (2) in the generator breaker. Only two (2) keys will be provided.

An automatic transfer system shall be provided. This system will be an automatic source selection with manual retransfer.
- O. Acceptable Manufacturers: Single source manufacturer is required for principal components of switchboard assemblies. Minor components, such as wire, small fuses and terminal blocks, maybe by a different manufacturer. Provide factory assembled units from one of the following:
 - 1. General Electric Company: Base Bid
 - 2. Square-D Company: Alternate
 - 3. Siemens: Alternate
 - 4. Rockwell: Alternate
- P. The Switchboard manufacturer will be same manufacturer as the Motor Control Center manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide a concrete housekeeping pad with chamfered edges for the switchboard to reside. Install pads, floor sills, anchor bolts and hardware required to level, align, secure, and connect switchboard components in accordance with manufacturer's instructions and applicable requirements of the National Electrical Code. Make all required electrical connections and leave switchboard in operating condition.

- B. All switchboards installed as service entrance equipment shall be provided with a bonding jumper in accordance with the 2002 edition of the National Electrical Code article 408.3(C).

3.2 TESTING

- A. Comply with Sections 16955, Electrical Equipment Testing and Adjustment and 01810, Commissioning.

END OF SECTION

SECTION 16440

DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section specifies fusible and non-fusible safety and disconnect switches, individually enclosed and group mounted or applied in combination with motor controllers/contactors in single or grouped installations.

1.2 QUALITY ASSURANCE:

- A. Refer to Section 16010, Electrical System General Requirements for Codes and Standards.
- B. In addition to the Codes and Standards summarized in Section 16010, disconnect switches shall comply with the requirements of NEMA 250, NEMA KS 1, and UL 98.
- C. UL Labeling or Listing: Furnish switches bearing UL label.
- C. NRTL Labeling or Listing: Furnish switches bearing label of a Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.

1.3 SUBMITTALS

- A. Submit Product Data on each switch showing ratings, overall dimensions, enclosure type, and accessories, in accordance with Section 01330, Submittal Procedures.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. General: Fusible and non-fusible "Heavy Duty" safety and disconnect switches with ratings as shown on Drawings and 75°C or higher temperature rating.
- B. Components:
 - 1. Line terminal shields.
 - 2. Visible blades.
 - 3. Non-teasible, positive, quick-make, quick-break interrupter operating mechanism.
 - 4. Reinforced Class R rejection-type fuse clips.
 - 5. Handle whose position ("OFF" or "ON") is easily recognizable and can be multiple padlocked in "OFF" position.
 - 6. Defeatable door interlocks that prevent door from opening when operating handle is in "ON" position.

7. Auxiliary control contact operated by handle mechanism to signal that switch is in the closed position where indicated on Drawings.
 8. Factory installed ground lugs.
 9. Factory installed cover mounted metal nameplate containing a permanent record of:
 - a. Switch type.
 - b. Catalog number.
 - c. Horsepower ratings using both standard and time delay fuses.
- D. Horsepower Ratings:
1. Horsepower rated switches for use as motor disconnecting means, with sizes in accordance with individual manufacturer's published ratings.
 2. For applications in excess of switch ratings, provide non-automatic molded case circuit breakers rated not less than 125% of motor full load current.
- E. Fuses: Current-limiting-type UL RK1 with a minimum interrupting rating of 200,000 RMS symmetrical amperes and of continuous current ratings as shown on Drawings.
- F. Enclosures:
1. NEMA 1 for dry, indoor areas.
 2. NEMA 3R for damp indoor or outdoor locations.
 3. Others as noted.
- G. Acceptable Manufacturers:
1. General Electric Company.
 2. Square-D Company.
 3. Siemens

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Enclosure:
1. Mount switch enclosure plumb and level and rigidly attach to structure.
 2. Mount 1 inch off structure with top 6'-6" above finished floor.
 3. Install supports in a manner to permit vertical flow of air behind enclosure.

- 4. Use steel supports fabricated from standard rolled structural steel shapes as specified in Section 16190.
- B. Wiring: Install all incoming and outgoing power circuits.
- C. Grounding: Refer to Section 16450.
- D. Fuses: Install properly rated fuses.

3.2 IDENTIFICATION

- A. Refer to Section 16195.

END OF SECTION

SECTION 16450

GROUNDING

PART I - GENERAL

1.1 SECTION INCLUDES

- A. Section specifies grounding of electrical systems and equipment and grounding of conductive machine frames, enclosures, appliances, structures and other equipment for protection of life, equipment, circuits, and systems.
- B. All switchboards, transformers, load break switches and metering shall be grounded per the Utility and NEC requirements.

1.2 QUALITY ASSURANCE

- A. Refer to Section 16010, Electrical System General Requirements for Codes and Standards.
- B. In addition to the Codes and Standards summarized in Section 16010, Grounding shall comply with the requirements of IEEE 142, NFPA 70 Article 250 and UL 467.
- C. UL Labeling or Listing: Furnish grounding fittings bearing label of or listing by UL.
- D. NRTL Labeling or Listing: Furnish grounding fittings bearing label of or listing by a Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.

1.3 SUBMITTALS

- A. Test Reports: Submit to Engineer two (2) copies of grounding system test report certified by testing technician and Owner's representative, in accordance with Section 01810, Commissioning.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Conductors: Copper, refer to Section 16121.
- B. Exothermic Welding: Molds and charges by Erico Products, Inc. "Cadweld" or Continental Industries, Inc. "Thermoweld".
- C. Ground Rods: (5/8)-inch diameter, 10 feet long, copperclad sectional ground rods.
- D. Grounding Clamps: O-Z/Gedney or Steel City "G" series.
- E. Connectors, Terminals, and Tape: Refer to Section 16121.
- F. Flexible Conduit Connectors: Refer to Section 16111.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install grounding system comprised of the following major components:
1. Steel reinforcing bars in column footings with Eufel ground bonded together as grounding electrodes to provide connection to earth.
 2. Ground loop.
 3. Driven rod at service entrances.
 4. Continuous equipment grounding conductors in electrical raceways and cable runs to ensure a positive path for connection of equipment that must be grounded.
 5. Water pipe electrode.
 6. Continuous bond of all items listed above. Connection of Equipment to Framing
- C. Steel:
1. General: Connect below grade and concealed conductors using exothermic welds. Connect above grade using mechanical connectors.
 2. Transformer Neutrals: Connect 9 KVA and larger transformer neutrals to the grounding system using conductor sized in accordance with NEC Table 250.66 but no smaller than No. 2 AWG.
 3. Distribution Equipment: Connect ground bus in switchgear assemblies, motor control centers, motor control panelboards, and power panelboards to the grounding system using a conductor sized in accordance with NEC Table 250.122 but no smaller than No. 2 AWG.
 4. Motor Frames: Connect motor frames rated above 300 volts and located within 6 feet above finished floor to the grounding system using a conductor sized in accordance with NEC Table 250.122 but no smaller than a No. 2 AWG.
 5. Tanks and Vessels: Provide No. 2 AWG conductor from each metal tank or vessel to the nearest grounding system.
 6. Telephone Equipment: Provide No. 4/0 AWG conductor from the grounding system into each telephone equipment room or telephone service entrance terminal cabinet and terminate as directed by the telephone company.
- D. Equipment Grounding:
1. Provide electrically continuous equipment grounding conductors sized per NEC Table 250.122, or as indicated on Drawings, in electrical raceways containing conductors rated higher than 30 volts.
 2. Bond grounding conductors to grounding bushings, grounding locknuts, grounding lugs, equipment, fixtures, enclosures and transformer neutrals.

- E. Flexible Metal Conduit: Provide an external grounding jumper on flexible conduit runs longer than 6 feet.
 - 1. Spiral wrap the grounding conductor through a minimum of 360° around outside of flexible conduit.
 - 2. Terminate jumper and flex on each end with an insulated grounding fitting.
 - 3. Size jumper same as equipment grounding conductor in the flexible conduit but no smaller than No. 6 AWG.
- F. Expansion Joints: Provide No. 4/0 AWG jumper with 6 inches of sag across structure expansion joints.
 - 1. Bond jumpers to framing steel on both sides of the joint using exothermic welds.
 - 2. Provide a jumper every 50'-0" maximum along expansion joint with a minimum of two jumpers per expansion joint.

3.2 FIELD QUALITY CONTROL

- A. Tests: After complete installation of grounding system, measure ground resistance using the three terminal "Fall-of-Potential" method.
 - 1. Comply with IEEE 81.
 - 2. Space electrodes so that the potential electrode is located from the reference starting point a distance equal to 62% of the sum of the distances from the reference starting point of the test object and the current electrode.
- B. Testing Firm: Employ an independent testing firm using NETA certified testing technicians.
- C. Test Values: Maximum resistance value of the ground electrode system is not to exceed 5 ohms. If test results exceed 5 ohms, proceed as directed by the Engineer.

END OF SECTION

SECTION 16461

DRY-TYPE TRANSFORMERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section specifies general purpose and specialty dry-type transformers with windings rated 600 Volts or less.

1.2 RELATED SECTIONS

- A. Section 16010 Electrical System General Requirements
- B. Section 16011 Submittal Procedures
- C. Section 16012 Electrical Product Substitution Procedures
- D. Section 16030 Equipment Installation
- E. Section 16195 Identification
- F. Section 16450 Grounding

1.3 QUALITY ASSURANCE

- A. Refer to Section 16010, Electrical System General Requirements for Codes and Standards.
- B. In addition to the Codes and Standards summarized in Section 16010, dry-type transformers shall comply with the requirements, ANSI/IEEE C57.12.01., NEMA ST 1. , NEMA ST 20. , UL 506. , and UL 1561.
- C. UL Labeling or Listing: Furnish transformers bearing UL label.
- D. NRTL Labeling or Listing: Furnish transformers bearing the label of a Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.

1.4 SUBMITTALS

- A. Submit Product Data on each transformer showing ratings, number of phases, winding configuration, KVA capacities, overall dimensions, and weight in accordance with Section(s) 01330, Submittal Procedures.
- B. Submit one copy of manufacturer's sound rating certification.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. General: Provide transformers with the following characteristics:
1. Ratings, Configurations, and Capacities: Primary and secondary voltage ratings, number of phases, winding configuration, and KVA capacities as shown on the Drawings.
 2. Windings: Electrical Grade Copper, two windings per phase, totally enclosed, non-ventilated, self-cooled. Aluminum windings are not permitted.
- B. Shielded isolation transformers shall be provided with an electrostatic shield between the primary and secondary windings.
- C. Primary Taps:
1. Below 30 KVA: 2@ 5% FCBN.
 2. 30 KVA and Above: 2@ 2-1/2% FCAN and 4@ 2-1/2% FCBN.
- D. Insulation: BIL shall be a minimum of 10kV.
1. Below 30 KVA: Class 185.
 2. 30 KVA and Above: Class 220.
- E. Temperature Rise (Over 40°C Ambient):
1. Below 30 KVA: 115°C.
 2. 30 KVA and Above: 150°C.
- F. Sound Rating: Do not exceed ANSI and NEMA maximum levels for specified KVA capacities. Sound levels shall be guaranteed by the manufacturer not to exceed the following.
1. 45db for transformers 15-50 kVA
 2. 50db for transformers 51-300 kVA
 3. 55db for transformers 301-500 kVA
- G. Sound levels for transformers mounted in Hospitals, Schools, Office Areas and other sensitive areas shall be nominally 5 db below ANSI levels referenced in paragraph 2.1 G above. Note: "other sensitive areas" will be designated on the drawings.
- H. Enclosure: Suitable for indoor locations (NEMA 1) or outdoor (NEMA 3R) locations with the addition of weathershield kit and including a wiring compartment suitable for conduit entry. All transformers shall be provided with rodent screens. Transformers through 75 kVA shall be designed so they can be either floor or wall mounted. Above 75kVA they shall be of a floor mounted design.

- I. The entire transformer enclosure shall be degreased, cleaned, phosphatized, primed and finished with grey, baked, enamel.
- 2.2 Buck/boost transformers shall be encapsulated type, suitable for 80°C rise in 40°C ambient. Secondary windings shall be rated 12/24V and/or 16/32V as indicated on the drawings.
- 2.3 Provide transformer with engraved nameplates with designation as indicated on the drawings or as directed by the Owner's Representative in accordance with Section 16195 – Identification.
- 2.4 **ACCEPTABLE MANUFACTURERS:**
 - A. General Electric Company.
 - B. Square-D Company.
 - C. Siemens.

PART 3 - EXECUTION

3.1 INSTALLATION.

- A. Mounting: Refer to Section 16190 for proper support and anchorage. Provide 4-inch tall concrete housekeeping pads when transformers are mounted in equipment rooms or areas subject to occasional moisture on the floor. In all outdoor locations concrete transformer pads are required.
- B. Raceway Connections: Connect raceways to transformer enclosure using flexible conduit as specified in Section 16111. Use pieces of flex approximately ten diameters in length.
- C. Wiring: Terminate wiring connections in accordance with Section 16121.
- D. Grounding: Refer to Section 16450.
- E. Assure National Electrical Code clearances on all sides for adequate ventilation.
- F. Transformers shall be installed in accordance with manufacturer's recommendations. In addition, all transformers shall be installed with Isomode, Aeroflex or Energy Kinetics vibration isolation devices under feet or contact points.
- G. Adjust transformer taps for proper secondary voltage.

END OF SECTION

SECTION 16470

PANELBOARDS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section specifies circuit breaker and fusible panelboards for use in control and protection of lighting, receptacle, and general power loads rated 600 volts or less.

1.2 QUALITY ASSURANCE

- A. Refer to Section 16010, Electrical System General Requirements for Codes and Standards.
- B. In addition to the Codes and Standards summarized in Section 16010, panelboards shall comply with the requirements, NEMA PB 1, NEMA PB 1.1, and UL 67
- C. UL Labeling or Listing: Furnish panelboards bearing UL label.
- D. NRTL Labeling or Listing: Furnish panelboards bearing the label of a Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.

1.3 SUBMITTALS

- A. Submit Product Data on each panelboard in accordance with Section(s) 01330, Submittal Procedures, including:
 - 1. Enclosure dimensions and type.
 - 2. Voltage and number of phases.
 - 3. Bus material, ampere rating, and bracing.
 - 4. Overcurrent device frame designations, trip ratings, and interrupting rating.
 - 5. Customer's panelboard designation.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. General: Conform to schedules and diagrams as shown on Drawings. Each schedule shall indicate:
 - 1. Panelboard designation.
 - 2. Arrangement diagram.
 - 3. Current and voltage ratings for each component.
- B. Acceptable Manufacturers: Single source manufacture is required. Provide factory-assembled panelboards as follows:

1. Power, Lighting and Receptacle Panelboards (PP & RP):

a. 480/277 Volt: Power Panelboard

<u>Manufacturer</u>	<u>Type</u>
General Electric Co.	AE
Square D Co.	NF
Siemens	S2

b. 208/120 or 120/240 Volt: Receptacle Panelboard (RP)

<u>Manufacturer</u>	<u>Type</u>
General Electric Co.	AQ
Square D Co.	NQOD
Siemens	S1

C. Bus Work: Copper bus bars, isolated neutral bar as indicated on schedules, and grounding bar. Bond grounding bar to panelboard enclosure.

D. Enclosure:

1. Minimum Widths:

- a. Power Panelboards: 24 inches.
- b. Lighting and Receptacle Panelboards: 20 inches.

E. Enclosure Doors and Trim:

- 1. Door Locks: Provide each door with a pin-cylinder type lock. Key locks alike.
- 2. NEMA 1 Door/Trim: Steel with primed and baked-on gray enamel and of "door-in-door" construction.
 - a. Hinge outer door to box so that access to wiring gutters is provided.
 - b. Hinge inner door to outer door so that dead-front access to the overcurrent device operators is provided.
- 3. NEMA 1 Door/Trim: Steel with primed and bake-on gray enamel.
 - a. Attach trim to box with rotating quarter-turn clamps or similar clamping system.
 - b. Hinge door to trim so that dead-front access to the overcurrent devices is provided.
- 4. NEMA 3R Door/Trim: Steel with primed and bake-on gray enamel.

- a. Hinge weatherproof, gasketed trim to side of box so that access to wiring gutters is provided.
 - b. Hinge weatherproof, gasketed door to trim so that dead-front access to over current device operators is provided.
- F. Circuit Breakers: Refer to Section 16475.
- 1. Trip ratings, frame sizes, and interrupting ratings are shown on Drawings.
 - 2. Ground fault circuit interrupters with sensitivity trip level of 5 milliamperes, trip indication, and test button.
- G. Fused Switches: Refer to Section 16440.
- H. Panelboard Directory: Provide each panelboard with a circuit directory card mounted in a holder located on inside of door. The circuit directory shall have the same data fields as the panelboard schedules included in the project plans. The contractor shall revise and update all load data fields as necessary due to field changes and actual load data as specified on equipment nameplates.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Enclosure:
- 1. Mount enclosures plumb and level, 6'-6" to top, and rigidly attach to structure using materials and methods specified in Section 16190.
 - 2. Install surface mounted units in a manner to permit vertical flow of air behind cabinets and enclosures.
 - 3. Clean interiors before installing trim.
 - 4. Close unused circuit positions with blanking plates.
- B. Wiring:
- 1. Install wiring in accordance with Section 16121.
 - 2. Check buses for proper insulation resistance prior to energizing.
 - 3. Connect grounding conductors and conduit bushing grounding terminals to panelboard grounding bar.
- C. Circuit Breakers: Set circuit breaker instantaneous trip adjustments to minimum setting unless designated otherwise on Drawings.
- D. Fusible Units: Provide full complement of fuses of designated class and ratings and 10% (minimum of 3) spare fuses of each size specified.
- E. Flush Mounted Panelboards: From each flush mounted panelboard extend into an accessible location a 3/4 inch empty conduit for every three spare branch circuits and spaces or as shown on Drawings.

3.2 APPLICATION

- A. Power, Lighting and Receptacle Type Panelboards: As designated by Panelboard Schedules on Drawings.
- B. Enclosure:
 - 1. NEMA 1 for indoor locations unless indicated otherwise on Drawings.
 - 2. NEMA 3R for outdoor installations.
- C. Ground Fault Circuit Interrupters: Provide for all 120 volt circuits supplying 15 and 20 ampere receptacles installed outdoors or as shown on Drawings.

3.3 IDENTIFICATION

- A. Refer to Section 16195.

END OF SECTION

SECTION 16475

MOLDED CASE CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section specifies molded case circuit breakers in individual enclosures, panelboards, combination motor starters, and control panels.

1.2 RELATED SECTIONS

- A. Section 16010 Electrical System General Requirements
- B. Section 16011 Submittal Procedures
- C. Section 16012 Electrical Product Substitution Procedures
- D. Section 16030 Equipment Installation

1.3 QUALITY ASSURANCE

- A. Refer to Section 16010, Electrical System General Requirements for Codes and Standards.
- B. In addition to the Codes and Standards summarized in Section 16010, molded case circuit breakers shall comply with the requirements of:
 - 1. NEMA AB 1.
 - 2. UL 489.
- C. UL Labeling or Listing: Furnish circuit breakers bearing UL label.
- D. NRTL Labeling or Listing: Furnish circuit breakers bearing label of a Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1910.7.

1.4 SUBMITTALS

- A. Submit Product Data on each circuit breaker showing ratings, overall dimensions, enclosure type, and accessories in accordance with Section(s) 01330, Submittal Procedures.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. General:
 - 1. Voltage rating for the point of application, frame size, trip rating, and interrupting rating are noted on Drawings.
 - 2. Circuit breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break over-center switching mechanism. Automatic tripping of the

breaker shall be clearly indicated by handle position. Contacts shall be non-welding silver alloy and arc extinction shall be accomplished by means of arc chutes.

3. All breakers shall be "bolt on" type.
 4. When used for switching lighting circuits, breakers shall be marked "SWD" (Switch Duty Rated).
 5. All multi-pole breakers shall have common trip. Wires, pins, etc., between single pole breakers to form common trip will not be acceptable.
 6. The use of "Pushmatic" or miniature "Quicklag" breakers shall not be permitted.
 7. Provide individually enclosed and panelboard mounted circuit breakers of the thermal-magnetic type with inverse time and instantaneous trip characteristics rated for operation in a 40°C ambient.
 8. Provide breakers used in combination with motor starters with adjustable instantaneous trips.
 9. Provide shunt trip devices, motor operators, interlocks, auxiliary contacts, bell alarm switches, and other modifications as noted on Drawings or specified in Section 16481.
 10. Do not use "trunk type" latches on enclosures.
- B. Enclosures:
1. NEMA 1 for dry, indoor areas.
 2. NEMA 3R for damp or outdoor locations.
 3. Other ratings as noted.
- C. Acceptable Manufacturers:
1. General Electric Company.
 2. Square D Company.
 3. Siemens.

PART 3 - EXECUTION

3.1 INSTALLATION:

- A. Mounting: Refer to Section 16190. Mount individually enclosed circuit breakers with top of enclosure 6'-6" above finished floor unless indicated otherwise on Drawings.
- B. Trip Settings:
- C. Set adjustable instantaneous trips to minimum, unless indicated otherwise on Drawings.

- D. On magnetic breakers in combination with starters, set trips at the lowest value that will permit motor starting, but not higher than 13 times the motor nameplate full-load current.

3.2 IDENTIFICATION

- A. Refer to Section 16195.

3.3 TESTING

- A. Refer to Section 16955.

END OF SECTION

SECTION 16481

MOTOR STARTERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Manual motor starters.
- B. Combination magnetic motor starters.

1.2 RELATED SECTIONS

- A. Section 16010, Electrical System General Requirements.

1.3 REFERENCES

- A. Refer to Section 16010, Electrical System General Requirements for Codes and Standards.

1.4 SUBMITTALS

- A. Comply with the provisions and requirements of Section 01330, Submittal Procedures.
- B. Product Data: Provide dimensions, mounting, weight, electrical ratings, control schematics, wiring diagrams and recommended overload heater sizes.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. General Electric
- B. Square D
- C. Siemens

2.2 MANUAL MOTOR STARTERS

- A. Shall have "quick-make, quick-break" toggle mechanism.
- B. Overload heater(s) shall be sized per motor nameplate and manufacturer's recommendations.
- C. Provide NEMA Type 1 enclosure unless otherwise shown on the drawings.
- D. Shall be suitable for the voltage, HP and the number of phases as shown on the drawings.

2.3 COMBINATION MAGNETIC MOTOR STARTERS

- A. Starters shall be combination, full voltage, nonreversing unless shown otherwise, and shall utilize motor circuit protectors or fusible switches as shown on the drawings.

- B. Starters shall be equipped with a fused control power transformer, 120-volt operating coil, ambient compensated overload relays and one NO and one NC spare auxiliary contacts wired to the terminal strip.
- C. Each starter shall be provided with the control devices shown on the drawings. If control schematics are not shown on the drawings, provide the following:
 - 1. A 'HAND-OFF-AUTO-COMPUTER' selector switch mounted on the cover.
 - 2. A red 'RUN' light and green 'STOP' light.
 - 3. The 'AUTO' side of switch shall be wired to the external terminal strip for connection to a field-mounted control device.
- D. Control power transformers shall be sized for the operating coil and any other loads shown on the drawings. One side of the control power transformer shall be grounded. Primary fusing shall be provided in accordance with the NEC.
- E. Motor circuit protectors (MCP) shall provide adjustable magnetic protection and be provided with a pin insert to stop the magnetic adjustment at 1,300 percent motor nameplate full load current. The MCP shall have a "tripped" position on the unit disconnect and a push-to-test button on the MCP. The MCP shall include a transient override feature for motor inrush current.
- F. Fuses used in fused switches shall be in accordance with Section 16050. Fuse clips shall be rejection type accepting only current limiting fuses.
- G. Overload heaters shall be sized per motor nameplate and manufacturer's recommendations. A manual reset button shall be provided on the cover of the door.
- H. Control accessories shall be heavy-duty oil tight type. Indicating lights shall be transformer type with 6.3-volt lamps and push-to-test feature.
- I. Hour meters (elapsed time meters) shall be 2-1/2-inch square case type for flush panel mounting. The meter face shall have black trim on white or aluminized face. The meters shall have a six-digit nonreset register with the last digit indicating tenths of an hour.
- J. Terminal strips shall be provided for connection to external devices.
- K. Enclosures shall be NEMA type as shown on the drawings. Where NEMA type enclosures are not shown on the drawings, provide NEMA type most suitable for the environmental conditions where the motor starter is being installed.
- L. Enclosures shall be thoroughly cleaned, given a rust-inhibiting primer coat, and painted with manufacturer's standard colors.
- M. Provide nameplates for each control device on door in accordance with Section 16010.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install per manufacturer's and NEC requirements.
- B. Ensure National Electrical Code clearances.
- C. Verify proper overload heater and fuse sizes and replace/adjust if required.
- D. Adjust all motor circuit protectors per manufacture's recommendations.
- E. Test all control and safety devices to ensure proper operation.

END OF SECTION

SECTION 16482

SOLID STATE MOTOR CONTROLLERS (SOFT STARTS)

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Solid state motor controllers (SSMC) for use with NEMA Design "B" 480 VAC motors to reduce the current inrush as well as mechanical shocks that can result from starting or stopping a motor across the line.
 2. This section pertains to stand-alone solid state motor controllers in addition to those provided as part of a Motor Control Center or Switchboards.
 3. Provide SSMC fully assembled as part of a Motor Control Center, Switchboards or as a standalone controller, ready for field installation, testing, and startup.

1.2 SUBMITTALS

- A. Submit the following in accordance with Specification 16000, General Electrical Requirements:
1. Complete electrical data on the SSMC and all accessories.
 2. Dimensional and weight information on the enclosure (if applicable).
 3. Fully developed ladder style elementary diagrams complete with terminal and wire designations. Label or tag all control devices.
 4. Comprehensive bill of material for all components used to assemble the finished product.
 5. Anticipated heat load for sizing of building HVAC system.
 6. Verification that unit is listed by an independent testing laboratory in accordance with Electric Industrial Control Equipment Specification UL 508.
 7. List of recommended spare parts for one year operation.

1.3 QUALITY ASSURANCE

- A. Final assembly to be provided with a UL 508 label installed at the point of manufacturer.
- B. The manufacturer shall be a certified ISO 9002 facility.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Package unit to protect against shipping damage.
- B. Store unit in a clean, dry, controlled environment until scheduled installation.

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- C. Handle units in accordance with manufacturer's recommendations and in such a manner as to prevent damage.
- D. Replace any unit damaged as a result of improper shipping, storage, or handling.

1.5 PROJECT/SITE CONDITIONS

- A. Unit shall be designed specifically for the environment into which it will be installed.
- B. Provide weather protection, space heating to prevent condensation, and cooling or ventilation as recommended by SSMC manufacturer.
- C. Provide sufficient clearance and housekeeping pads to allow air circulation and to prevent damage from standing water.

PART 2 - PRODUCT

2.1 MANUFACTURERS

- A. GE, Square "D", Rockwell.

2.2 GENERAL DESCRIPTION

- A. Provided in a configuration suitable for panel mounting.
- B. Uses a thyristor bridge consisting of at least two SCRs per phase to control the starting and stopping of industry standard motors. A soft start/current limit will be obtained by a timed voltage ramp of the thyristors. The thyristors will be controlled in such a manner that a smooth and stable acceleration ramp is ensured, independent of motor load.
- C. Controlled by a microprocessor that continuously monitors the current and thyristor phasing of the starter.
- D. All soft start power ratings shall use the same control module.

2.3 RATINGS

- A. Designed to operate in an ambient temperature of 0° C to 40° C.
- B. Storage temperature range shall be -25° C to 70° C.
- C. Maximum relative humidity shall be 93% at 40° C, non-condensing.
- D. Designed to operate in attitudes up to 3,300 feet. For higher altitudes, de-rate by 1.2% for each additional 330 feet.
- E. Capable of operation within -15% to +10% of nominal voltage rating and automatically adapt for 50 Hz or 60 Hz.
- F. Capable of supplying 300% of rated full load current for 60 seconds at maximum ambient temperature.

- G. The SCRs shall have a minimum P.I.V. rating of 1,400 V. Lower rated SCRs with "protection" by MOVs will not be acceptable.

2.4 ADJUSTMENTS AND CONFIGURATIONS

- A. All dialog functions, display units, remote functions, terminal blocks, configuration switches and adjustment potentiometers shall be accessible on the front of the control module. Exposure to control circuit boards or electrical power devices during routine adjustments shall be prohibited.
- B. Dialog indication shall provide, as a minimum, the following conditions:
 - 1. Soft start ready for start.
 - 2. Soft start starting/stopping motor.
 - 3. Soft start running at full voltage.
 - 4. Thermal pre-alarm condition.
 - 5. Thermal fault.
 - 6. Soft start internal fault.
 - 7. Power supply fault.
- C. Dip switches shall be used for configuring the soft start and will select:
 - 1. Manual or automatic reset.
 - 2. Freewheel or controlled stopping.
 - 3. Stop by deceleration ramp or DC injection braking.
 - 4. Full voltage boost on start (on or off).
- D. Potentiometers or keypads shall be used for adjusting the operating parameters and will provide:
 - 1. Motor full load amps adjustable from 50% to 100% of the controller's current rating.
 - 2. Current limitation on starting adjustable from 2 to 5 times rated motor current.
 - 3. Voltage ramp adjustable from 1 to 30 seconds.
 - 4. Deceleration ramp or DC injection time adjustable from 2 to 60 seconds.
- E. Output relays shall provide the following status indications:
 - 1. Fault Trip or Soft Start: One Form A and one Form B, minimum.
 - 2. Thermal Pre-alarm: One Form A and one Form B or one Form C, minimum.

3. End of Start (voltage ramp complete and current below 130% motor FLA): One Form A.
 4. Brake (for control of braking contactor if this function is specified): One Form A.
- F. Relay functions listed above must be isolated with respect to common.

2.5 PROTECTION

- A. A microprocessor controlled thermal protection system shall be included, which continuously calculates the temperature-rise of the motor and soft start and provides:
1. An overload pre-alarm which indicates by relay contact that the motor has exceeded its rated temperature rise by 100%. This function shall be annunciated only without resulting in fault trip of the motor.
 2. A thermal fault condition which stops the motor if the temperature-rise exceeds 120% of the motor thermal capability.
 3. An analog electronic circuit with a time constant adjustable to the motor's thermal cooling time constant ensuring the memorization of the thermal state even after power supply disconnection or shorting out of the power semiconductors.
- B. The soft start shall have phase loss, phase unbalance, and undervoltage protection.

2.6 CONTROL OPTIONS

- A. Provide lockable disconnecting means to isolate the SSMC from incoming power. Disconnect may be either fused or circuit breaker style as shown on the Contract Drawings.
- B. Provide lights, pushbuttons, selector switches, indicators, run time meters, and other accessories as shown on the Contract Documents. These accessories are to be full size, NEMA 4 rated, heavy-duty type. Lights are to be 120 VAC, transformer style, LED, with push-to-test feature.
- C. Control relays are to be plug in style, 120 VAC, provided with DIN rail mounting sockets and shall have an indicating light to show when relay is energized. Contact sets to be rated at minimum 5 amps, 250 VAC.
- D. Provide a control power transformer, 480:120 V, sized to accommodate all the control circuit requirements in addition to 25% spare capacity.
- E. The soft start shall accept control logic either by operator devices (pushbuttons, selector switches, etc.) wired directly into the unit or from external relay logic.
- F. Provide warning label in accordance with the NEC if power is available from more than one source.
- G. Provide nameplates identifying all panel mounted equipment and operator controls.

2.7 SHORTING CONTACTOR

- A. A microprocessor shall control the operation of the shorting contactor via an output relay.
- B. The shorting contactor shall close, shorting the thyristors after the motor current is below 130% of motor FLA and voltage is below nominal voltage (indicating the acceleration ramp is complete), and open on a stop command to allow a deceleration ramp or DC injection stop.
- C. Overload protection shall continue to protect the motor when shorting is used.

2.8 BRAKING CONTACTOR

- A. If required by Contract Drawings, a microprocessor shall control the operation of the braking contactor via an output relay.
- B. If an overload condition occurs during the injection brake period, braking shall continue as set. When braking is complete, restart shall be prohibited until the motor has cooled.

2.9 ISOLATION AND BYPASS CONTACTORS

- A. If required by contract drawings, provide NEMA rated 3-pole isolation contactor to completely isolate the SSMC from the incoming power in the event of a shorted SCR or another defined fault condition.
- B. If required by Contract Drawings, provide NEMA rated 3-pole reversing style contactor to both isolate the output of the SSMC, as well as allow across-the-line starting of the motor.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Mount the SSMC in accordance with manufacturer's recommendations.
- B. Provide sufficient clearance for air circulation and operation of any vent fans or cooling equipment.
- C. Install conduit, pull and terminate all power and control conductors.

3.2 TESTING

- A. Test in accordance with Specification 16920, Electrical Acceptance Testing.

END OF SECTION

SECTION 16483

MOTOR CONTROL CENTERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Section specifies standardized, freestanding, metal enclosed, plug-in, grouped, motor control equipment.

1.2 RELATED SECTIONS

- A. Section 16010 Electrical System General Requirements
- B. Section 16011 Submittal Procedures
- C. Section 16012 Electrical Product Substitution Procedures
- D. Section 16030 Equipment Installation
- E. Section 16111 Metallic Conduit and Fittings
- F. Section 16121 Low Voltage Copper Wire and Cable
- G. Section 16190 Supports and Fasteners
- H. Section 16195 Identification
- I. Section 16450 Grounding
- J. Section 16481 Motor Starters
- K. Section 16950 Acceptance Testing and Calibration

1.3 QUALITY ASSURANCE

- A. Refer to Section 16010, Electrical System General Requirements for Codes and Standards.
- B. UL Labeling or Listing: Furnish motor control center standard structures and units bearing UL label.
- C. NRTL Labeling or Listing: Furnish motor control center standard structures and units bearing the label of a Nationally Recognized Testing Laboratory (NRTL) as defined in OSHA Regulation 1917.

1.4 SUBMITTALS

- A. Submit Product Data and Shop Drawings on each motor control center in accordance with section 01330. Submittals shall include but not be limited to:
 - 1. NEMA Class and Type.
 - 2. Dimensions, weights, and anchor bolt layout.
 - 3. Shipping split locations.
 - 4. Voltage and number of phases.

5. Bus material, ampere rating, and bracing.
6. Individual controller sizes, wiring diagrams, and accessories.
7. Overcurrent device frame designations, trip ratings, and interrupting ratings.
8. Customer's motor control center designation.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. NEMA Class and Type: NEMA Class I, Type B.
 1. All power cable shall be 600 volt copper Type SIS insulation for Type "B" and "C", #12 AWG or larger. All control wiring shall be 600 volt copper Type SIS insulation, #14 AWG stranded minimum. Connect wiring in accordance with diagrams on Drawings
 2. Horizontal wiring trough shall be provided at the top and bottom of the motor control center and shall extend the full length. Wiring trough at the top shall be protected from the horizontal bus bars by means of a steel barrier plate. Troughs shall be equipped with cable supports and shall be large enough to permit the installer to make bends in the power cables with a minimum radius of ten times the cable diameter. Provide increased wiring space where parallel conductors are used.
 3. A vertical wiring trough shall be provided for the full working height of each section. The vertical wiring trough shall be equipped with cable clamps and shall be designed so as to allow installation wiring to control units with units in place.
- B. Components: Refer to drawings for additional requirements and Section 16481 for motor starter requirements. Motor Control Center shall be suitable for operation on a 480-volt, three phase, 3-wire 60-hertz system.
- C. Assembly:
 1. Arrange motor control units in accordance with cell assignments shown on Drawings, except where manufacturer's unit space requirements differ. In such cases, maintain order of units as close as possible and do not decrease number of blank units.
 2. Arrange motor control center units so that a minimum number of vertical sections are required.
 3. Do not install 2 separate motor control units in a single cell.
 4. Position motor control units so that the disconnecting means operating handle does not exceed 6'-0" above finished floor or working platform when in its highest position.

5. Compartments labeled "SPARE" shall be equipped with a control unit of the size and type indicated on the drawings, and those labeled "SPACE" shall be equipped to receive the largest unit which can be mounted in the allotted space.
- D. Buswork:
1. Silver-plated copper untapered main and riser buses with continuous current ratings as shown on Drawings.
 2. Braced for RMS symmetrical amperes as shown on Drawings.
 3. Insulating barriers between buswork and unit cell interiors.
 4. Full length copper ground bus sized in accordance with the latest edition of the National Electrical Code Table 250-122. Equip bus with clamp-type connectors for main feeder grounding conductor and each circuit originating in assembly. Drill bus for 1 future connector per blank cell. One clamp type ground connector shall be provided at each end of the motor control center for a connection of a bare #4/0 stranded copper ground cable. Six clamp type ground terminals suitable for #12 AWG to #2 AWG stranded copper shall be provided in each section for connection of ground cables, which serve as equipment grounds.
- E. Assembly Enclosure:
1. NEMA 12 with removable lifting angles, steel base channels, and a nominal depth of 20 inches. Provide front aligned or back-to-back mounting as indicated on drawings.
 2. Cell doors and vertical wiring trough covers with concealed hinges.
 3. Prior to assembly, clean, phosphatize, and finish steel surfaces with 2 coats of manufacturer's standard baked enamel paint.
- F. Terminal Blocks: Pull-apart type unit terminal blocks conforming to NEMA ICS 4, rated 600 volts, and suitable for Type "B" wiring in each individual starter unit.
- G. Terminal Blocks: Non pull-apart track mounted terminal blocks conforming to NEMA ICS 4, rated 600 volts, and suitable for Type "C" wiring in top or bottom most unit space of each vertical section.
- H. Internal Wiring: Minimum No. 14 AWG stranded copper with Type SIS insulation for Type "B" and "C" internal wiring assemblies. Connect wiring in accordance with diagrams on Drawings.
- I. Acceptable Manufacturers: Single source manufacturer is required for principal components of switchboard assemblies. Minor components, such as wire, small fuses and terminal blocks, may be of different manufacturer. Provide factory-assembled units from one of the following:
1. General Electric Company: Base Bid
 2. Rockwell: Alternate
 3. Square-D Company: Alternate

4. Siemens : Alternate
- J. The Motor Control Center manufacturer will be the same manufacturer as the Switchboard manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General:
 1. Install each motor control center using anchors sized and located in accordance with manufacturer's installation instructions.
 2. Shim to ensure assembly is plumb and aligned.
 3. Make mechanical and electrical connections between shipping splits.
 4. Touch-up marred factory finishes, with matching factory furnished paint.
- B. Raceways: Locate conduit entrances in correct vertical section, both bottom and overhead, within areas designated on Shop Drawings.
- C. Wiring:
 1. Install incoming and outgoing power and control circuits in accordance with Section 16121.
 2. Connect power circuits for proper phase rotation.
 3. Connect equipment ground conductors to ground lugs.
- D. Overcurrent Protection: Set circuit breaker instantaneous trips at proper value and install correct size fuses and thermal overload heater elements.
- E. Grounding: Connect ground bus to equipment ground grounding conductors and to grounding electrode system.
- F. Controls: Check interconnection and operation of control devices, interlocks, indicating lights, and control relays. Set timers and time delay relays for correct intervals. Check controller-operating coil for correct voltage rating.

3.2 IDENTIFICATION

- A. Refer to Section 16195.

3.3 TESTING

- A. Comply with Section 16955.

END OF SECTION

SECTION 16485

ENCLOSED CONTACTORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. General purpose contactors.
- B. Lighting contactors.

1.2 REFERENCES

- A. Refer to Section 16010, Electrical System General Requirements for Codes and Standards.
- B. In addition to the requirements of Section 16010, enclosed contactors shall comply with the following:
 - 1. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
 - 2. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.

1.3 SUBMITTALS

- A. Comply with the provisions and requirements of Section 01330, Submittal Procedures.
- B. Provide dimensions, size, voltage ratings and current ratings.
- C. Include manufacturer's installation instructions.
- D. Provide record drawings in accordance with Section 16010 and Section 01780, Closeout Submittals. Record the actual locations of each contactor and indicate circuits controlled on project record documents.

1.4 QUALIFICATIONS

- A. Manufacturer shall be a company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.5 REGULATORY REQUIREMENTS

- A. Refer to Section 16010, Electrical System General Requirements for Codes and Standards.
- B. Conform to requirements of NFPA 70.
- C. Provide Products listed and classified by Underwriters Laboratories, Inc., as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 GENERAL PURPOSE CONTACTORS

- A. Manufacturers:
 - 1. Square D Company.
 - 2. General Electric.
 - 3. ASCO.
- B. Description: NEMA ICS 2, AC general purpose magnetic contactor.
- C. Coil Voltage: 120 volts, 60 Hertz unless otherwise noted.
- D. Poles: As indicated.
- E. Size: As indicated.
- F. Enclosure: ANSI/NEMA ICS 6, Type 1 for indoor installation and type 3R for outdoor installation.
- G. Accessories: As shown.

2.2 LIGHTING CONTACTORS

- A. Manufacturers:
 - 1. Square D Company.
 - 2. General Electric.
 - 3. ASCO.
- B. Description: NEMA ICS 2, magnetic lighting contactor.
- C. Configuration: Electrically held 2 wire control.
- D. Coil Voltage: 120 volts, 60 Hertz unless otherwise noted.
- E. Poles: As indicated.
- F. Contact Rating: As indicated.
- G. Enclosure: ANSI/NEMA ICS 6, Type 1 for indoor installation and type 3R for outdoor installation.
- H. Accessories: As shown.

PART 3 - EXECUTION

Not Applicable

END OF SECTION

SECTION 16700

TELECOMMUNICATIONS STRUCTURED CABLING SYSTEMS

PART 1 – GENERAL

1.1 SCOPE

- A. This section generally describes the work and equipment required to furnish and install a complete commercial telecommunications cabling and pathway system with equipment rooms, telecommunications closets, backbone cable and pathways, cross-connect fields, patch panels, horizontal cabling and pathways, workstation faceplates, and testing. All active telephone or data network equipment shall be furnished and installed by the Owner, or under other sections of these Specifications.

1.2 RELATED SECTIONS

- A. Section 16010 Electrical System General Requirements
- B. Section 16011 Submittal Procedures
- C. Section 16012 Electrical Product Substitution Procedures
- D. Section 16030 Equipment Installation
- E. Section 16111 Metallic Conduit and Fittings
- F. Section 16121 Low Voltage Copper Wire and Cable
- G. Section 16190 Supports and Fasteners
- H. Section 16195 Identification
- I. Section 16440 Disconnect Switches
- J. Section 16450 Grounding
- K. Section 16475 Molded Case Circuit Breakers
- L. Section 16950 Acceptance Testing and Calibration

1.3 REFERENCE STANDARDS

- A. Refer to Section 16010, Electrical System General Requirements for Codes and Standards.
- B. In addition to the Codes and Standards summarized in Section 16010, comply with the following standards:
 - 1. 16010ANSI/TIA/EIA-568-A, Commercial Building Telecommunication Cabling Standard.
 - 2. ANSI/TIA/EIA-569, Commercial Building Standard for Telecommunications Pathways and Spaces.

3. ANSI/TIA/EIA-606, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
4. ANSI/TIA/EIA-607, Commercial Building Grounding and Bonding Requirements for Telecommunications.
5. TIA/EIA TSB-67, Performance Specifications for Field Testing of Unshielded Twisted-Pair Cabling Systems.
6. UL 444, Standard for Communications Cable

1.4 QUALIFICATIONS

- A. The telecommunications structured cabling system installer shall be a company regularly engaged in furnishing and installing telecommunications cabling systems, and shall have completed a minimum of five projects of similar design and complexity within the last two years. Pathways may be installed by non-specialized electricians, but shall be under the direction of the telecommunications system installer.
- B. The telecommunications systems installer shall employ a system designer, who shall supervise all phases of planning, documenting, installing and testing of the telecommunications system. The system designer shall be BICSI certified as an RCDD, or shall have comparable certification from other industry recognized third party organization. The installer shall also provide a jobsite foreman with certification by BICSI as Cable Installer, or certification by the manufacturer of the specific cable being furnished, and shall be on site to supervise the installation crew at any time that installation or termination activities are underway.
- C. The optical fiber installation portion of this project shall be installed and terminated by a specialty contractor who is qualified for installation of blown fiber systems and certified by the cable manufacturer as meeting the terms of the manufacturer's warranty. A certified installer shall be on site to supervise the installation crew at any time that installation or termination activities are underway.

1.5 SUBMITTALS

- A. Provide submittals according to requirements of Section 01330, Submittal Procedures for the following:
 1. Submit statement of qualifications, listing project references to verify required experience, and proof of certifications for system designer and cable installer.
 2. Submit complete shop drawings showing layout of telecommunications spaces and pathways in plan view at no less than 1/8-inch scale. Submit scaled elevation sketches showing the arrangement of pathways, hardware and cable management in telecommunications spaces. Submit schematic diagram of cabling installation. Indicate labeling scheme for spaces, pathways, cables and connection hardware.
 3. Submit product data on all pathway components, cable types, and termination and cross-connect hardware.

4. Review provisions in the building design for the telecommunications infrastructure, and submit an itemized list of any building features which will keep the installation from being fully ANSI/TIA/EIA standards compliant.
5. Submit a plan of proposed test procedures and test reports; Indicate testing methods, testing device calibration, and interpretations of test results for field acceptance tests. The Owner's representative must approve all test plans before testing may begin. Final test plans shall be delivered no less than two weeks prior to the start of the first test.
6. Submit complete test data following acceptance testing of completed cabling links. Furnish test results in printed bound volume, and in electronic format capable of being imported into standard commercial spreadsheet and database management software.

1.6 WARRANTIES

- A. Warranty documentation shall comply with the requirements of Section 01780, Closeout Submittals.

PART 2 – PRODUCTS

2.1 PATHWAYS

- A. Underground conduits shall be rigid galvanized steel, Schedule 40 PVC (non-encased), or type EB (concrete encased). All bends and risers shall be long radius rigid galvanized steel, suitable for installation of communications cable. Concrete encasement shall be minimum 2,000 psi concrete. All locating tape shall have metallic foil core.
- B. Interior conduits shall be rigid galvanized steel (RGS) or electric metallic tubing (EMT) meeting all requirements of Section 16111, Metallic Conduit and Fittings. Minimum conduit size shall be 3/4 inch. All bends shall be long radius, suitable for installation of communications cables.
- C. Cable tray and ladder rack shall be sized as indicated on the plans, and shall meet the requirements of ANSI/TIA/EIA-569.
- D. J-hooks shall be designed specifically to support telecommunications cabling of the type used in this project.
- E. Outlet boxes shall be minimum 4-11/16" square x 2-1/8" deep with single or two-gang plaster ring as required.

2.2 CABLES

- A. Interior backbone voice riser cable shall be 25-pair, 24 AWG, 100-Ohm, Category 5 UTP, with polyolefin insulation and flame retardant PVC jacket, Berk-Tek Power Sum or equal. Provide plenum rated sheath where cable is routed exposed through air handling plenums.

Provide quantity of cables as indicated on the plans. ANSI/TIA/EIA-568-B.2 Category 5 Backbone.

- B. Horizontal voice station cable shall be four-pair, 24 AWG, 100-Ohm, Enhanced Category 5E (350 MHz) UTP, with polyolefin insulation and flame retardant PVC jacket, Berk-Tek Landmark-100, or equal. Provide plenum rated sheath where cable is routed exposed through air handling plenums. ANSI/TIA/EIA-568-B.2 Category 5E.
- C. Horizontal data station cable shall be four-pair, 24 AWG, 100-Ohm, Category 6 (500 MHz) UTP, with polyolefin insulation and flame retardant PVC jacket, Berk-Tek Landmark-1000, or equal. Provide plenum rated sheath where cable is routed exposed through air handling plenums. ANSI/TIA/EIA-568-B.2 Category 6.
- D. Provide tube cable system for installation of blown fiber bundles, FutureFlex manufactured by Sumitomo Electric, or approved equal. Provide Outdoor/All-Dielectric cables for outdoor (damp) use, comprised of seven tubes wrapped with water blocking tape and polyethylene outer jacket. Provide Indoor/Plenum Rated cables where routed through air handling plenums, comprised of seven single fire and smoke retardant tubes enclosed in an Aramid skip-binder with no jacket. Provide tube distribution units (TDU's) at each telecommunications closet, and other locations where splices or redirections of tubes are required.
- E. Optical fibers shall be multi-mode 50/100 combined in bundles. FutureFlex manufactured by Sumitomo Electric, or approved equal, with quantity of strands as indicated on the plans, for blown-in installation in tube cable. Cables shall have appropriate jacket rating for the application and environment.
- F. Provide color coding of station cable jackets so as to readily distinguish between data and voice cables, and between field cables of various other low voltage systems, such as EMCS, CCTV, clocks, etc.

2.3 CONNECTING HARDWARE

- A. Equipment mounting backboards in telecommunications closets shall be 4' x 8' x 3/4" AC plywood, painted all sides with two coats of fire-retardant white paint, and mounted to the wall in the vertical orientation with "A" side facing into room.
- B. Equipment racks shall be black, 7' tall, 19" wide, conforming to EIA standards, complete with Panduit FMPVS45, or equal, vertical wire management, and Panduit WMP1, or equal, horizontal wire management. Secure rack to floor and wall with angle brackets and black ladder rack of PFT model PFT-LR1012J, or equal.
- C. Terminal blocks for voice backbone and horizontal voice station cables shall be Category 5E, type 110 wire termination units consisting of insulation displacement connectors mounted in plastic blocks, frames or housings. Blocks shall contain cable management hardware. Blocks shall be 19" rack mounted as indicated on the plans. Terminal blocks shall be Panduit "Pan-Punch" series or approved equal, model P110B100R4WJ, with P110CB4 connecting blocks for station cables, and P110CB5 connecting blocks for riser cables.

- D. Patch panels for termination of horizontal data station cable shall be 19" rack mounted, Category 6, consisting of front access 8-pin modular jacks in a jack-to-jack configuration. Patch panels shall include cable management hardware, and shall be Panduit "Mini-Com" CP48BL, or approved equal.
- E. Fiber optic rack mounted enclosures shall be 48 port, Panduit model FMD48 with slide out drawers, and shall be used for terminating cables with 24 strands or less. SC bulkheads shall be utilized in all enclosures, and shall be Panduit model FAP6WDSC, or equal.
- F. Optical fiber cable connectors shall be 3M SC Hotmelt 6300 series or equal. Connector will be of premixed epoxy by manufacturer. No crimp only or Anaerobic connectors will be allowed.
- G. All racks in the telecommunications closets shall be provided with an APC "Smart-UPS 1400 RM 1U XL", or equal, with the following:
 - 1. Output power capacity of 1400VA at 120VAC
 - 2. Waveform type – Sinewave
 - 3. Transfer time of 2ms typical
 - 4. Nominal input voltage of 120VAC
 - 5. Input frequency of 50/60 Hz +/- 3 Hz (auto sensing)
 - 6. Batteries shall be maintenance free sealed lead acid with suspended electrolyte and leakproof with 60 minutes at half rated capacity.
- H. Telecommunications outlet faceplates shall be as manufactured by Panduit or approved equal, and shall be of the same material and finish as specified for electrical device coverplates under Section 16140, Wiring Devices. Faceplates shall contain the indicated quantity of eight-pin modular jacks. Jacks for data shall be blue in color, and rated as Category 6. Jacks for voice shall be ivory, and rated Category 5E. Provide blank inserts for spare ports.
 - 1. Combination voice/data locations shall have a four-position faceplate with two jacks installed. The top (or left) jack shall be "voice." The bottom (or right) position shall be "data." The two center ports shall be spare.
 - 2. Voice only, or data only, locations shall have a four-position faceplate with a single eight-pin modular jack in the top (or left) position. The other three ports shall be spare.

2.4 GROUNDING

- A. Telecommunications grounding busbars shall be a solid copper bar 1/4 inch thick, 2 inches wide, and 24 inches long, drilled and tapped, and fitted with provisions for connecting compression fittings of the quantity and size required for the installation. The ground bus shall be mounted to the plywood backboard or wall surface at 6 inches above the floor, oriented horizontally, and attached using 1-inch insulated stand-offs.

- B. The telecommunications grounding system shall use #6 AWG insulated copper conductor between each busbar within a closet, and to the nearest accessible point of the telecommunications grounding system. The telecommunications grounding system shall be bonded to the electrical grounding electrode system with with #6 AWG bare copper conductor.

PART 3 – EXECUTION

3.1 TELECOMMUNICATIONS SPACES

- A. Provide equipment rooms and telecommunications closets as indicated on the plans. Layout of pathways, cross-connect fields, equipment racks, grounding busbars and power receptacles on the plans are diagrammatic in nature. The telecommunications system installer shall arrange the spaces to comply with TIA/EIA standards and requirements of the project. Reserve any spaces identified on the plans for Owner's active equipment, and coordinate with the Owner prior to rearranging layout.
- B. All optical fiber cables shall be installed in tube cable from end to end, without splices.
- C. All cables in telecommunications closets shall be neatly dressed down and terminated with wire management devices for cable routing.
- D. Patch cords shall be supplied by the Contractor.

3.2 PATHWAYS

- A. Provide cable tray, conduits and innerduct where indicated on plans. Provide pathways above accessible ceilings with J-hooks where cable tray or conduit is not used. All conduit, cable tray and J-hook pathways shall be routed parallel and perpendicular to building orientation. Diagonal runs will not be permitted.
- B. Install cable tray with clearance above for cable placement, and space below for removal of ceiling tiles. Support from structure with threaded rod at intervals as recommended by the manufacturer for the load rating of the cable tray.
- C. Provide continuous metallic conduit to enclose backbone cable from closet to closet, unless cable tray is provided for some or all of the route. Where cable tray is used, metallic conduit shall be provided for any portions of the backbone cable not installed in the cable tray. The conduit shall be securely clamped to the cable tray with a grounding clamp, or a grounding jumper shall be installed between the conduit and the cable tray.
- D. Provide continuous metallic conduit to enclose horizontal cable from outlet backbox to accessible ceiling space, and above hard ceilings. Route cable through cable tray where available. J-hooks may be used above accessible ceiling space, at intervals not to exceed 5 feet. No cable shall be permitted to rest on structural elements, ceiling grids or other building components. Where metallic conduit is extended to cable tray, the conduit shall be securely clamped to the cable tray with a grounding clamp, or a grounding jumper shall be installed between the conduit and the cable tray.

- E. Provide conduit fitting with insulated throat at each conduit end.
- F. Where indicated on plans, conduit shall be provided with innerduct, as manufactured by ENDOCOR, or equal, with pull strings. Quantity and size shall be as shown on the plans. Multiple innerducts in one conduit shall be multi-colored.
- G. Provide pull cord in each conduit and/or innerduct, whether containing cables or spare.

3.3 CABLES

- A. Install all cables per ANSI/TIA/EIA-568-A, and manufacturer's installation and termination instructions. Provide cable management hardware and riser supports as required. Do not exceed allowable pulling tension.

3.4 CONNECTION HARDWARE

- A. Terminate all installed cable. Terminate to rack mounted type 110 terminal blocks for voice cables, patch panels for data cables, and fiber shelves for fiber optic cable as indicated on the plans.

3.5 GROUNDING

- A. Provide grounding and bonding per ANSI/TIA/EIA 607. Provide a minimum of one telecommunications ground busbar in each space or closet, bonded together and to the building electric service grounding electrode system with 6 AWG copper.

3.6 ADMINISTRATION

- A. Implement a component identification and labeling scheme as defined by the Owner, in compliance with ANSI/TIA/EIA 606. Label each cable and pathway end. Provide labeling and color coding of termination and cross-connect fields.
- B. Cables shall be marked as follows:
 - 1. Termination points inside the telecommunications closet shall be marked with location of the opposite end of the cable, either station outlet location, or in the case of backbone cable, the location of the other telecommunications closet, and the position of the termination within the closet.
 - 2. Termination points outside the telecommunications closets shall be labeled with the location of the telecommunications closet of origin, and the position of the termination within the closet.
 - 3. Cables shall be Labeled with Shrink Tubing before termination
 - a. Tubing will be of heat shrink type
 - b. Shrink tubing will be type printed only
 - c. Locations designations shall be coordinated with the Owner at the time of installation.

- C. Contractor shall supply a list of all cable installed, by designation, along with the name of the installation supervisor onsite during installation and during termination.

3.7 TESTING

- A. Comply with Section 16955.
- B. Provide testing of each installed cable link per ANSI/TIA/EIA-568-A, and TIA/EIA-67.
- C. All testing results will show cable label, termination location and position within the telecommunications closet, and fiber strand or copper pair identification.
- D. Test copper Category 5E cable to 350 MHz, and Category 6 cable to 500 MHz.
- E. Testing of all installed Multi-Mode Fiber Optics shall conform to the following
 1. ANSI/EIA/TIA-526-14 Optical Power Loss Measurements Of Installed Multi-Mode Fiber Cable Plant.
 2. Multi-mode cables shall be tested at $850\pm 30\text{nm}$ & $1300\pm 20\text{nm}$ wavelengths.
 3. Test jumpers must be of the same fiber core size and type as the cable system
 4. Power meter and light source must be set to same wavelength
 5. Vendor shall provide proper documentation on power meter and light source to be used, including evidence of certified calibration.
 6. Attenuation Acceptance Values- Calculation of Attenuation will be as follows
 - a. Cable Attenuation - Manufacturers optical characteristics for Cable Attenuation Coefficient (db/Km) at wavelength x Length
 - b. Connector Attenuation – Optical characteristics Connector loss x # of connectors
 - c. Link Attenuation = Cable Attenuation + Connector Attenuation
 - d. Final Acceptance will be based on a tolerance of no more than +1db or better of final Link Attenuation.
 7. All power shoots must be documented and printed out for Customer. Each power shoot documented must coincide with specific strand of fiber as labeled. A failure of any strand will result in Contractor determining the cause of failure and, at no expense to Owner, correcting failure until all fiber strands pass.

END OF SECTION

SECTION 17010

INSTRUMENTATION GENERAL CONDITIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section covers items common to sections of Division 17 Process Integration. This section supplements the requirements of Division 1. Division 1 shall be used to clarify any anomalies associated with sections of Division 17.
- B. The Contractor shall take full responsibility for and shall coordinate the work of Division 11, Division 13, Division 15 and Division 16 to guarantee a complete and finished installation of the electrical and instrumentation and control systems. The Division 17 drawings and specifications are to be read together with drawings and specifications of all other Divisions and specifically Division 16. Additional information necessary to complete the work is included in other sections of the drawings and specifications.

1.2 RELATED SECTIONS

- A. 17015, I&C Scope of work
- B. 17800, Acceptance Testing and Calibration
- C. 17810, Commissioning and Start-up

1.3 REFERENCES

- A. Codes and Standards: this Division of Specifications contains references to the following documents. They are a part of this section as specified and modified. In case of conflict between the requirements of this Division and those of the listed documents, the requirements of this section shall prevail.
 - 1. NEC-08, 2008 National Electrical Code
 - 2. ASTM B68-86, Seamless Copper Tube
 - 3. ASTM D883-89, Terms Relating to Plastics
 - 4. IEC 61508, Functional Safety of Electrical Safety-Related Systems
 - 5. ISA RP7.1-56, Pneumatic Control Circuit Pressure Test
 - 6. ISA S5.4-76, Instrument Loop Diagrams
 - 7. ISA S51.1-79, Process Instrumentation Terminology
 - 8. ISA-S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
 - 9. ISA S20, Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves

10. ISA RP12.6-87, Installation of Intrinsically Safe Systems for Hazardous (Classified) Locations
11. NEMA 250-2008, Enclosures for Industrial Controls and Systems
12. NEMA ICS 1-88, General Standards for Industrial Control and Systems
13. NEMA ICS 2-88, Industrial Control Devices, Controllers, and Assemblies
14. NEMA 70E, Test Methods for Electrical Wires and Cables
15. SAMA PMC 17-10-63, Bushings and Wells for Temperature Sensing Elements
16. UL 1012-89, Power Supplies
17. UL 508, Standards for Industrial Control Equipment
18. Weik, Martin H., Communications Standard Dictionary, Van Nostrand Reinhold Co., 1983.
19. ANSI/EIA/TIA568A, Commercial building Telecommunications wiring standard and all the Telecommunications Bulletin Boards (TSBs) and Addenda issued by the above standard body at the time of bid.
20. ANSI/EIA/TIA-568.B.2.1 Commercial Building Telecommunications Cabling Standard Part 2 (Including latest issue of TSB36 SSTB40).
21. Building Industry Consulting International (BICSI) TDMM Manual 10TH edition.
22. Building Industry Consulting International (BICSI) Network and LAN Design Manual 4th edition.

B. Instrumentation and Control Qualifications

1. The Contractor responsible for Instrumentation & Controls work shall be trained and conversant with control integration and instrumentation required for this project. The Contractors shall attach a copy of the certifications and proof of their belonging with a certified installer program from the manufacturer along with their submissions. The installing / integrator Contractor shall have at least five years experience in the PLC – controls industry and at least five similar installation projects in South-East Michigan with the system proposed for the project. Please refer to Section 17015 for system integrator requirements.
2. The Contractor shall provide fully qualified journeyman instrumentation and electrical personnel capable of performing the requirements of this work. The work identified in this Contract also includes installation; testing, configuring, verification and commissioning of DeviceNet and Ethernet based components of electrical and instrumentation and control systems. The qualifications of the instrumentation personnel shall include adequate and appropriate training in communications technology.
3. The Contractor shall provide evidence of suitability to complete the scope of work under this contract, e.g., similar completed projects, key project personnel resumes, certificate of recognition at the request of Engineer.

1.4 GLOSSARY OF TERMS

A. An explanation of definitions used throughout Division 17 are as follows:

AI/AO	Analog Input / Output
CDACS	Computer and Data Acquisition Control System; see SCADA
DI/DO	Digital Input / Output
FAT	Factory Acceptance Testing
EDS	Electronic Data Sheet
EIA	Electronic Industries Association
EMI	Electromagnetic Interference
GUI	Graphical User Interface
HMI	Human Machine Interface – an industrial computer panel or operator interface terminal usually installed outside of a control area, which allows viewing of various process area real-time graphics, viewing alarms, changing of process parameters and modes and other operator control actions. The functionality of MI is independent of the SCADA computer (servers / clients).
I/O	Input / Output Signals
ILD	Instrument Loop Diagram
ISA	International Society of Automation
LAN	Local Area Network
MCC	Motor Control Center
MTBF	Mean Time Between Failures
MOV	Motor Operated Valve
OEM	Original Equipment Manufacturer
OIT	Operator Interface Terminal
OPC	OLE for Process Control (communication interface driver)
PC	Personal Computer
PCS	Plant Control System – all automatic process control components including SCADA / PLC, standalone controllers, Operator Interface Terminal, etc. Same as SCADA.
PICS	Process Instrumentation and Control System

PID	Proportional, Integral, Derivative Process Control Actions
PLC	Programmable Logic Controller
RAM	Random Access Memory
RFI	Radio Frequency Interference
SAT	Site Acceptance Testing
SCADA	Supervisory Control and Data Acquisition (also referred to in this context as PCS). A SCADA system includes controllers, processors, networks, SCADA computers, computer software user interface (SCADA software), communication equipment and communication protocol. A SCADA system monitors the entire plant process in real time.
UL	US Underwriters Laboratory
UPS	Uninterruptible Power Supply
WAN	Wide Area Network
WTP	Water Treatment Plant

- B. FIELD WIRING: Shall mean all labor and material necessary to connect all instrumentation and control devices and equipment, both discrete and analog, regardless of voltage and current, and all associated power supply wiring and shall also include all interconnecting cables between portions of the system.
- C. COMMUNICATION WIRING: Shall mean all work and material required for connection of control data communications including but not limited to Ethernet, BACNet, DeviceNet and Modbus communications.
- D. Interpret specialized terms not explicitly defined herein in accordance with ISA S51.1, NEMA ICS 1, ANSI/IEEE Std 100, and The Communications Standard Dictionary, by Martin H. Weik.

1.5 REQUIREMENTS OF WORK

- A. The Contractor shall be ultimately responsible and shall provide for the supply, installation, certification, adjustment, tuning and start-up and commissioning of a complete, coordinated system that shall reliably perform the intended functions.
- B. The Work includes all hardware, labor and services necessary to provide fully functional, coordinated control system for the entire Barton and South Industrial Pump Stations Electrical Improvements. Supply all items and accessories specified by the Contract Drawings or the specification in the quality and quantity required. Perform all operations as designated by the specification according to the methods prescribed, complete with all necessary labor and incidentals.

- C. Codes, Rules, Permits & Fees.
1. Comply with all laws, ordinances, rules, regulations, codes and orders of all authorities having jurisdiction relating to this work.
 2. Comply with all rules of the Electrical Safety Act of the State, National Electrical Code, US Underwriters Laboratories and applicable Building Codes, whether specifically shown on drawings or not, relating to supply of products and installation quality.
- D. Refer to Section 17015 for basic of the scope of instrumentation and control work under this contract. Refer to all other drawings and specifications for the complete scope of the Instrumentation and Controls work.
- E. Where packaged, stand-alone control systems are supplied under other Divisions of this Contract, coordinate and ensure Submittal Drawings, Motor Control Schematics, Instrument Specification Sheets (ISS), and Control Wiring Drawings are provided in accordance with the requirements of this section and in accordance with the Division 17 Drawings.
- F. Where modifications are made to packaged systems, stand-alone control systems, or other Contractor equipment supplied under other Divisions of this Contract, and the modifications are due to vendor or Contractor changes to the systems in question, the systems may be considered acceptable provided:
1. The proposed system and/or its modifications satisfy the intent of the specifications.
 2. The changes or modifications combined for all aspects of work by all trades do not result in a cost addition to the Contract
 3. Approved by the Engineer.
- G. Where packaged, stand-alone equipment with control systems are supplied by other Divisions of this Contract, provide all necessary labor, material and cabling to install and connect the equipment to the required remote monitoring and/or control functions. Coordinate and provide all supplies to complete end-to-end commissioning of all required remote monitoring and/or control functions. Ensure the correct functionality of any equipment supplied under other Divisions.
- H. The contract drawings for Division 17 detail the wiring requirements, cables, terminations, and Plant Control System (PCS) interface requirements for equipment and control systems contained within packaged systems supplied under other Divisions of this Contract or pre-purchased. These drawings have been produced to accurately show the control intent for the packaged system. If the packaged system provided differs from that shown on the drawings, or if modified terminations, cabling or interfaces are required to properly integrate the actual equipment to the process, electrical distribution, or PCS, the Contractor is to provide cables, wiring, and terminations to satisfy the general intent as per the drawings, at no additional cost to the Contract.
- I. The Contractor's responsibility also includes receiving, uncrating, examining for shortages or damage, assembling, field fitting, installing, mounting, wiring and testing of vendor supplied component subsystems.
- J. Subsystems of the instrumentation and control system will generally include the following:
1. Primary elements and transmitters;

2. Final control elements;
 3. Instrumentation and control field devices;
 4. Instrumentation and associated power cabling;
 5. Instrumentation power supplies;
 6. Communication wiring;
 7. Conduit and cable tray;
 8. Instrumentation and control junction boxes and marshalling panel;
 9. Plant Control System Hardware;
 10. Instrumentation and control local control panels with the associated equipment.
- K. Plant Control System (PCS) is the overall plant computer control. Refer to Control System Architecture drawing I-600. The PCS includes but is not limited to:
1. An existing SCADA Server located in the SCADA server cabinet in the main control room.
 2. One Panel View Plus (SCADA Client/RSView) located in the Barton Drive Pump Station.
 3. One Panel View Plus (SCADA Client/RSView) located in the South Industrial Pump Station.
 4. PCS Software.
 5. Ethernet Switches as indicated on the Control System Architecture Drawing.
 6. Equipment cabinets and racks as detailed in drawings.
 7. One main PLC control panel with power supplies, CPU and I/O panel racks as detailed on drawings:
 - a. PLC-110 (Barton Pump Station)
 - b. PLC-120 (Industrial Pump Station)
 8. Various Local Control Panels (LCP) equipment as detailed on drawings.
 9. Various Vendor supplied Control Panels (VCP) and instrumentation.
 10. Miscellaneous Controls and Instrumentation.
 11. HVAC Control Interface with Mechanical Equipment.
 12. Integration of communications for PLC-110 back to the plant via an existing Ethernet radio system.

13. Integration of communication of PLC-120 back to the plant via an existing fiber optic network.
- L. All software, field devices, wiring and local control panels and system integration work not specifically defined as supplied by others shall be provided under this Contract.
- M. Compliance:
1. Failure to comply with the Drawings and Specifications shall be cause for rejection of the work and the Contractor shall be required to make all required changes to comply with the drawings and specifications at no additional cost to the Owner or their agents and representatives.
 2. Where a conflict exists between any applicable code, regulation, directives, standard or manufacturers recommended practice for any item and what is shown on drawings or specified, seek clarification from the Engineer prior to submitting Bid or allow for the most expensive alternative.
- N. Where packaged, stand-alone control systems are supplied under other divisions of this specification, provide cabling to connect to the required remote monitoring and/or control functions. Install and wire equipment and provide end-to-end commissioning of all required remote monitoring and/or control functions. Ensure the correct functionality of any equipment supplied under other divisions of this specification. Integrator shall provide full system integration into the main plant SCADA system.
- O. Documentation provided by the Contractor shall meet overall requirements of Division 1 as well as the specific requirements detailed in each Section.
- P. Documentation provided to the Contractor by the Engineer includes the following:
1. P&ID's – depict the general intent of the control systems and are to be used as the governing document for the scope of work.
 2. Control System Architecture Drawing(s) – showing connection diagram between major I&C system components, including Ethernet Fibre & Cat 6 and DeviceNet or other Ethernet networks.
 3. Instrument & Input/Output Index – a sorted index of the detailed information, database and I/O points for the devices shown on the P&ID's. The index lists the appropriate support documentation for the devices' supply and installation. The instrument index is the controlling document for the supply of materials, it is the responsibility of this contract to update and maintain during approval and construction to date, to reflect the "As Built" condition.
 4. Instrument Specification Sheets (ISS) - detail the relevant data for the supply of devices.
 5. Typical Instrument Loop Diagrams (ILDs) – showing interconnections and hook-up of devices with conventional I/Os. The Contractor is responsible to reproduce an ILD for each device and record all relevant as-built information on each sheet for submission at the completion of the work. Fill in all terminal and wiring numbers etc. from the shop drawing as they become available. Typical examples are provided in the design drawings.

6. Location Drawings – indicates in plan and/or elevation views where the instrument elements and any other control system components are physically located. These drawings are provided to assist the Contractor in locating the devices.
7. Plant control system network topology drawing.
8. Instrumentation single line diagrams, LCP schematics and general arrangement drawings.

1.6 COORDINATION

- A. Equipment provided under this Contract shall be installed by the Contractor, and placed in proper operating condition in full conformity with drawings, specifications, engineering data, instructions and recommendations of the equipment manufacturer unless exceptions are noted by the Engineer.
- B. The Contractor shall verify that each component of the system is compatible with all other parts of the system; that all piping, connectors, wiring, and service conditions are appropriate; and that all devices necessary for a properly functioning system have been provided. Where specific hardware, materials or work is required to create fully compatible mounting and interconnection they shall be included in the Work without additional cost.
- C. Where two or more units of the same class of equipment are required, they shall be the product of a single manufacturer; however, all the component parts of the system need not be the products of one manufacturer.
- D. Approximate instrument locations are indicated on the Drawings. Exact instrument locations shall be coordinated with installed piping and equipment arrangements to provide adequate instrument access. In addition proposed location shall be sign-off with the Owner personnel and the Engineer prior to install.

1.7 DOCUMENTATION

- A. Contract Drawings and Specifications
 1. Refer to General Conditions.
 2. Supply and install all items and accessories specified by the drawings or the specification in the quality and quantity required. Perform all operations as designated by the specification according to the methods prescribed, complete with all necessary labor and incidentals.
 3. Treat any item or subject omitted from this division's specifications or drawings, but which is mentioned or specified in other divisions' specifications or drawings and pertains to the instrumentation and control system, as being integral to the overall system. Provide such specified items or subjects.
 4. Provide all minor items and work not shown or specified but which are reasonably necessary to complete the work.
 5. If discrepancies or omissions in the drawings or specifications are found, or if intent or meaning is not clear, consult the Engineer for clarification before submitting tender. If a ruling has not been requested, the Contractor shall allow in the tendered price for more expensive alternative.

6. The responsibility to determine which division provides various products and work rests with the Contractor. Additional compensation will not be considered because of differences in interpretation of specifications.

B. Submittals

1. Submittals shall comply with the requirements of Specification Section 01330, Submittal Procedures. The list of equipment for which shop drawings are to be provided includes, but is not limited to:
 - a. Control Panels – Engineered shop drawings
 - b. Field Panels & Remote I/O Panels - Engineered shop drawings
 - c. Cable Junction Boxes – Engineered shop drawings
 - d. Instrumentation Equipment – including instrument specification sheet for each device as per Section 17701
 - e. PLC Equipment – including all hardware and associated control panel assemblies details.
 - f. Terminal blocks
 - g. Communications, control & power cables
 - h. Relays
 - i. Terminal and Wire Marking System
 - j. All Ethernet Network Equipment
 - k. All Device Net and Fieldbus Network Equipment
 - l. Cat 6 and Fiber Cables and Patch Cords
 - m. Equipment Server cabinets and Racks

C. Operations and Maintenance Manuals and As-Built Drawings

1. Submit O&M Manuals in accordance with the requirements of Section 01781, Operations and Maintenance Data.
2. The Contractor shall submit an updated instrument index list with accurate loop drawings numbers for each instrument which has the associated loop drawing.

D. Standards of Workmanship

1. Execute all work in a manner which will result in the completed installation presenting an acceptable appearance to a level of quality defined in the general conditions of this specification.
2. Unless otherwise specified or shown, install products in accordance with the recommendations and ratings of the product manufacturers.

3. Remove advertising labels from all products installed that have such labels attached. Identification or UL labels are not to be removed.
4. Remove dirt, rubbish, grease, etc. resulting from work performed under this section of the Contract from all surfaces.

1.9 EQUIPMENT

A. Receiving, Storing, and Protection of Components during Construction:

1. Examine each component upon delivery to site. Report all damage noted to the Engineer prior to accepting or rejecting delivery. All instrumentation primary elements, control components, panels, etc. shall be placed in a secure, dry, heated storage building. Maintain the space temperature above 60° F and the space relative humidity below eighty (80%) percent.
2. Perform a preliminary examination upon delivery to ensure that all instrumentation and control components supplied for this project under this section of the specification comply with the requirements stated in the instrument specification sheets and drawings.
3. Itemize all non-conformities noted above and forward them to the Engineer. Any delays in construction resulting from the delivery to site of non-conforming instrumentation and control components to be the responsibility of the Contractor.
4. Precautions:
 - a. Do not install primary elements or other sensitive equipment until construction is sufficiently completed to provide an "operating condition" environment. Notify the Engineer prior to installing any equipment of this type.
 - b. The physical dimensions of the components are such that they can be installed without interference with the building structure or other equipment, and that, after installation, there are sufficient clearances on all sides for maintenance, servicing and operation of the equipment
 - c. Ensure that covers where required are properly installed on all equipment. Provide all covers, padding, guards, etc. as required to guard any equipment against damage.
5. Return all damaged equipment to the factory for total corrective repairs.

1.10 SITE

A. Classification of Plant Areas

1. Refer to Division 16.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The instrumentation and equipment shall be supplied in accordance with the individual instrument specifications and the Instrument Data Sheets provided in Section 17701, Instrument Data Sheets, Appendix A.

2.2 TAGGING

- A. Each instrument and controlled device provided under this Section, whether specifically identified on Instrument Data Sheets or not, shall be provided with a permanent identification tag which agrees with the designation assigned by the Owner. Where primary elements and transmitters are physically separated, an identification tag for both devices shall be provided. All field-mounted elements and transmitters shall have stamped stainless steel identification tags. Panel, sub-panel, and rack-mounted devices shall have laminated phenolic identification tags securely fastened to the device.
- B. Identification tags shall contain tag numbers as shown on the Instrument Data Sheets provided in Section 17701 - Instrument Data Sheets or as specifically assigned by the Owner during the Project.
- C. The Contractor shall provide tags for Owner supplied instruments unless otherwise noted in Section 17701 - Instrument Data Sheets.
- D. The Contractor shall submit to the Engineer and receive approval for the wording of all tags prior to fabrication.
- E. Identify all wires where they terminate at the marshalling panels, fibre optic patch panels, local control panels, junction boxes, and field devices with a heat shrink sleeve with machine printed labelling. All Fibre, Cat6 Ethernet, DeviceNet, Modbus cables, analog cables and wires, control cables and wires for digital inputs/outputs, 120VAC power cables and wires for local control panels and instruments shall be identified at both ends.
 - 1. Identify all wiring with permanent indelible numbered markings at each end of each cable and conductor with approved type wire markers. Submit proposed cable numbering for review by the Engineer and Owner before commencing the installation.
 - 2. The cable and wire numbering system shall be as per Section 16140. Color coding to NEC current edition unless otherwise indicated.
- F. Clearly mark all panels, pull boxes, junction boxes, etc. to indicate the nature service.
- G. Provide neatly typed circuit directories for panel power distribution systems to indicate loops or devices powered by the circuit and the fuse size.
- H. Identify all exposed control conduits at all pull box locations, where the conduits enter or leave a location, and 30 feet on center throughout the location. This shall apply to conduits above removable ceilings.

PART 3 - EXECUTION

3.1 SITE EXAMINATION

- A. Refer to the requirements of Division 1.

3.2 COORDINATION WITH OTHER DIVISIONS

- A. Examine the drawings and specifications of all divisions associated with this work and familiarize. Before commencing work, obtain a ruling from the Engineer on any conflicting issues between divisions.
- B. Provide work plan and identify methodologies for equipment installation with provision made for the most expeditious means to complete the work.
- C. Structural members shall not be cut without prior approval of the Engineer.

3.3 PRODUCT HANDLING

- A. Use all means necessary to protect the installation and to protect products and installed work of all other trades.
- B. Any damage to the products and/or installed work shall be repaired or replaced by the Contractor at no additional cost to the owner, and to the approval of the Engineer.

3.4 SEPARATION OF SERVICES

- A. Maintain separation between the electrical wiring system, building piping, ductwork and the instrumentation cables so that each system is isolated (except at approved connections to such systems) to prevent galvanic corrosion. In particular, contact between dissimilar metals, such as copper and aluminum, in damp or wet locations is unacceptable.
- B. Classifications of Circuits:
 - 1. The circuit categorization shall of first priority follow NEC code with respect to separation for electrical safety and the following shall apply with respect to electro-magnetic compatibility and for determining necessary separations:

Very Noisy	High voltage circuits and their associated grounding
	High current (>200A) LV circuits
	Harmonic-rich LV circuits
	DC circuits: un-suppressed or above 50V
Noisy	Low current class 2 circuits Medium power pulsed or radio frequency circuits
Indifferent	ELV digital status circuits Intrinsically safe circuits Telecommunications circuits

	Fire alarm and emergency lighting circuits (note that some fire alarm circuits may fall into the category of signal circuits)
	Any other emergency, shutdown, or high integrity circuit (e.g., toxic gas alarm)
Sensitive	Analog signal circuits
	Data communication circuits
Very Sensitive	Low level voltage and current signals (e.g. from instrument sensors)

2. Separation of Circuits

- a. This section relates to running cables carrying differing types of circuits in close proximity to one another and to other services. Sensitive circuits and very sensitive circuits shall normally be run in individually twisted pair shielded cable.
- b. For cables sharing the same support / containment system, the following shall provide guidance to minimize extraneous interference.

3. Segregation details:

Segregation between circuits	Very Noisy	Noisy	Indifferent	Sensitive	Very Sensitive
Very Noisy	Thermal grouping as per NEC code	6 inches	12 inches	12 inches	12 inches
Noisy	6 inches	Thermal grouping as per NEC code	6 inches	6 inches	6 inches
Indifferent	12 inches	6 inches	Separation of circuit types	4 inches	4 inches
Sensitive	6 inches	6 inches	4 inches	Touching	2 inches
Very Sensitive	12 inches	6 inches	4 inches	2 inches	Touching

- 4. Do not support wiring from pipes, ductwork, etc. Hangers for suspended ceilings may be used for the support of wiring only when approval is obtained from the Engineer and the ceiling installer, and only if approved clips or hangers are used.

3.5 WIRE AND CABLE

- A. Refer to Section 16114 and 16122.

3.6 EQUIPMENT CONNECTIONS

- A. Prior to the connection of signal wiring to process control and instrumentation devices, check the device voltage rating and polarity for compatibility with the corresponding loop and/or schematic diagram. Where device and circuit characteristics are found to be incompatible, the connections are not to be made. Report the condition immediately to the Engineer.
- B. All control wiring diagrams illustrate typical control circuits applicable to the type of equipment specified. Control circuits may vary with different manufacturer's equipment. Verify all control circuits with the suppliers of the equipment and make any corrections to the control wiring diagrams that may be required.
- C. Provide power disconnect terminals in the marshalling panels for all devices or control system input/outputs sourced from the panel.
- D. Provide a disconnecting means in the cable connecting each ultrasonic transponder to the transmitter. This disconnect shall consist of a terminal strip in a local WP junction box with approximately 10 feet of cable from the transponder.

3.7 WIRING TO EQUIPMENT SUPPLIED BY OTHERS

- A. Equipment supplied by the Owner or by other Divisions, that have external or field mount control devices, is to be installed, wired and commissioned by this Division.

3.8 ACCESS PANELS

- A. Provide access panels where instrumentation and control system junction boxes are concealed. Panels to be of adequate size for servicing of the concealed junction box and complete with necessary frames and hinged doors held closed with captive fasteners. The type and size of panels are to be coordinated with the Engineer.
- B. In removable ceiling areas provide markers on ceiling tile to locate equipment requiring access. Use a 1-inch dia. blue circle painted on the access panel to indicate that it is for instrumentation and control system access.

3.9 SEALING OF WALL AND FLOOR OPENINGS

- A. Seal all conduit and cable entries passing through outside walls of buildings, through partition walls separating electrical rooms from other areas, through fire separations, and through floors above grade.
- B. Seal openings after all wiring entries have been completed.
- C. Sealing material shall be fire resistant and not contain any compounds which will chemically affect the wiring jacket or insulating material. Cable penetrations through fire separations, if required, are to be sealed. Acceptable methods are Canstrut "Fire Stop", Electrovert "Multi-Cable Transit" or Dow Corning RTV Silicone Foam.
- D. Cable transit blocks (with knock out blocks) are also acceptable as long as they have capability to be sealed.

3.10 SLEEVES

- A. Provide sleeves of galvanized steel pipe with machine cut ends of ample size to accommodate conduits passing through walls, partitions, ceilings, floors, etc.
- B. For wall, partitions and ceilings the sleeve ends are to be flush with the finish on both sides. For floors the ends shall extend 4-inches above finished floor level.
- C. Fill the space between the sleeve and the conduit with fire stop material and caulked around the top and bottom with approved permanently resilient, non-flammable and weatherproof silicone base compound. Ensure that the seal is compatible with the floor and ceiling finishes.
- D. Locate the sleeves and position exactly prior to construction of the walls and floors.
- E. Failure to comply with the above requirements shall be remedied at the Contractor's expense.

3.11 INSTRUMENT MOUNTING STANDS

- A. All instrumentation and equipment furnished under this Section shall be provided with all required mounting hardware to mount the device according to the mounting requirements indicated in the individual device specification or the Instrument Data Sheet.
- B. Supply and install instrumentation mounting stands as required. Stands are to be either floor or wall mounted. The mounting stands are to be fabricated from aluminum or stainless steel.
- C. Supply and install protective drip shield for any exterior stand-mounted instrumentation equipment. The drip shield is to extend 2-inches at the top and sides from the front face of the equipment. The drip shield is to be fabricated from aluminum.

3.12 CONNECTIONS TO MECHANICAL, ELECTRICAL AND EXISTING SYSTEMS

- A. Refer to Divisions 11, 13, 15 and 16 for the required tie-in procedures.

3.13 CALIBRATION AND CONFIGURATION

- A. Refer to Section 17800, Acceptance Testing and Calibration, for instrument calibration requirements and procedures.

3.14 COMMISSIONING

- A. Refer to the requirements of Section 01810 and Section 17810 for commissioning requirements.

3.15 PROPER MOUNTING

- A. Follow the appropriate instrument installation standard details and manufacturers recommendations for installing local and field instrumentation and electrical devices.
- B. Do not install instrumentation on any support structures which could be removed e.g., process piping, plumbing, handrails. In general instruments shall only be installed on their own instrument support.

3.16 TRAINING

- A. Provide training and training literature, described in Section 01820, Demonstration and as described specifically for Instrumentation and Controls under Section 17820, Personnel Training, in the proper operation and maintenance of all control devices, control valves, and ancillary instrumentation described under this section of the specification.

END OF SECTION

SECTION 17015

I&C SCOPE OF WORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Plant Control System Description
 - 1. The system to be installed under this Contract is summarized on the Plant Control System (PCS) Architecture Schematic drawings.
 - 2. The equipment installed by the Contractor will include but not be limited to:
 - a. Local Control Panels
 - b. I/O Control Panels
 - c. Fiber Optic & Cat6 Ethernet wiring and communication equipment including: Industrial Ethernet, Modbus TCP and Ethernet / IP.
 - d. DeviceNet, Fieldbus and Modbus wiring and communication equipment.
 - e. Instrumentation associated field wiring and power supply wiring.
 - f. Provide necessary license for SCADA and HMI software.
- B. Description of Process Area Control Equipment
 - 1. The P&ID drawings, Control System Architecture drawings, an instrument index in and PLC I/O list Section 17701 and typical instrument loop diagrams are included and describe most of the instrumentation signals, complete with their wiring requirements, to be connected as PCS I/O and communication ports. The Contractor shall take a detailed take-off from all drawings and specifications for an accurate list of instrumentation signals.
- C. Owner's Responsibilities Under This Contract
 - 1. Provide TCP/IP network scheme and assigned addresses.
- D. Work Under This Contract
 - 1. The Control System / Instrumentation work to be done under this Contract includes, but is not limited to, the supply of materials, labor, equipment, and permits necessary for the complete control system manufacturing, assembly, shop testing, installation, site testing and commissioning for the upgrades to both the Barton and South Industrial Pump Stations, and associated equipment.
 - 2. System Integration Qualifications:
 - a. The CONTRACTOR performing the work of Division 17 shall meet or exceed the following qualifications. Upon request by the ENGINEER and prior to award of the Contract, the CONTRACTOR shall be required to demonstrate compliance with the stated qualification requirements.

- b. Organization that has been established for a minimum of 10 years and actively involved in the business of process control and instrumentation systems integration and has adequate plant facilities, organization structure, manpower, and technical and managerial expertise to properly perform the work under and in conformance with these specifications.
 - c. Involvement in 5 (minimum) projects of similar scope and size involving the design, integration, installation, testing and commissioning of water and wastewater treatment facility process instrumentation and control systems over five (5) years.
 - d. Shall have at the time of project advertisement an experienced engineering and technical staff capable of process control system design, integration, testing, and commissioning, as well as a thorough understanding of water treatment processes.
 - e. Shall have the in-house resource of permanent personnel for the preparation of system documentation and system operation and maintenance training. All instrumentation and industrial electronic systems shall be provided under the supervision of a single systems integrator, chosen by the CONTRACTOR, which is regularly engaged in the design and installation of such systems of similar scope and complexity.
 - f. CONTRACTOR shall have personnel located within a 4 hour response time of the project. CONTRACTOR shall also provide contract information directly to involved personnel once the process systems are functional.
 - g. The organization must have a direct formal relationship with the specified hardware manufactures. This relationship at a minimum shall include certification as a Rockwell Automation System Integrator.
 - h. The following CONTRACTORS have been pre-qualified for this project: Commerce Controls, Motor City Instrumentation and Controls, UIS Group of Companies and Windemuller.
 - i. Additional system integrations for will be approved if the criteria of 17015 D.2. a-h are documented and approved with the ENGINEER or Owner.
3. The work under this Instrumentation and Control (I&C) Section of the Contract includes supply of Instruments as specified in the Instrument Index and Instrument Specification Sheets (ISS) including those supplied with packaged equipment.
4. The Contractor shall solicit the services of a suitably qualified systems integrator, as their sub-contractor to provide the following control systems engineering:
- a. Supply One HMI Industrial Touch Screen Computer with RSView (SCADA Client) located in the Barton Pump Station.
 - b. Supply One HMI Industrial Touch Screen Computer with RSView (SCADA Client) located in the South Industrial Pump Station.
 - c. Supply of all PCS software programming necessary to provide a fully functional and coordinated control system for the both Barton and South Industrial booster stations. This will include the development of all necessary ladder logic programs and HMI graphics.

- d. Workshops to develop ladder logic and HMI graphics.
 - e. Supply of all PCS software programming necessary to integrate PLC Controls and HMI graphics onto a single control system platform.
 - f. Complete Software Integration of Motor Control Centers/Switchboards power monitoring with the PCS.
 - g. Supply of Plant Control System Application Manual.
 - h. Supply all PCS related operators training.
 - i. Conduct testing of all communication interfaces.
 - j. Setup, test, and commission all communication equipment and parameters for all Ethernet, Device Network, and Ethernet IP devices.
 - k. Documented and remark Modbus tables suitable integration to the existing Intellution iFIX SCADA systems.
5. Notwithstanding the responsibilities set out above, the general contractor shall retain overall responsibility of the complete electrical and instrumentation systems.
6. The General Contractor will review contract documents to determine the complete instrumentation, electrical, and data communications network requirements, and assemble a list of contract design information for clarification by the Engineer. The Contractor will be required to produce a work schedule in a compatible format with the Master Project Schedule, and submit it to the Engineer for approval. The submission task milestones will be compliant with the milestones of the Master Project Schedule.
- E. Related Work Shall Include But Not Be Limited To:
- 1. Electrical work - specified in the Electrical Sections under Division 16, shall be considered to be a part of these Specifications for proper coordination between the Control system and the Electrical portions of the Work. The Electrical system work (Divisions 16) shall be supplied under the General Contract. The Division 17 Contractor shall be under the Division 16 responsibility for purpose of contract coordination.
 - 2. Various Process Equipments will be supplied under separate divisions. The process Equipment shall be incorporated by the Contractor into the overall process control system at the Ann Arbor WTP. The Various Process Equipment will be installed on site by other divisions, and tied into the control system by this division.

1.2 RELATED SECTIONS

- A. 17010 Instrumentation for Process Control General Provisions
- B. 17440 Control Panels – PLC
- C. 17720 Computerized SCADA System
- D. 17800 Testing and Calibration for Instrumentation

- E. 17810 Commissioning Plan
- F. 17820 Personnel Training

1.3 WORK INCLUDED

- A. The Work included is the provision and commissioning of a complete and fully functional treatment facility with associated systems and plant control system. The work shall include any equipment, material and labor not specifically noted or detailed in the specifications and drawings but which is evidently required to furnish a complete system. The work shall include but not be limited to:
 - 1. Provide all instruments shown in the specifications and drawings, unless specifically noted as supplied by others, complete with their required installation and mounting supports and hardware, sunshields, field, communication and power supply wiring to the associated control panels, calibration, setup, testing, adjusting and commissioning. The Contractor shall coordinate with the General Contractor and Process system installer and all other divisions.
 - 2. Installation of all instruments shown as supplied by others, complete with all field, communication and power wiring to the associated Area and Vendor Control Panels, required installation and mounting supports and hardware, programming, setup, adjusting fine tuning, testing and commissioning.
 - 3. Provide engineered and complete Local Control Panels (LCP) as indicated in Section 17440. All required mounting hardware is to be supplied by the Contractor.
 - 4. Install Vendor Control Panels (VCP) provided by packaged equipment suppliers, others and the Owner as indicated in Section 17440. All required mounting hardware is to be supplied by the Contractor. Provide power supply and field wiring to all associated instruments. The vendor control panels supplied by others shall include but not be limited to:
 - a. Sump Pump Control Panels.
 - b. Generator Control Panel
 - 5. Wire and setup all electric, hydraulic & pneumatic valves, gates, and damper actuators and positioners.
 - 6. Provide setup and commission DeviceNet networks. Terminate both ends of each DeviceNet bus.
 - 7. The Contractor is responsible to setup all parameters for the MCC's smart overloads and Soft Starters and to do all necessary adjustments until the plant is fully functional to the satisfaction of the engineer. Use services of a factory trained technician.
 - 8. Provide calibration for all new installed sensors.

9. Allow in the contract sufficient time to test, adjust, demonstrate and troubleshoot the complete control system including all devices and wiring. The Contractor shall have a fully qualified and available Control technician(s) to work totally independently or with the installed equipment representative until a complete control system is commissioned and works reliably and trouble free. The technician must be available and dedicated to the commissioning during all the time of the commissioning. The expected duration of commissioning is one man month.
10. Notwithstanding item 9 above, allow time in the contract to work as directed by the Owners representative to make any changes and adjustments to final installed PCS system for one month after final commissioning.
11. The Contractor shall be fully qualified and equipped to carry out the testing of all control and instrumentation equipment and systems or as an alternative, shall provide the services of a qualified manufacturer's representative to carry out testing. Certified calibration certificates are required for all calibration equipment.
12. The Contractor will assume full responsibility for protection and safekeeping of all equipment supplied.
13. Preparation for Division 17 shop drawings to be submitted to the Engineer for review and approval as directed in Division 1.
14. FAT - Factory Acceptance Tests (at manufacturer's / integrator's shop).
15. SAT - Site testing and site acceptance tests.
16. FAT and site testing will also be conducted by the Contractor to assess the quality of control system components and marshalling and local control panels.
17. Allow in the Contract for all work necessary to identify and tag wiring in process provided new packaged equipment as required to determine the correct points and connection procedures required to integrate the equipment into the new instrumentation and control systems. Where necessary, obtain and review schematic diagrams, wiring diagrams and operating and maintenance information for other divisions provided equipment to assure correct connection.
18. All seismic restraints for all I&C equipment and installations.
19. Provide as-built drawings.
20. The Contractor will make provision to participate in overall plant operations testing during plant start-up and full commissioning. They will respond to field instrumentation/data communications problems during this period and provide the necessary corrective action when required.
21. Following completion of the plant operations testing, the General Contractor to rectify any outstanding deficiencies.
22. The Contractor will also be required to provide Warranty Services Support during the maintenance period for the equipment applicable under its scope of responsibilities.
23. The Contractor will be responsible to properly identify and tag all items supplied sufficiently to prevent loss. Tagging will be of particular importance when the equipment is delivered to site. An equipment list will be made available to the Engineer following delivery to site.

1.4 WORK EXCLUDED

A. General Requirements

1. Not applicable.

B. Other Work Excluded

1. All wireways such as conduits, cable trays etc, provided by Division 16.
2. Power supply to all Local and Vendor Control Panels (Provided by Division 16).
3. Provision of all valves, gates, dampers complete with associated actuators – by Process/Mechanical (Division 11).

PART 2 - PRODUCTS

N/A

PART 3 - EXECUTION

N/A

END OF SECTION

SECTION 17114

INSTRUMENTATION AND CONTROL CABLES

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Materials and installation of wires and cables.

1.2 RELATED SECTIONS

- A. Section 16122 - Wire and Cable - 0 - 1000 V.
- B. Section 16145 – Instrumentation Cable

1.3 REFERENCES

- A. Refer to Section 17010.

1.4 SUBMITTALS

- A. Submit product data in accordance with Section 01330 - Submittal Procedures.

PART 2 - PRODUCTS

2.1 TWISTED PAIR SHIELDED CABLES (TPSH)

- A. TPSH shall be constructed as follows:
 - 1. Two (2) copper conductors, stranded, minimum #18 AWG, PVC insulated, twisted in nominal intervals of 2 inches.
 - 2. Insulated for 600V, 180° F.
 - 3. One hundred (100%) percent coverage aluminum foil or tape shield.
 - 4. Separate bare stranded copper drain wire, minimum #18 AWG.
 - 5. Overall flame retardant PVC jacket to NFPA
 - 6. The entire cable assembly to be suitable for pulling in conduit or laying in cable tray.
 - 7. Shaw approved type or Belden equivalent.
- B. Where multi conductor TPSH cables are called for, each pair shall be individually shielded, continuous number coded, and the cable assembly shall have an overall shield and overall flame retardant PVC jacket.

2.2 RTD AND MULTI-CONDUCTOR SHIELDED CABLE

- A. RTD cables shall be UL approved and shall be constructed as follows:
 - 1. Three (3) or more copper conductors, stranded, minimum #18 AWG.
 - 2. PVC insulated for 600V.
 - 3. One hundred (100%) percent coverage aluminum foil or tape shield.
 - 4. Separate bare stranded copper drain wire.
 - 5. Overall flame retardant PVC jacket to meet latest UL standards

2.3 CABLES

- A. As per Section 16140.
- B. Low energy 300 V control cable: stranded annealed copper conductors sized as indicated, with PVC insulation type TWH polyethylene insulation with shielding of tape coated with paramagnetic material tape coated with diamagnetic material, wire braid metalized tapes over each conductor pair and overall covering of polyethylene jackets interlocked armour of aluminum strip.

PART 3 - EXECUTION

3.1 INSTALLATION OF CONTROL CABLES

- A. Install control wiring as follows:
 - 1. In conduit systems in accordance with Section 16111.
 - 2. In underground ducts in accordance with Section 16112
 - 3. In wireways and auxiliary gutters in accordance with Section 16121.
- B. Install instrumentation cables in conduit systems or in cable trays. Use a minimum of 12 inches length of liquid tight flexible conduit to connect the field sensors to the conduit. Refer to Division 16 conduit or cable tray requirements.
- C. Where armored instrumentation cables are installed in cable trays, provide barriers in the tray to separate instrumentation cables from power cables.
- D. At each end of the run leave sufficient cable length for termination.
- E. Terminate armor with approved connector.
- F. Do not make splices in any of the instrumentation cable runs. Where splices are required, obtain approval from the Engineer prior to installing the cable.
- G. Where splices are necessary in instrumentation cables other than coaxial cables, perform such splices on terminal blocks in terminal boxes. Keep splices in instrumentation cable to a

minimum and separated physically from power circuits. Cable shields shall be terminated on insulated terminals and carried through to the extent of the cable.

- H. Where splices are made to coaxial cables, use standard coaxial cable connectors.
- I. Ground cable shields at one end only. Unless otherwise specified, ground the shields at the marshalling / local control panels.
- J. Protect all conductors against moisture during and after installation.

3.2 ANALOG SIGNALS

- A. Use TPSH cable for all low level analog signals such as 4-20 mA, 1-5 VDC, 0-10 VDC, pulse type circuits 24 VDC and under, and other signals of a similar nature.
- B. Use RTD cable for connections between RTDs and transmitters. Install control cables in conduit were indicated.

3.3 DIGITAL SIGNALS

- A. Use TPSH cable for all low level input (24V and below) and output signals to the plant control system.
- B. Use specified cable or wire and conduit for power to instruments, for 120V signals other than those mentioned above and as otherwise indicated on the drawings. Use stranded wire and cable to supply power to instruments.
- C. For discrete wiring use #14AWG THWN. Color code shall be:
 - 1. White 120VAC neutral
 - 2. Black 120VAC hot – power circuit
 - 3. Red AC Control circuits
 - 4. Blue DC Control Circuits - +24VDC
 - 5. Brown DC Control Circuits - 0V
 - 6. Red 120 VAC Discrete Inputs
 - 7. Yellow 120 VAC Discrete Outputs
 - 8. Black/White Analog Inputs & Outputs
 - 9. Orange UPS Line & Load
 - 10. Gray UPS Neutral
 - 11. Green Ground

3.4 INSTRUMENT POWER SUPPLY– 120VAC

- A. Use 2C + GND #12AWG cable unless otherwise noted.

3.5 CONDUCTOR TERMINATIONS

- A. All equipment supplied shall be equipped with terminal blocks to accept conductor connections.
- B. Instrumentation conductors, where terminated at equipment terminals other than clamping type terminal blocks, shall be equipped with Burndy-YAE-2 or STA-KON, self-insulated, locking type terminators, sized as required to fit conductors and screw terminals.
- C. Use heat shrink printable labels to identify individual terminated wires in a control cable.

3.6 TESTING

- A. Test all conductors for opens, shorts, or grounds. Resistance values shall not be less than those recommended by the cable manufacturer.

3.7 IDENTIFICATION

- A. Identify all instrumentation cables.
 - 1. Identify each conductor with wire numbers using a machine printed heat shrink wire marker.

END OF SECTION

SECTION 17120

ENCLOSURES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Equipment, products and execution must meet all requirements as detailed in Section 17010. This section covers the requirements of Instrumentation and Control Panel enclosures.
- B. The I/O and wiring marshalling panels are defined as the panels located in the station to arrange and group field wiring in proper order and allow for easier installation and troubleshooting.
- C. The local control panels are defined as the panels located in the station and where the control processors and/or associated I/O modules, and various communication modules and equipment are installed and all field wiring from the associated instruments is terminated. These panels will be connected to, but installed remotely from, the marshalling panels in a location of easy and unrestricted access for the plant operators.

1.2 RELATED SECTIONS

- A. 17010 Instrumentation for Process Control General Provisions
- B. 17440 Control Panels – PLC
- C. 16010 Electrical General Provisions

1.3 GENERAL REQUIREMENTS

- A. The enclosures must be suitable for carrying the weight of the equipment mounted inside the panel and on the doors without any distortion or warping.
- B. The enclosures shall be sized to accommodate the proper layout and mounting of equipment devices as per the drawings and specifications.
- C. The contractor shall supply all instruments and components mounted on or within panels unless otherwise noted.
- D. All free-standing enclosures must be installed on 4 inches concrete house-keeping pads.

1.4 DOCUMENTATION

- A. Refer to Section 01330, Submittal Procedures for Submittal requirements.

PART 2 - PRODUCTS

2.1 PANEL ENCLOSURES

- A. Provide NEMA Type 12 gasketed enclosures in electrical rooms and control rooms.

- B. All enclosures for mounting outside of electrical rooms and control/server rooms to be NEMA Type 4X watertight as a minimum unless otherwise specified or required to meet the electrical area classification.
- C. All local control panels with NEMA 4 rating must have ventilation louvers, an exhaust fan and thermostat. All local control panels installed outside or non air-conditioned environments shall have an integral heater complete with thermostat.
- D. All local control panels with NEMA 4X rating must have positive air pressurization.
- E. All enclosures to have a corrosion inhibitor:
 - 1. Daubrite 5 Disk VCI Emitter for enclosures < 5cu ft.
 - 2. Daubrite 10 Disk VCI Emitter for enclosures > 5 cu. ft.
- F. Unless otherwise specified, provide outside finishes on all enclosures in ANSI 61 Grey.
- G. Each enclosure must be supplied with a data pocket for storing wiring diagrams, operation manuals and other documentation inside the enclosure.
- H. Enclosures for certain equipment in corrosive atmospheres to be NEMA Type 4X approved for the classification. Stainless steel or approved equal shall be used.
- I. Enclosures for mounting field control indicator lamps and switches in unclassified areas to be approved model die cast enclosures. Allen-Bradley model 800H-xHHX7, or equal from Telemecanique or ABB modular series.
- J. Supply, fabricate, checkout, layout, document and deliver to site fully equipped and functional panels.
- K. Fabricate panels/enclosures from 11 gauge steel panels complete with necessary stiffening to form a rigid free-standing line-up. The structures must be suitable for carrying the weight of the equipment mounted inside the panel and on the doors. Provide removable top and bottom cable entry plates.
- L. Provide panels with front access only. Doors shall be key lockable and fitted with 3-point heavy duty latching assemblies. Provide a continuous piano hinge and a pneumatic hold open device on each door.
- M. Finish the interior of the enclosure with white paint. Provide a switched fluorescent light fixture and 120VAC duplex convenience receptacle inside the enclosure.
- N. Supply all components contained on or within the panels fully wired under this section of the specification.
- O. For necessary information regarding the engineering and manufacturing of the Local Control Panels, refer to Local Control Panel drawings, the applicable Instrumentation Standard Details in Section 17440, Instrument loop Diagrams in Section 17700, all applicable drawings and specifications and installation and user manuals for the selected equipment.
- P. Panel enclosures supplied as I&C local control panels and housing PLC's, Remote I/O modules HMI modules and other control equipment shall be supplied with devices to protect the equipment from damage due to supplied power failure, spikes and drops,

noise/harmonics and temporary power failure. Power for all instruments shall be from the UPS system.

- Q. The Local Control Panel drawings represent suggested control panel layout. It is the contractor's responsibility to build the Local Control Panels based on actual physical dimensions of the supplied equipment and panel components. Final layout and panel size will be determined at the shop drawing approval stage. Fuses required shall be determined based on actual instrumentation provided.

2.2 WIRING AND ACCESSORIES

- A. Provide wiring inside the panels according to the following specifications:
1. Control wiring to be a minimum of #16 AWG tinned or crimped ferrule stranded copper; insulation rated at 600 V.
 2. Wiring for power distribution shall be a minimum of #14 AWG tinned or crimped ferrule stranded copper; insulation rated at 600 V.
 3. Analog wiring to be a minimum of #18 AWG single pair copper 300V CIC white/black cable with overall foil shield and drain wire. The black wire shall be positive and white wire shall be negative. Drain wires shall be clipped in the field and terminated on individual terminal blocks in the control panel. The shield shall be grounded at only one end in the control panel grounding terminals, and cut back and insulated at the instrument end.
 4. Refer to Division 16 for cable routing requirements.
- B. Tag each wire at both ends with a heat shrink sleeve that is machine printed.
- C. Wiring systems with different voltage levels or types shall be suitably segregated within the panel, according to relevant electrical codes. As a minimum separate control wiring from analog signal and communications wiring.
- D. Run all wiring in enclosed plastic wireways such as Panduit. Size all wireways so that the total cross sectional area of the insulated wire and cable does not exceed forty (40%) percent of the cross sectional area of the wireway.
- E. Provide a minimum clearance of 2 inches between wireways and any point of wire termination.
- F. Terminate all wiring, incoming and outgoing, at terminal strips mounted inside the panels. Identify each terminal strip with a terminal strip number, defined as follows:
1. Wire identification to use the connected field device tag name with the wire's corresponding terminal number appended to it.
 2. Identify every joint and/or terminal of the above wire run with the same identifier until the wire meets another tagged device, at which point the wire identifier will change to use the new device name and terminal number.
 3. Identify spare wires by using the destination identifier, i.e., the location and terminal identifier of the opposite end of the wire are combined to form the wire tag. All spare wires must be terminated in the dedicated terminals at both ends.

4. Arrange wiring on terminal blocks such that all internal panel wiring terminates on the inboard side of the terminal block and all external wire connections are made on the outboard side.
- G. Provide a 120 VAC panel power distribution system and a 24VDC power distribution system in each panel. Provide a thermal magnetic circuit breaker on each main power circuit and a fused terminal block with blown fuse indicator for each branched circuit off the main.
- H. Provide disconnect type fused terminal blocks Phoenix Contact, Weidmuller or Wago to isolate field wiring that is powered or sourced from the panel.
- I. Provide sufficient terminals so that not more than two (2) wires are connected to the same terminal. Provide twenty (20%) percent spare terminal capacity at each terminal block assembly.
- J. Wire terminals shall be Allen-Bradley interface modules, Phoenix Contact, Weidmuller or Wago of type color coded as follows (except for interface modules):
- | | | |
|--------|---|--------------------------------------|
| Red | = | positive 24Vdc |
| Black | = | 0Vdc common and analog signal plus |
| White | = | analog signal common and VAC neutral |
| Grey | = | 120 VAC |
| Green | = | Ground |
| Yellow | = | Shield |
- K. Provide nameplates for each device on or within the panels and enclosures. Nameplates shall be black lamicaid with white lettering, a minimum of 1 inch x 3 inches in size with up to three lines of ½ inch lettering. Securely fasten nameplates in and situate them in a visible location.
- L. Every cable entering or leaving the enclosure shall be labelled with permanent marking identification subject to the review by the Engineer.

2.3 PANEL GROUNDING

- A. Provide noise free low resistance grounding connection using stranded ground wire to all equipment installed in the panel according to manufacturer's recommendations and all applicable standards and codes.
- B. Provide a ground system for the instrumentation circuits, isolated from the main power system ground to each marshaling panel.
- C. Provide 1 x 8 inch copper grounding bus mounted in each local control panel c/w grounding lugs for each panel, suitable for termination of up to #2 AWG copper grounding conductor. The grounded bus shall be bonded to the ground.
- D. Provide in each marshaling panel an isolated grounding buss bar 1/4 x 1 x 16 inches, equipped with necessary lugs for accepting two #2 AWG grounding conductors. The grounded bus shall be bonded to the ground.
- E. Firmly bond all panel mounted devices on or within the panels to ground. Provide supplementary bonding conductors for back panels and doors. Attach a separate bonding conductor to all devices that are not firmly fastened to the panels with screws for such devices as case mounted instruments, meters, etc.

- F. Bond each enclosure door to the grounding lug.

2.4 LOCAL CONTROL AND PLC PANEL EQUIPMENT AND INSTRUMENTS

- A. Provide panel equipment and instruments, as applicable, unless otherwise indicated:

- 1. Power Supply 24VDC, 10A
 - a. Input: 120VAC
 - b. Output: 24VDC, 10A
 - c. Din Rail Mounted
 - d. Temperature Rating: +10°F to +120°F (without de-rating)
 - e. Efficiency: $\geq 87\%$
 - f. Mount in control panels as per drawings, specifications and manufacturer's recommendations.
 - g. Relay Output: 120VAC, 2A to indicate Power OK status.
 - h. Approved Manufacturers: Siemens SITOP, Allen Bradley 1606-XL series, Phoenix Contact Quint power series, Sola Heavy-Duty SDN series or Weidmuller.
- 2. Power Supply 24VDC, 4A
 - a. Input: 120VAC
 - b. Output: 24VDC, 4A
 - c. Din Rail Mounted
 - d. Temperature Rating: +10°F to +120°F (without de-rating)
 - e. Efficiency: $\geq 85\%$
 - f. Mount in control panels as per drawings, specifications and manufacturer's recommendations.
 - g. Relay Output: 120VAC, 2A to indicated Power OK status.
 - h. Approved Manufacturers: Siemens SITOP, Allen Bradley 1606-XL series, Phoenix Contact Quint or Mini power series, Sola Heavy-Duty SDN series or Weidmuller.

- B. Surge Suppressor

- 1. Input: 120VAC
- 2. Output: 120VAC, pure sine wave

3. Din Rail Mounted
 4. Current: min 10A
 5. Temperature Rating: +10°F to +100°F (without de-rating)
 6. Dry 120VAC rated contacts to indicate device failure
 7. Warranty: 10 years
 8. Mount in control panels as per drawings, specifications and manufacturer's recommendations.
 9. Approved Manufacturers: Liebert Isatrol Elite and Sola Heavy-Duty STV25K series or Phoenix Contact, Weidmuller or Wago series.
- C. Pilot Lights
1. Provide pilot lights of LED type for extended lamp life, oil tight, push to test, complete with appropriate color lenses. Normal colors used are run=green, stop=red unless otherwise depicted elsewhere. Refer to Division 16 for additional information.
- D. Terminals
1. Provide strap screw type terminal blocks rated for 600 volts.
 2. Identify each terminal block within an enclosure with a unique machine printed terminal block number. Cabinet chassis grounding terminal blocks to be identified by the electrical ground symbol.
 3. Connections to screw terminals to be locking fork tongue insulated crimp type wire connectors equal to Panduit PAN-TERM series or T&B STA-KON series.
 4. Terminals to be Phoenix Contacts, Weidmuller or Wago reference as follows;
 - a. DIN Rail NS 35/7.5 PERF 2000MM
 - b. UT 2.5 Terminal Block
 - c. UT 2.5-PE Ground Block
 - d. UTTB 2.5 Two Level Terminal Block
 - e. UT 4-HESILED 24 (5x20) Fused Terminal Block – for 24VDC rated circuits c/w all required fuses
 - f. UT-4-HESILED 250 (5x20) Fused Terminal Block – for 120VAC rated circuits c/w all required fuses
 - g. CLIPFIX 35-5 End Bracket
 - h. D-UT 2.5/10 End Cover for Terminal Block
 - i. DP-UTTB 2.5/4 End Cover for Two Level Terminal Block

j. FBS 2-5 Bridge

5. Provide a group of terminals for each of 120 VAC hot and neutral and 24 VDC positive and negative power. Distribution wiring to have a thermal magnetic circuit breaker upstream of all major blocks of loads, adequately sized to protect the connected load while not causing nuisance tripping. Provide nickel-plated terminals for all high capacity applications in excess of 15 A.
6. Provide Phoenix Contact disconnect type terminal blocks w/fuses for each load or loop powered from the control panels.
7. All terminals shall be identified with marker pins and/or strips.

E. Nameplates

1. Refer to Section 17010 for nameplate specification.

F. Signal Current Isolator

1. Isolator to provide galvanic isolation of milliampere transmission signals from transmitters with inadequately isolated output circuits.
2. Isolator to be housed in a NEMA 250, Type 4/7 conduit body and derive its operating power from the signal input circuit.
3. Input and output signals to be 4-20mA DC, with an error not exceeding 0.1% of span. Input resistance will not exceed 550 ohms with an output load of 250 ohms.
4. Isolator to be by Phoenix Contact, Weidmuller or MTL.

G. Isolation Relay

1. Three isolated channels
2. Rated for Class 1 Zone 0
3. Power Supply: 120VAC
4. Relay outputs: Three dry contacts 120VAC rated N.O.
5. Fail-safe earth fault protection
6. Reference Model: MTL 2213.
7. Approved products from; Phoenix Contact, Weidmuller or Turk

H. Consumables

1. Supply all consumables such as fuses, lamps, bulbs, etc., until and during start-up and commissioning. At completion of commissioning, provide 10% spare inventory of each type of consumables.
2. Provide a tabulated list of all consumables utilized, indicating where used, type, rating, and reorder details. Include the list with the operation and maintenance manual information.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Locate as indicate on the drawings
- B. Connect instrumentation, power, control, communication cables and field wiring,
- C. Conduit and cable entrance shall be from bottom only, unless otherwise specified.
- D. All spare I/Os on the PLC shall be wired to a terminal strip and clearly marked.

3.2 MOUNTING HEIGHT

- A. Unless otherwise specified or a conflict exists, mount all panels, starters and disconnects 8 inches to top of cover.

3.3 IDENTIFICATION

- A. Each enclosure shall be clearly identified with a 1/8 inch thick lamacoid nameplate black face and white core, mechanically attached with self tapping screws to the panel door. The nameplate to indicate panel name as indicated on drawings.
- B. If more than one power source is present in a panel, a separate warning nameplate with red face and white core, mechanically attached with self tapping screws to the panel door shall be provided. The nameplate to indicate the number of power sources and their origin.
- C. All instruments within the panel shall be identified as per 2.5.A.
- D. Provide a list of all circuit breakers and fuses laminated in plastic. The list shall be located in each associated enclosure.
- E. All wires shall be identified.
- F. Size and wording on nameplates to be submitted for approval.
- G. Color scheme for nameplates will need to be submitted for approval. Color scheme will be selected by owner.

3.4 REFERENCES

- A. Refer to Section 17010.

3.5 RELATED WORK

- A. Interconnection to the associated panels terminal strips, communication and field devices.
- B. Installation of interconnecting cables to field devices, instruments and Communication devices.

END OF SECTION

SECTION 17126

INDUSTRIAL CONTROL NETWORK

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. The Work includes the provision of all Industrial Ethernet Equipment.
- B. Refer to Section 17010 for general instrumentation and control requirements related to communication requirements.

1.2 RELATED SECTIONS

- A. 17010 Instrumentation for Process Control General Provisions
- B. 17440 Control Panels – PLC
- C. 17720 Computerized SCADA System
- D. 17800 Testing and Calibration for Instrumentation
- E. 17810 Commissioning and Start-Up

1.3 REFERENCES

- A. Refer to Section 17010.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. All provided equipment and material to be rated for industrial use.
- B. Provide shop drawings and product data in accordance with Division 1 and Section 17010.

2.2 CABLES

- A. Provide industrial Ethernet Cat 6 24 AWG Bonded-Pair cables Al interlocked armour PVC outer jacket cable.
- B. Maximal distance 100m
- C. Color code: Orange or Blue
- D. Unarmored cable shall be installed in a dedicated conduit and armored cable shall be installed in Division 17 instrumentation cable trays.
- E. No splices are allowed.

- F. Manufacturer and cable type: Belden Category 6 DataTuff Twisted Pair Cables or Engineer approved equal.

2.3 ETHERNET SWITCHES

- A. Provide only Industrial graded Ethernet switches with Advanced Management Firmware – reference NTRON Industrial Series.
 - 1. Two (2) - Eight Cat5e (RJ45) and two fiber (ST/SC) ports Ethernet Switches shall be 509FX-A
 - 2. Fiber to Copper media converters shall be 102MC-FL-A.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All non-armored Cat6e cables shall be installed in dedicated communication wireways.
- B. All Ethernet cables within LCPs and MCCs shall be installed separately from power wires.
- C. Connect devices as indicated on the drawings.
- D. All installation shall be in accordance with manufacturer’s instructions and good network practices.
- E. Setup and test TCP/IP address for all listed equipment in the table below. Subnet mask for all devices is 255.255.255.0 and Gateway is TBD. Coordinate proposed TCP/IP addresses changes with the owner representative to avoid possible conflicts.

Equipment	TCP/IP Address	Notes
PLC-110 (BARTON)	TBD	Process Network
PANVIEW-110 (BARTON)	TBD	Process Network
PANVIEW-120 (BARTON)	TBD	Process Network
POWMETER-110 (HOBART)	TBD	Process Network
POWMETER-111 (PHOENIX)	TBD	Process Network
PLC-120 (S. INDUSTRIAL)	TBD	Process Network
PANVIEW-121 (S. INDUSTRIAL)	TBD	Process Network
POWMETER-121 (S. INDUSTRIAL)	TBD	Process Network

- F. Prior to the final commissioning and demonstration, test TCP/IP configuration from the main Ethernet switch using PING command and verify all links.

- G. Performance degradation of the Ethernet communication links will occur if the Cat5e and/or Cat6 cables are exposed to extreme high-frequency noise. It is the Contractor's responsibility to properly route cables and condition power to the equipment in order to assure communication reliability.

END OF SECTION

SECTION 17130

INSTRUMENTATION PANEL COMPONENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. The Work includes the provision of miscellaneous instrumentation and control components.
- B. Refer to Section 16010 and 17010 for general electrical, instrumentation and control requirements

1.2 RELATED SECTIONS

- A. 17010 Instrumentation for Process Control General Provisions
- B. 17440 Control Panels – PLC
- C. 17720 Computerized SCADA System
- D. 17800 Testing and Calibration for Instrumentation
- E. 17810 Commissioning and Start-up

1.3 REFERENCES

- A. Refer to Section 17010.

1.4 GENERAL

- A. Use normally open contacts for alarm actuation which close to initiate the alarm.
- B. Use normally open contact outputs to control equipment. The contacts close to start the equipment.
- C. For contacts monitored by solid state equipment, such as programmable controllers or annunciators, hermetically seal and design for switching currents from 20 to 100 mA at 24 volts DC.
- D. For contacts monitored by electromagnetic devices, such as mechanical relays, rate NEMA ICS 2, designation B300.
- E. Provide double barriers between switch elements and process fluids such that failure of one barrier will not permit process fluids into electrical enclosures.
- F. Use switch electrical enclosures that are rated NEMA 4X as a minimum.
- G. Where required, use 120 VAC switches that have a 4A rating.

PART 2 - PRODUCTS

2.1 SELECTOR SWITCH

- A. 2 or 3 position maintained, unless indicated spring return, as per Drawings and Specifications
- B. Mounting hole size 30.5 mm with standard knob, front enclosure NEMA 4 with front panel mounting ring mounting method.
- C. One million mechanical cycles.
- D. Legend with legend as indicated on drawings and specifications.
- E. Each position to have minimum two sets of N.O. contacts rated at 10A at 120VAC.
- F. Approvals: UL
- G. Approved manufacturer Allen Bradley Bulletin 800T equal from Cutler-Hammer, Telemecanique or ABB modular series.

2.2 PILOT LIGHTS

- A. Cap color as per drawings and specifications.
- B. Mounting hole size 30.5mm with standard knob, front enclosure NEMA 4 with front panel mounting ring mounting method.
- C. LED type, voltage rating as per drawings and specifications.
- D. Legend plate with legend as indicated on drawings and specifications.
- E. Push to test type.
- F. Approval: UL
- G. Approved manufacturer Allen Bradley Bulletin 800T or equal from Telemecanique or ABB modular series.

2.3 PUSH BUTTONS

- A. Flush head unit.
- B. Mounting hole size 30.5mm with standard knob, front enclosure NEMA 4 with front panel mounting ring mounting method.
- C. 250,000 mechanical cycles.
- D. Legend plate with legend as indicated on drawings and specifications.
- E. Each position to have minimum of three sets of N.O. contacts rated at 120VAC.
- F. Approval: UL

- G. Approved manufacturer Allen Bradley Bulletin 800T or equal from Telemecanique or ABB modular series.

2.4 CIRCUIT BREAKERS IN CONTROL PANEL

- A. Finger safe design.
- B. A positively trip-free mechanism (breaker cannot be defeated by holding the handle in ON position).
- C. Mounts on DIN rail.
- D. Tripping Characteristics: Type C.
- E. Maximum voltage: 240VAC.
- F. Electromechanical life: 6000 operations (1 operation = 2 switching events ON/OFF).
- G. Interrupt Rating: 1 pole 10kA @240VAC
- H. Approval: UL
- I. Approved manufacture: Allen Bradley Bulletin 1492-SPU or equal from Weidmuller or Telemecanique.

2.5 GENERAL PURPOSE RELAYS

- A. 4DPDT AgCdO contacts, rated 10A @ 120VAC
- B. Coil Voltage as required (24VDC, 24VAC, 120VAC)
- C. Plug-in Quick Connect Solder Terminals
- D. DIN Rail mounted bas with screw terminals.
- E. LED or mechanical relay status indication.
- F. Life expectancy: 250,000 cycles
- G. Approved product; Omron LY4N, Omron MY4N or equal from Allen-Bradley, Telemecanique or Idec.

2.6 MAG FLOWMETER INTERPOSING RELAYS

- A. Solid State Relay
- B. Load Voltage: 120VAC
- C. Control (Input) Voltage: 24VDC
- D. DIN Rail mounted bas with screw terminals.
- E. LED relay status indication.
- F. Life expectancy: 200,000 energized hours.

- G. Approvals: UL
- H. Approved product; Allen Bradley Bulletin 700-SK, Omron, Telemecanique or ABB.

2.7 PLC DIGITAL OUTPUT INTERPOSING RELAY

- A. 1SPDT contact
- B. Contact Voltage: 24VDC, 120VAC
- C. Control (Input) Voltage: 24VDC
- D. DIN Rail mounted.
- E. LED or mechanical relay status indication.
- F. Approvals: UL
- G. Approved product; Phoenix Contact – type ART-NR.2961105, Allen Bradley or Weidmuller.

2.8 E-STOP SWITCH

- A. Push – Pull and Twist to release.
- B. Two positions
- C. Non illuminated.
- D. Additional contacts: 3 N.O. and 3 N.C. (3 x Allen Bradley 800T-XA)
- E. Built-in contacts: 1 N.O. and 1 N.C.
- F. UL Approved
- G. Reference Product: Allen Bradley 800T-FXT6A1 or equal from Telemecanique or ABB

2.9 POSITION SWITCH – DOOR CONTRACT

- A. Mechanical Protection: IP67.
- B. Accessories: Lever arm or as required by the application.
- C. Built-in contacts: 1 N.O. and 1 N.C.
- D. UL Approved
- E. Model: Siemens 3SE2, Schneider 9007C or equal from Allen-Bradley.

2.10 KEY SWITCH

- A. Two position – maintained
- B. 2.5 mm two positions
- C. Contacts: 3 N.O.

D. UL Approved

E. Model: Allen Bradley 800FM or equal from Telemecanique or ABB

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locate and wire as indicated on the drawings.

END OF SECTION

SECTION 17210

PRIMARY ELEMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Process taps and primary elements as detailed in Division 11.
- B. Equipment, Products and Execution must meet all requirements detailed in Section 17010.

1.2 RELATED SECTIONS

- A. 17010 Instrumentation for Process Control General Provisions
- B. 17800 Testing and Calibration for Instrumentation
- C. 17810 Commissioning and Start-up

PART 2 - PRODUCTS

2.1 PROCESS TAPS

- A. Provide pressure gauge & sensor and thermowell taps. Coordinate requirements with Division 11. Refer to P&ID drawings and Division 17 installation details.

2.2 PRIMARY ELEMENTS

- A. Provide primary elements and transmitters as specified on the Instrumentation Specification Sheets (ISS) of Section 17700.
- B. Provide written assurance that the instrument manufacturer approves the selection of materials of primary elements, which are in contact with the specified process fluid and inert to the effects of the process fluid.
- C. Provide drip pots installed below sensing elements measuring gas. Provide seamless, stainless steel drip pots consisting of a 2 inch by 1 foot pipe with an isolating valve and a drain valve. Provide a separate drip pot for each sensing line. Locate the drain valve within 1 ½ feet of the floor.
- D. Each pressure gauge & sensor and pressure switch shall be isolated from the process liquid by a diaphragm seal as shown on the drawings. Provide diaphragm seals as shown on the drawings and ISS. Refer to P&ID drawings and Division 15 installation details:
- E. There are two types of diaphragm seal isolators:
 - 1. The isolator shall consist of a 316 stainless steel housing, and a Buna-N flexible liner. The diaphragm seal shall have the capability of being isolated so that in the event of plugging, the elastomer slurry ring area, which isolates the instrument, can be flushed. The diaphragm seal shall be tapped for a 1/2 inch NPT gauge connection. Diaphragms shall be "Red Valve Series 42 Diaphragm Seals" with isolation valves for flushing.

2. The isolator shall consist of a carbon steel housing, carbon steel assembly flanges, and a Buna-N flexible liner. The isolator shall be suitable for installation between two flat-faced, ANSI/ASME B16.1, Class 125 cast iron pipe flanges and shall be tapped for a 1/2 inch NPT gauge connection. Isolators shall be Ashcroft series, Robbins & Myers "RKL Series W Pressure Sensor/Isolator", or Red Valve "Series 40 Flanged Sensor".
- F. Provide ethylene glycol factory filled assembly calibrated by the manufacturer when in-line pressure sensors are specified with a pressure gauge and/or a pressure switch and/or pressure sensor. All necessary fittings to be provided by the contractor.

PART 3 - EXECUTION

Not Applicable.

END OF SECTION

SECTION 17300

INSTRUMENTATION REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. General instrumentation requirements.

1.2 RELATED SECTIONS

- A. 17010 Instrumentation for Process Control General Provisions
- B. 17800 Testing and Calibration for Instrumentation
- C. 17810 Commissioning and Start-Up

1.3 GENERAL INSTRUMENTATION REQUIREMENTS

- A. Provide instruments with conformably coated printed circuit boards if available from the listed manufacturers in order to prevent damage by dust, moisture, fungus and airborne contaminants.
- B. Provide instruments complete with mounting hardware, floor stands, sunshades, wall brackets or instrument racks as required by the manufacturer.
- C. Provide instrument enclosures NEMA rated for the environment. In areas subject to flooding, provide submergence rated enclosures. Enclosures in process areas a minimum of NEMA 4 / 4X.

1.4 SUBMITTALS

- A. Comply with the provisions and requirements of Section 01330, Submittal Procedures.
- B. In addition to the requirements of Section 01330, provide the following for each model instrument provided:
 - 1. Manufacturer's design and performance specification data and descriptive literature.
 - 2. Equipment dimensioning and installation requirements and recommendations.
 - 3. Required and optional accessories lists.
 - 4. Electrical/pneumatic signal and power connection diagrams.
 - 5. Calibration certifications from the manufacturer for each calibrated instrument.
 - 6. List of recommended spare parts and spare parts to be provided.
 - 7. Tag number and description.
 - 8. Instrument Data Sheets (ISA Standard -S20) with all fields completed.

9. Catalog literature edited to indicate specific items provided.
10. Mounting details for all typical installation requirements and special details for non-typical applications.
11. Methods and materials required for installation. Include power and signal connection details.
12. Other relevant submittal information as required in the particular instrument specification.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. Provide instrumentation as required and specified in Instrument Specification Sheets (ISSs) in Section 17701 to provide fully functioning Instrumentation and Control system.
- B. In general, alarm contacts close to alarm. Normally closed contacts that open on detection of the alarm condition or loss of power are only required for high priority critical or safety shutdown/interlock alarms.
- C. Provide all additional data communication hardware and software required to configure, test and commission all Profibus and Modbus devices between field devices and panel devices.
- D. Unless specifically noted otherwise, all Magnetic Flow meters, Pressure and Temperature Transmitters, Level Transmitters, shall have an integral HART protocol communications options.
- E. Hydrostatic Level, Temperature and Pressure Transmitters shall have 4-20mA output.
- F. For more information about instruments I/O & communication and power wiring requirements refer to Section 17700 Loop Drawings and instrument's user and installation manuals.

2.2 INSTRUMENT MANUFACTURER

- A. Provide instruments from the manufacturers listed in Instrument Specification Sheets (ISSs) in Section 17701.

2.3 SETUP, STARTUP AND COMMISSIONING

- A. Refer to Section 17800, Acceptance Testing and Calibration and Section 17810, Commissioning and Startup.
- B. Setup, test, startup and commission all instruments.
- C. The contractor shall allow for services of a qualified equipment representative to carry out setup and testing of all instruments.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All transmitters installed outside shall have sun-shade protection.

- B. 120VAC power for instruments shall be provided by Division 16.

END OF SECTION

SECTION 17320

INSTRUMENTATION ANALYTICAL ELEMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section specifies the supply and installation of various analytical instrumentation.
- B. Responsibility shall include supply and installation of all component and Vendor subsystems as to provide a fully functioning system, including supervision, calibration, checkout, start-up operating adjustment and documentation, tagging and compliance with data sheets.

1.2 RELATED SECTIONS

- A. Section 17010 – Instrumentation for Process Control General Provisions
- B. Section 17114 – Instrumentation Cables
- C. Section 17705 – Process Control System, Instrument Installation Details
- D. Section 17800 – Acceptance Testing and Calibration for Instrumentation

1.3 REFERENCES

- A. Refer to Specification Section 17010.

1.4 PRODUCT DATA

- A. Submit product data in accordance with Section 01330 Submittal Procedures.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. All instrumentation, control, and electrical devices provided under this Section shall be UL approved and shall bear the UL approval seal.
- B. Provide each instrument with mechanisms that are corrosion resistant.
- C. Provide each instrument with mechanisms enclosed in a dust-proof and a moisture-proof case.
- D. Provide all indicator and gauge dials finished in permanent white with black graduations and figures.
- E. Each component shall be carefully selected and designed for a long lifetime with ample margin to withstand transient and other surge voltages which may occur in the circuits from any source in the power supply.
- F. Each component and composite instrument shall be suitable for the location and installation position at the attitude designated on the drawings, eg. horizontal, vertical or sloped position.

1. If sensing systems utilize probes then the probes shall be braced to the structure with a minimum of two 316 SS clamps to prevent sensor movement for any reason.
 2. Where probes are suspended into vessels or chambers, stilling tubes shall be used to prevent excessive movement.
 3. Sensing units shall be mounted so that interference to the sensing function is not caused by surrounding structures. The sensor shall preferably be mounted on its own support, purpose built to manufactures recommendations, to facilitate maintenance and/or adjustment.
- G. Provide each instrument powered with 120 VAC with a circuit protector fuse / breaker.
- H. All control panel mounted instruments shall be suitable for flush mounting and shall be furnished with bezel.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all instruments in strict accordance with the recommendation of the manufacturer.
- B. Carry out installation, calibration and adjustment in accordance with manufacturer's installations instructions, recommended practices and as indicated on drawings and elsewhere in these specifications.

3.2 EQUIPMENT MOUNTING

- A. All mounting plates, pedestals, bolts, shims, angle iron and other miscellaneous steel or hardware items required for the securing of equipment shall be supplied unless specifically noted otherwise.
- B. All instruments to be installed in accordance with the Manufacturer's installation instructions.
- C. Instruments or raceway will be installed so as not to obstruct access routes, equipment maintenance space or space for future equipment.
- D. Where the removal of filter cartridges and heater elements is necessary, attention will be paid to instrument locations and tubing runs.
- E. Instrument supports shall be located and installed to provide a fully supported, secure system with minimum vibration.

3.3 WIRE AND CABLE

- A. Instrumentation cables shall be as described in Section 17114 of this specification. Single pair twisted shielded cable to be run in conduit.
- B. Control wiring shall be either multi-conductor Belden run in cable tray or single conductor wire run in conduit.

3.4 GAUGES AND INDICATORS

- A. Select instruments so that normal operating point is just above midpoint of instrument range. (60 – 70%)

- B. All indications shall be displayed on a linear scale unless otherwise specified. Local indicators shall be in engineering units.

3.5 TESTING

- A. Refer to Section 17800, Acceptance Testing and Calibration for requirements.
- B. Upon completion of testing of each device, affix a tag to the instrument certifying that calibration and testing have been completed and specifying the calibration points.

3.6 COMMISSIONING

- A. Refer to Section 17810, Commissioning and Startup.

END OF SECTION

SECTION 17321

LEVEL ELEMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section specifies the supply installation, field testing, and placing into operation of various level elements and transmitters.
- B. Responsibility shall include supply and installation of all component and Vendor subsystems as to provide a fully functioning system, including supervision, calibration, checkout, start-up operating adjustment and documentation, tagging and compliance with data sheets.

1.2 RELATED SECTIONS

- A. Section 17010 – Instrumentation for Process Control General Provisions.
- B. Section 17114 – Instrumentation Cables
- C. Section 17705 – Process Control System, Instrument Installation Details
- D. Section 17800 – Acceptance Testing and Calibration for Instrumentation

1.3 SUBMITTALS

- A. Submit product data in accordance with Section 01330 Submittal Procedures.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. All instrumentation, control, and electrical devices provided under this Section shall be UL approved and shall bear the UL approval seal as detailed in Section 17300 - Instrumentation General Requirements.
- B. Each device shall be a pre-assembled packaged unit. Upon delivery to the Work Site, each level measuring system shall be ready for installation with only minor piping and electrical connections required by the Contractor.
- C. Power supply to the transmitters shall be 120V AC, 60 Hz, single phase unless otherwise indicated. Primary elements shall derive any required power from the transmitter.
- D. The systems shall be installed to measure the specified process at the ranges and conditions indicated on the Instrument Data Sheets. The devices will be installed at the locations indicated on the Drawings.
- E. Environmental, temperature and pressure requirements for the instruments shall be as specified.

- F. Preferred instruments have been selected on their ability to support a smart technology. The contractor shall provide instruments that best match the chosen process automation system and the Hart protocol.
- G. Each instrument shall be complete with mounting flanges and/or brackets. The flanges shall conform to Division 11.
- H. Sensing units shall be mounted so that interference to the sensing function is not caused by surrounding structures. The sensor shall preferably be mounted on its own support, purpose built to manufactures recommendations, to facilitate maintenance and/or adjustment.
- I. Where amplifier/transmitter electronics is installed in a classified environment the housings shall be suitable for the application. i.e. Class 1, Div 2 and suited to a wet and corrosive environment.
- J. The system design shall be based on the process ranges and service requirements listed in the Instrument Data Sheets.

2.2 FLOAT TYPE LEVEL SWITCHES

- A. Level switches shall consist of a non-mercury type switch element encapsulated in a nominal 5 inch diameter PVC float housing. The switch contact shall be single-pole, double throw, rated 10 amperes at 120 volts AC. The float shall be supported from a flexible three-conductor 14 AWG cable which also acts as the float hinge. The cable shall be suitable for fixed mount or weighted suspension type installation as indicated on the drawings or in the Instrument Data Sheets. All necessary mounting hardware shall be provided. The hinge-cable length shall be field adjustable in a manner which allows the deadband to be adjusted between 1 inch and 3 feet.
- B. Mounting and installation hardware shall be 316L stainless steel. If necessary, the Contractor shall provide and install a pipe section for installation of the float switches. A junction box shall be provided for each float switch for termination of the manufacturer supplied cable. Multiple float switches in a common area can be provided with a single junction box. A multi-pole receptacle shall be provided and installed for connection of switches as detailed in Installation Standards.
- C. Interconnecting cable from the float switch to the switch junction box shall be provided and installed. Cable shall be of the type approved by the float switch manufacturer. Length of cable shall be a minimum of nine feet or as indicated in the Instrument Data Sheet.
- D. Also provide each probe with the appropriate/necessary level signal interface relays to connect into remote rack mounted I/O modules. Intrinsically safe relays shall be provided to interface with switches in classified areas.
- E. Securely mount the float switches to prevent damage or entanglement with other equipment or devices. Provide all cabling for a fully functional system.
- F. Tools and spare parts shall be furnished and packaged in accordance with Section 17330 - Spare Parts and Maintenance Materials. As a minimum, the following spare parts shall be furnished:
 - 1. One spare float assembly.
- G. Acceptable manufacturers: ITT-Flygt, Magnetrol, or approved equivalent.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all instruments in strict accordance with the recommendation of the manufacturer.
- B. The mechanical installation of items such as flanges, is specified in Division 11, Process Mechanical.
- C. Carry out installation, calibration and adjustment in accordance with manufacturers' installations instructions, recommended practices and as indicated on drawings and elsewhere in these specifications.

3.2 EQUIPMENT MOUNTING

- A. All mounting plates, pedestals, bolts, shims, angle iron and other miscellaneous steel or hardware items required for the securing of equipment shall be supplied unless specifically noted otherwise.
- B. All instruments to be installed in accordance with the Manufacturer's installation instructions.
- C. Instruments or raceway will be installed so as not to obstruct access routes, equipment maintenance space or space for future equipment.
- D. Where the removal of filter cartridges and heater elements is necessary, attention will be paid to instrument locations and tubing runs.
- E. Instrument supports shall be located and installed to provide a fully supported, secure system with minimum vibration.

3.3 WIRE AND CABLE

- A. Instrumentation cables shall be as described in Section 17114 of this specification. Single pair twisted shielded cable to be run in conduit.
- B. Control wiring shall be either multi-conductor Belden run in cable tray or single conductor wire run in conduit.

3.4 INDICATORS

- A. Select instruments so that normal operating point is just above midpoint of instrument range. (60 – 70%)
- B. All indications shall be displayed on a linear scale unless otherwise specified. Local indicators shall be in engineering units.

3.5 TESTING

- A. Refer to Section 17800, Acceptance Testing and Calibration for requirements.

3.6 COMMISSIONING

- A. Refer to Section 17810, Commissioning and Startup.

END OF SECTION

BARTON AND SOUTH INDUSTRIAL PUMP STATIONS ELECTRICAL IMPROVEMENTS

SECTION 17323

PRESSURE SWITCHES AND GAUGES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This section specifies the supply installation, field testing, and placing into operation of various pressure switches and gauges.
- B. Responsibility shall include supply and installation of all component and Vendor subsystems as to provide a fully functioning system, including supervision, calibration, checkout, start-up operating adjustment and documentation, tagging and compliance with data sheets.

1.2 RELATED SECTIONS

- A. Section 17010 – Instrumentation for Process Control General Provisions
- B. Section 17114 – Instrumentation Cables
- C. Section 17705 – Process Control System, Instrument Installation Details
- D. Section 17800 – Acceptance Testing and Calibration for Instrumentation

1.3 SUBMITTALS

- A. Submit product data in accordance with Section 01330, Submittal Procedures.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. All instrumentation, control, and electrical devices provided under this Section shall be UL approved and shall bear the UL approval seal.
- B. Preferred instruments have been selected on their ability to support a smart technology. The contractor shall provide instruments that best match the chosen process automation system.
- C. Each instrument sensing line shall be complete with an isolation valve. The isolation valves shall conform to Division 15.
- D. Sensing units shall be mounted so that interference to the sensing function is not caused by surrounding structures. The sensor shall preferably be mounted on its own support, purpose built to manufactures recommendations, to facilitate maintenance and/or adjustment.

2.2 PRESSURE GAUGES

- A. Pressure gauges shall be of the indicating dial type, with C-type phosphor bronze Bourdon tube; stainless steel rotary geared movement; phenolic or polypropylene open front turret case; adjustable pointer; stainless steel, phenolic, or polypropylene ring; and acrylic plastic or shatterproof glass window.

- B. Gauge dial shall be 4 ½ inches size, with white background and black markings. The units of measurement shall be indicated on the dial face. Subdivisions of the scale shall conform to the requirements of the governing standard.
- C. Panel-mounted and surface-mounted gauges shall be provided with ¼ inch NPT connections. All stem-mounted gauges shall be provided with ½ inch NPT connections. Where indicated on the Instrument Data Sheet, stem mounted gauges shall have an adjustable viewing angle to allow the gauge to be positioned for optimum viewing.
- D. All pressure gauges shall measure in psi and all vacuum gauges in inches water. All gauges shall have a suitable range to give mid-scale readings under normal conditions. Gauge accuracy shall be 0.5% of scale range.
- E. Each gauge shall be provided with a threaded end, ball-type gauge valve. Gauge valve materials shall be in accordance with the Material Class Sheets. Where not covered by the Material Class Sheets, gauge valves shall have 316SS wetted parts and teflon seals. Multi-port valves shall have all unused ports plugged.
- F. Where indicated in the Instrument Data Sheets, the pressure gauge shall be provided with a pressure snubber. Each snubber shall be of a size and pressure range compatible with the gauge served.
- G. Where indicated on the Instrument Data Sheet, a diaphragm seal shall be provided for the respective gauge. Diaphragm seals shall be thread-attached type with removable AISI Type 316 stainless steel diaphragm, zinc or cadmium plated carbon steel upper housing, and stainless steel lower housing. The upper housing shall be contoured to fit and provide a seat and seal for the diaphragm and shall be designed to permit removal of the gauge with the system under pressure. The lower housing shall be provided with a tapped and plugged ¼ inch NPT flushing connection. Each diaphragm seal and the gauge served shall be factory assembled, filled with a suitable fluid, and calibrated as a unit.
- H. Each gauge shall be provided with all required mounting hardware to securely mount the unit according to the mounting requirements indicated in the Instrument Data Sheet. Mounting and installation hardware shall be 316L stainless steel.
- I. Tools and spare parts shall be furnished and packaged in accordance with Section 17330 - Spare Parts and Maintenance Materials.
- J. Acceptable manufacturers: Refer to Instrument Data Sheet in specification 17701

2.3 PRESSURE SWITCHES

- A. Pressure switches shall be diaphragm actuated type switches. Switches shall be field adjustable type, with trip point repeatability better than 1% of actual pressure. Switches shall be housed in NEMA Type 4 enclosures. Switches shall be differential type where indicated on the Instrument Data Sheet. Switch wetted parts shall be in accordance with the Material Class Sheets. Where not covered by the Material Class Sheets, the switch shall be provided with a teflon coated diaphragm, viton seals, and a stainless steel connection port.
- B. Panel mounted and surface mounted switches shall be provided with ¼ inch NPT connections. All stem mounted switches shall be provided with ½ inch NPT connections.
- C. All pressure switches shall measure in psi and all vacuum switches in inches water. Unless otherwise indicated, switches shall have a fixed deadband and shall be auto-reset type. As a minimum switches shall be SPDT, rated 10 amperes at 120 volts AC.

- D. Each switch shall be provided with a threaded end, ball-type shutoff valve. Shutoff valve materials shall be in accordance with the Material Class Sheets. Where not covered by the Material Class Sheets, valves shall have 316SS wetted parts and teflon seals. Multi-port valves shall have all unused ports plugged.
- E. Each switch shall be powered with a multi-pole receptacle on the switch enclosure for connection of external wiring. The receptacle shall be a male connector with integral leads for each pole. Number of poles shall be equal to the number of switch terminal connections for external wiring (to a maximum of 10 poles per connector). The connector shall be installed in a knockout or hub, with leads connected to the switch terminals. Receptacles shall be as indicated in Installation Standards.
- F. Where indicated on the Instrument Data Sheet, a diaphragm seal shall be provided for the respective switch. Diaphragm seals shall be thread-attached type with removable AISI Type 316 stainless steel diaphragm, zinc or cadmium plated carbon steel upper housing, and stainless steel lower housing. The upper housing shall be contoured to fit and provide a seat and seal for the diaphragm and shall be designed to permit removal of the switch with the system under pressure. The lower housing shall be provided with a tapped and plugged ¼ inch NPT flushing connection. Each diaphragm seal and the switch served shall be factory assembled, filled with a suitable fluid, and calibrated as a unit.
- G. Each switch shall be provided with all required mounting hardware to securely mount the unit according to the mounting requirements indicated in the Instrument Data Sheet. Mounting and installation hardware shall be 316L stainless steel.
- H. Tools and spare parts shall be furnished and packaged in accordance with Section 17330 - Spare Parts and Maintenance Materials.
- I. Acceptable manufacturers: Refer to Instrument Data Sheet in specification 17701.

2.4 MISCELLANEOUS

- A. All indications shall be displayed on a linear scale unless otherwise specified. Local indicators shall be in Engineering units.
- B. Instruments shall be suitable for the environmental conditions in which they are to be installed. The Supplier shall determine where injurious conditions may be expected to occur and make proper provision to protect the instruments to ensure their proper and reliable operation. Provide power surge protectors, heating cables and devices to protect instruments, equipment and lines from being functionally impaired or damaged by power surges or environmental conditions.
- C. Those parts of the gauge or switch which are in contact with the process fluid shall be made of materials which are inert to the effects of the process fluid. It shall be incumbent on the Supplier to review the application to ensure that the specified device is suitable for the service conditions.
- D. All clean service pressure gauges, transmitters and switches shall be installed with a gauge/root valve equal to Whitey SS-6NDGM12-F8 complete with bleed valve SS-BVM8 and SS-1/2 inch plugs as required.
- E. All dirty service pressure gauges, transmitters and switches shall be installed with an appropriate seal as indicated in the drawings and specified elsewhere.

PART 3 - EXECUTION

3.1 INSTALLATIONS

- A. Install all instruments in strict accordance with the recommendation of the manufacturer.
- B. The in-line mechanical installation of items such as meters, is specified in Division 11, Process Mechanical.
- C. Carry out installation, calibration and adjustment in accordance with manufacturer's installations instructions, recommended practices and as indicated on drawings and elsewhere in these specifications.

3.2 EQUIPMENT MOUNTING

- A. All mounting plates, pedestals, bolts, shims, angle iron and other miscellaneous steel or hardware items required for the securing of equipment shall be supplied unless specifically noted otherwise.
- B. All instruments to be installed in accordance with the Manufacturer's installation instructions.
- C. Instruments or raceway will be installed so as not to obstruct access routes, equipment maintenance space or space for future equipment.
- D. Where the removal of filter cartridges and heater elements is necessary, attention will be paid to instrument locations and tubing runs.
- E. Instrument supports shall be located and installed to provide a fully supported, secure system with minimum vibration.

3.3 WIRE AND CABLE

- A. Instrumentation cables shall be as described in Section 17114 of this specification. Single pair twisted shielded cable to be run in conduit.
- B. Control wiring shall be either multi-conductor Belden run in cable tray or single conductor wire run in conduit.

3.4 GAUGES AND INDICATORS

- A. Install primary sensors or indicators in uninterrupted straight pipe, minimum 3 pipe diameters downstream and 3 pipe diameters upstream, on supply lines downstream of pumps, or according to manufacturer's recommendations.
- B. Select instruments so that normal operating point is just above midpoint of instrument range. (60 – 70%)
- C. All indications shall be displayed on a linear scale unless otherwise specified. Local indicators shall be in engineering units.

3.5 TESTING

- A. Refer to Section 17800, Acceptance Testing and Calibration for requirements.

3.6 COMMISSIONING

- A. Refer to Section 17810, Commissioning and Startup.
- B. Verify signal levels and wiring connections to all instrumentation and control equipment.

END OF SECTION

SECTION 17330

SPARE PARTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. The Work includes the provision of spare parts for Instrumentation and Controls equipment.
- B. Refer to Section 17010 for general instrumentation and control requirements.

1.2 RELATED SECTIONS

- A. 17010 Instrumentation for Process Control General Provisions
- B. 17440 Control Panels – PLC
- C. 17810 Commissioning and Start-Up

1.3 SUBMITTALS

- A. Submit product data in accordance with Section 01330, Submittal Procedures.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. All provided equipment and material to be rated for industrial use.

2.2 EQUIPMENT

- A. Provide the following spare parts:

No.	Description	Qty.
1.	PLC Power Supply 1756-PA75	1
2.	PLC DeviceNet Module 1756-DNB	1
3.	PLC Ethernet Module 1756-ENBT	1
4.	PLC Discrete Input Module 1756-IA32	1
5.	PLC Analog Input Module 1756-IF16	1
6.	One Float	1

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide spare parts as indicated above.

END OF SECTION

SECTION 17360

CONTROL SYSTEM HMI

PART 1 - GENERAL

1.1 RELATED WORK

- A. Refer to Division 1 for General Requirements related to the general contract
- B. Refer to Division 11 (Process Mechanical), Division 15 (Mechanical), and Division 16 (Electrical) for Mechanical and Electrical work related to Process Control and Instrumentation.
- C. Refer to Division 9 for Finishes related to Control and Instrumentation.
- D. The following Sections of Division 17 are included in Process Control and Instrumentation.
 - 1. Instrumentation General Conditions Section 17010
 - 2. Instrumentation Cable Section 17114
 - 3. Enclosures Section 17120
 - 4. Industrial Control Network Section 17126
 - 5. Instrumentation Panel Components Section 17130
 - 6. Instrumentation Requirements Section 17300
 - 7. Instrumentation; Analytical Elements Section 17320
 - 8. Control Panel - PLC Section 17440
 - 9. Instrument Loop Diagrams Section 17700
 - 10. Instrument Spec Sheets Section 17701
 - 11. Computerized SCADA System Section 17720
 - 12. Acceptable Testing and Calibration Section 17800
 - 13. Startup, Calibration & Commissioning Section 17810

1.2 SUBMITTALS

- A. Submit product data in accordance with Section 01330, Submittal Procedures.

1.3 DESCRIPTION

- A. This Section describes the requirements for the supply, installation and commissioning of the hardware, software and configuration for human machine interface (HMI) and Programmable Logic Control (PLC) system.
- B. The following describes the minimum requirements for the system and the extent of control required.
 - 1. The Contractor is responsible for:
 - a. HMI is to be Rockwell Automation Industrial PC with integrated 15 inch TFT display part number 6181F-15TPXP
 - b. Developing the SCADA HMI graphics and screens for the new Logix PLC's associated with the Barton and South Industrial Pump Stations Improvements, as well as the complete integration including existing equipment and new vendor systems. Contractor will develop and document Modbus table for functions as it relates to Barton and South Industrial Pump Stations.

1.4 TAGNAMES

- A. All tagnames to have a maximum of ten characters. Tagnames shall be pre-approved by Engineer/Owner.

1.5 PROGRAMMING AND DOCUMENTATION GUIDELINES

- A. Programming
 - 1. All programs shall be written and function in an efficient manner.
 - 2. Wherever possible and without sacrificing efficiency and clarity, a minimum number of RUNGs shall be created to accomplish the objectives of the program.
 - 3. All RUNG layouts shall be in a clear, logical, easy to follow format.
 - 4. All new RUNGs shall begin at the end of existing RUNGs i.e., do not insert new logic within existing logic.
 - 5. RUNG annotations shall be written for each RUNG describing its function.
 - 6. Both short and long comments shall be utilized throughout the program. Each register used in the program shall have a descriptor. Additionally, long comments shall be generously utilized to describe all the functions of a particular register and give all RUNGs names where the register appears.
 - 7. Avoid using abbreviations in comments and titles.
- B. Documentation
 - 1. Documentation shall be provided for new programs, and for additions or modifications of existing programs and shall be broken down into the following categories:

- a. Philosophy
 - b. Flowcharts
 - c. Detailed Description
 - d. Points List
2. Philosophy
- a. The written philosophy shall include the purpose of the program and a description of the sequence of events that the program follows to achieve its objective.
3. Flowcharts
- a. The logic that the program follows shall be clearly displayed on flowcharts.
4. Detail Description
- a. Description shall give a detailed explanation for each RUNG and event (e.g. what closes, when and why etc.)
 - b. Description of each program element, coil and register.
 - c. Documentation shall be generated for the whole program not just the additions.
5. Points List
- a. Points List shall include Rack, Slot, Point Address, or Register #, Point # and Description. Preliminary points list has been prepared. Refer to Appendix (I/O List).
6. Presentation
- a. After the program has been successfully written and tested, a formal presentation shall be made to the Engineer and Owner. The author shall describe the program RUNG by RUNG.
- C. Execution
1. Flowchart
- a. A draft flow chart shall be submitted to the Engineer and Owner for the Operations Supervisor, and Plant Instrument Technician to review prior to programming.
2. Tag Names
- a. Following finalization of the flowchart, the Points List shall be submitted to the Owner for review of tag names.

3. Training

- a. Documentation and presentation shall occur prior to system acceptance.

1.6 HMI GRAPHICS & DATABASE STANDARDS

- A. Graphics - In general, the graphics standards are selected to make dynamic information that is updating or changeable highly prominent. Shutdown and alarm information is presented in high contrast to make them immediately identifiable. Values which the operator may change are shown in sunken black boxes with white text.

The sensing point on the process outline will be indicated using a black, dotted connecting line. General monitoring points are displayed as sunken black boxes with yellow text on the graphic. Descriptors are in a lower contrast color.

The active components such as valves will show operating status using color and fill. Active areas will have blue backgrounds or be shown as pushbuttons.

- B. Layout - All displays shall have a background of either of the standard background colors. They shall contain a title in white, centered at the top of the screen. Graphic displays will follow the conventions of Process and Instrumentation Diagrams including ISA symbols. If a display contains mixed graphic and tabular information, the graphic will be in the top half of the display, text in the bottom half or bottom right corner.

In general process flow is from left to right or alternatively from top to bottom. Note that on a display dedicated to a utility, the utility piping becomes the primary process piping.

In general, groups of user buttons will be in the bottom left corner or along the bottom of the display.

- C. Navigation - Movement between graphics (i.e. opening new graphic windows) shall be performed by selecting an item from a textual list or table, by selecting a graphic representation of a site on an area overview, by selecting a graphic using a hot button on a graphic or by clicking on a process arrow.

- D. Interaction with the displays shall be based on the systems standard interface templates and through the use of graphic representations of buttons and sunken boxes for data change or entry. The following types of buttons are typical:

1. Buttons which open pop-up control panels. Either a symbol or a label on the diagram should indicate the control that is available. For example, if the diagram contains controllable valves, a hot spot behind the valve to indicate that it can be controlled. This hot spot when clicked on, opens a control panel for the valve.
2. Other navigation tools that are typical to the Windows environment and Web browsing: Forward, Back, etc.

- E. Control Panels - When the user requires more information than is available on the display to control an operation, a hot point or button will activate a pop-up control panel. The control panel will have a background color to differentiate it from other displays

In general there will be control panels for the following functions:

1. Pump/VFD - Hand/Off/Computer Control

2. PID Control
 3. Shutdown Control
 4. Changing Flow Calculation Parameters
 5. Changing alarm and process value parameters and/or set-points
- F. Tabular Displays - Tabular displays show a wide variety of data in a highly compressed form. They will be used to provide overview information for logical groups within a facility. These will generally include summary flows, pressures, temperatures, analytical data and laboratory data.
- G. Text Formatting - All static text on the graphics shall be Arial, with a size that is easily read on the display. Text that may change during the course of polling data shall be located in sunken black boxes to distinguish it from static text. Note that static text may be linked to database attributes, for example the point description or units. It is not expected that these attributes will change due to database polling. Titles shall be centered at the top of the control panel.
- H. Usage of Colors – Wherever possible, reservoirs and vessels shall include dynamic fill. If not possible then a bar symbol on the side will indicate the level and be sized to show the approximate range of the level indication, rather than using the fill capability for the entire vessel. Yellow markers will be used to indicate critical points.

Where appropriate, information text shall be in a low contrast color appropriate to the background.

- I. Equipment Status - Symbols will be activated using standard ISA coding. A symbol shown in green implies operation; i.e. a pump in operation or an open valve. A red symbol implies no operation: a stopped pump or closed valve. Thus, a valve which is in a normally closed position is shown as a red valve symbol; a pump that should be operational and has failed is shown as flashing red / black.
- J. Alarms - New alarms shall show on current display and in the standard alarm displays.

When a PLC is not being polled, the associated custom displays will indicate that the PLC is not being polled. An Alarm shall be generated indicating communication has been lost to that PLC.

The alarm summary will show the alarms in reverse chronological order. Unacknowledged alarms will flash. After acknowledgment, the alarms will stop flashing. On return to normal, an event will be recorded in the alarm history.

- K. Control of Devices - To control a device, the operator is expected to complete the following types of actions:
1. Select the device (point at and “click” on the device), which will bring up a control panel popup
 2. Pick an action or enter a setpoint.

Preferably, this will be performed directly from the display. Alternatively, the user may activate a control panel.

The control panel is accessed from either a pushbutton or a blue background active area on the primary graphic.

- L. Physical Units of Measurement - The displays and database will use English units as follows:
 - 1. Pressure readings will be shown in psi.
 - 2. Levels will be shown in feet.
 - 3. Flows will be shown in cubic feet per time unit.
 - 4. temperatures will be shown in degrees Fahrenheit.

- M. Standard Graphic Objects - Standard graphic objects shall be developed for all repeating symbols. These shall include at a minimum:
 - 1. Pumps
 - 2. Soft starts
 - 3. Flow meters
 - 4. On-off valves, modulating valves, etc.

These shall contain all the information for linking to the database, except for the database address.

- N. Trends - The system shall have standard displays that trend the real-time and historical data associated with each value. In other words, when a trend display is closed and reopened, it shall show previous stored historical values that correspond to the time scale of the trend display

- O. Standard Day - A standard day will set as 7:00 am to 7:00 am with adjustment for daylight savings time when calculating flow totals, daily averages, etc.

- P. Historian - There shall be standard tabular displays that indicate the recorded status of all operating parameters. All the historized points shall be included in pre-configured tabular displays.

- Q. Faceplates - The following describes the functionality required of the HMI Operator Faceplates and Detail Faceplates for both control loops & indicators and motors. The intent is to present useful process and equipment diagnostic information to the facility operations and maintenance personnel. Information available should include but not be limited to the following:
 - 1. Motor Faceplates:
 - a. Permit to run.
 - b. Start/Stop buttons.
 - c. Target/Actual motor status.
 - d. Motor current with units and overload warning/trip points.

- e. Starter tripped indication.
 - f. Feedback timers.
 - g. Logic mode (HAND/OFF/AUTO) (LOCAL/OFF/REMOTE).
 - h. Device State info.
 - i. Fail Alarm info.
 - j. Button access to Detail Faceplate.
 - k. Button access to Prime Display.
 - l. Button access to Motor Current and State Trend.
 - m. Button access to Event Chronicle.
 - n. Alarm acknowledgement button.
2. Motor Detail Faceplates:
- a. Indication of active interlocks using text descriptions.
 - b. Indication of starter/drive diagnostics (via DeviceNet/Ethernet).
 - c. Ability to reset starter overload (password protected).
 - d. Ability to set motor logic timers.
 - e. Access to motor run time accumulator.
 - f. Ability to reset motor run time accumulator.
 - g. Access to number of motor starts counter.
 - h. Ability to reset number of motor starts counter.
3. Control Loop Faceplates:
- a. Bar graph and numerical display of PV, SP and CV.
 - b. Alarm indications for HI, HI-HI, LO and LO-LO alarms.
 - c. Target Loop Mode (AUTO, MAN, CAS, etc.).
 - d. Actual Loop Mode.
 - e. Button access to Detail Faceplate.
 - f. Button access to Prime Display.
 - g. Button access to Motor Current and State Trend.
 - h. Button access to Event Chronicle.

4. Control Loop Detail Faceplates:
 - a. Access to alarm settings for HI, HI-HI, LO and LO-LO alarms.
 - b. Ability to enable, disable and suppress all alarms (password protected).
 - c. Access to all PID loop tuning parameters (password protected).

END OF SECTION

SECTION 17440

CONTROL PANEL - PLC

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Each panel shall be a pre-assembled, factory tested unit. Upon delivery to the Work Site, each panel shall be ready for installation with only minor electrical connections required by the Contractor.
- B. Power supply to the panels shall be 120 volts, 60 Hz, single phase unless otherwise indicated or required for a properly operating system. All internal panel power distribution shall be provided by the Supply Contractor as indicated on the Drawings and as required for proper operation of the panel mounted components.
- C. All panels shall be suitable for operation in the indicated environment. Unless otherwise indicated, all outdoor panels shall be provided with thermostatically controlled heaters and cooling fans. Air conditioners, sun shields, or rain shields shall be provided for outdoor panels, where indicated on the Drawings.

1.2 RELATED SECTIONS

- A. Refer to Division 1 for General Requirements related to the general contract.
- B. Refer to Division 11 (Process Mechanical), Division 15 (HVAC Mechanical), and Division 16 (Electrical) for Mechanical and Electrical work related to Process Control and Instrumentation.
- C. Refer to Division 09 for Finishes related to Control and Instrumentation.

1.3 REFERENCES

- A. Refer to Section 17010.

1.4 SYSTEM RELIABILITY

- A. Separate isolated power supplies shall be used for system power and field loop power.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. All instrumentation, control, and electrical devices provided under this Section shall be UL approved and shall bear the UL approvals seal. All panels shall conform to the requirements of NEMA ICS-6.

2.2 ENCLOSURES

- A. All enclosures in electrical rooms shall be NEMA Type 12, gasketed.

- B. All enclosures outdoors shall be at least NEMA Type 4 or 4X stainless Steel if specified.
- C. Field Panels and Field Termination/Junction Boxes shall be NEMA 4, PLC panels shall be as manufactured by Rittal EB, BG, AE and KS Series, Hoffman or Saginaw.

2.3 CONTROL DEVICES

- A. All control devices shall be as detailed in section 17130 and shall be corrosion resistant and suitable for process locations, for all local control stations (e.g. pushbuttons and selector switches).
- B. Enclosures shall be as specified under the Section 17120.
- C. Pilot lights shall be transformer type with LED lamps for extended lamp life, oil tight, push to test, complete with appropriate color lenses. Normal colors used are run/on/open = green, stop/off/closed = red or unless otherwise depicted elsewhere.

2.4 CONTROL PANEL

- A. This specification covers the minimum requirements for the shop fabrication and testing of control panels as described herein.
- B. All components contained on or within the panel are to be supplied and fully wired under this contract.
- C. Responsibility shall include the supply, fabrication, checkout, layout, documentation and delivery to site of fully equipped and functional panels.
- D. The panels must bear approval from a recognized certification agency accredited by Underwriters Laboratory.
- E. Layout and design the panels generally as indicated on project drawings to provide a well organized arrangement.
- F. Documentation shall include:
 - 1. Equipment description data.
 - 2. Equipment installation and operations/maintenance manuals and spare parts list.
 - 3. Schematic loop and interconnecting wiring diagrams.
- G. Nameplates shall be provided for all installed devices on or within the panels identified in accordance with the nameplates on the layout drawings or its tag number.
 - 1. Nameplates shall be securely fastened to the panels with screws or rivets. All tags must be permanent and placed in a visible location within the panel.
- H. Wiring inside panels shall be a minimum of #18 AWG stranded copper terminated with crimped ferrule or tinned with solder, insulation rated at 600 V.
 - 1. Wiring for power distribution shall be a minimum of #14 stranded copper terminated with crimped ferrule or tinned with solder, insulation rated at 600 V.

2. Each wire must be tagged at both ends with a heat shrink sleeve that is machine printed.
 3. Wiring systems with different voltage levels or types must be suitably segregated within the panel.
 4. All wiring shall be run in enclosed plastic wire ways such as Panduit. Wire ways shall be sized so that the total cross sectional area of the insulated wire and cable does not exceed 40% of the cross sectional area of the wireway.
 5. A minimum clearance of 1 ½ inches shall be provided between wire ways and any point of wire termination.
- I. Firmly bond all panel mounted devices on or within the panels to ground. Provide supplementary bonding conductors for back panels and doors.
1. Attach a separate bonding conductor to all devices that are not firmly fastened to the panels with screws for such devices as case mounted instruments, meters, etc.
- J. Type 12 enclosures shall be fabricated from 11 gauge steel panels, complete with necessary stiffening to form a rigid assembly. The structures must be suitable for carrying the weight of the equipment mounted inside the panel and on the doors.
- K. All wiring incoming and outgoing, shall terminate at terminal strips mounted inside panels. Each terminal strip must be identified with a terminal strip number.
- L. Grounding lugs shall be provided for each panel, suitable for termination of up to #6 AWG copper grounding conductor.
1. Provide a 1/4 x 1 x 6 inch long copper ground bar across the bottom of control panel for cable ground termination.
 2. Ground items of instrumentation and control equipment to ground bus with individual stranded copper connections size #14 AWG min
 3. Provide an insulated #6 GND from each control panel terminal strip to outside ground grid.
- M. Provide sponge type corrosion inhibitor quantity to suit panel volume as per manufacturer's sizing table.
- N. The control panels shall be fabricated to the applicable codes and standards as follows:
1. National Electrical Manufacturers Association (NEMA).
 2. US Underwriters Laboratory (UL).
 3. National Electric Code (NEC).
 4. Institute of Electronic and Electric Engineers (IEEE).
 5. The local inspection authority, having jurisdiction, where the panels will be installed.

2.5 EQUIPMENT IDENTIFICATION

- A. Provide equipment identification.
- B. Nameplates:
 - 1. Owner requirements, Size 3 x 6 inch min.

2.6 FREE STANDING VERTICAL PANELS

- A. The following specific requirements shall apply to the freestanding vertical panels:
 - 1. Construction
 - a. Each panel shall be a completely enclosed, dust-tight, indoor cubicle, formed from steel structural members and plates. The base of the panel shall be formed of steel channels, with flanges extending upwards, and shall be provided with ½ inch diameter holes at 12 inch centers so that it can be bolted to the floor or concrete equipment base. Welds, seams, and edges of all exposed surfaces shall be ground smooth. Suitable lifting facilities shall be provided for handling and shipment. The panel structure shall be rigid and freestanding, suitably braced and of sufficient strength to support all mounted equipment, to withstand handling and shipment, and to remain in proper alignment. The panel shall be painted per Owners color preference. The unit will be a baked on factory finish.
 - 2. Hinged Front Panel
 - a. The front of the panel shall consist of a hinged door or doors, with mounted instruments and control devices, fabricated from USS 10 gauge carbon steel sheet and suitably braced and supported to maintain alignment. Panels with hinged front shall be wide enough to permit the doors to be opened without interference with rear projection of any flush-mounted instruments. The top, sides, and back to the panel shall be fabricated from USS 10 gauge or heavier carbon steel sheets.
 - 3. Doors
 - a. Doors shall be essentially full height, with turned-back edges and sufficient bracing to ensure rigidity and prevent sagging. Doors shall be mounted with strong, continuous, piano type hinges. Positive latches, acting from a door handle, shall hold doors securely against rubber gaskets at top, side, and bottom. Each panel which contains PLC equipment shall be provided with at least one folding shelf, mounted to the inside of a front door near the location of the PLC racks. The shelf shall be designed for the intended use and shall be provided with adequate bracing to support a minimum of 20 kg.
 - 4. Panel Size and Arrangement
 - a. Panel dimensions and general device arrangement shall be approximately as indicated on the Drawings. If the panel fabricator feels that alternate panel sizes or devices arrangements are required, the proposed arrangement shall be submitted to the Engineer for review before work proceeds. Panel front-mounted devices shall be arranged for optimum operator access and viewing with switches and controls mounted between

36 and 60 inches from the bottom of the panel and indicating lights and instruments mounted between 36 and 80 inches from the bottom of the panel.

5. Conduit and Cable Entrance

- a. The bottom of each panel shall be provided with 24 x 12 inch removable access plates, which may be drilled to accommodate external wiring and conduit to be installed from below. Each panel shall be provided with a removable top hat for housing incoming cables were required. The top hat shall include nominal 12 x 10 inch cutouts on the top-side and removable front and side plates. The top hat shall be mounted to the top of the panel in the field.

6. Interior Lighting

- a. Illumination of panel interiors shall be provided by ceiling-mounted lamp fixtures with a common "On-Off" switch or automatic door interlock switch near each door. Fixtures shall be fluorescent tube type, equally spaced throughout the panel, and sized for approximately one watt per cubic foot of panel volume. Duplex grounded receptacles for service and maintenance tools shall be provided throughout the length of the panel at spacing not to exceed 5 feet. The lighting and receptacle circuit shall be fused separately from the PLC systems.

2.7 WALL MOUNTED PANELS

- A. Wall mounted panels shall be NEMA rated as indicated in the panel schedule and shall be suitable for wall or pipe-strut mounting. The enclosures shall be equipped with hinged and gasketed full-sized doors. The doors shall have three-point latches and lockable chromium-plated or stainless steel handles. A removable sub panel shall be provided for installation of all internal mounted devices. Wall mounted panels which house PLC components shall be provided with an internal fold-down shelf, attached to the inside of the front door.

2.8 PANEL MOUNTED DEVICES

A. Selector Switches

1. Selector switches shall be heavy-duty, oil-tight type with gloved-hand or wing lever operators. Position legends shall be engraved on the switch faceplate. Switches for electric circuits shall have silver butting or sliding contacts, rated 10 amperes continuous at 120 volts AC. Contact configuration shall be as indicated on the Drawings or as required for the application. Switches used in electronic signal circuits shall have contacts suitable for that duty. Selector switches shall be manufactured by Allen-Bradley or Idec. Refer to the Drawings for manufacturer's part number or model series.

B. Indicating Lights

1. Indicating lights shall be heavy-duty, oil-tight type with a low voltage lamp. A built-in transformer shall be used for AC service. Legends shall be engraved on the lens or on a legend faceplate. Lamps shall be easily replaceable from the front of the indicating light. Indicating lights shall be as manufactured by Allen-Bradley, Telemecanique, ABB or Idec. Refer to the Drawings for manufacturer's part number or model series.

C. Pushbuttons

1. Pushbuttons shall be heavy-duty, oil-tight type with legend engraved on the pushbutton faceplate. Pushbutton contacts shall be rated 10 amperes continuous at 120 volts AC.

D. Power Supplies

1. DC power supplies shall be switching type, selectable for either 120 VAC or 240 VAC input power. Power supply output shall be rated 24 volts DC adjustable up to 30VDC. Minimum power supply rating shall be 300 watts. Power supplies shall be UL approved, compact style, suitable for DIN rail mounting. Power supplies for instrument loop applications shall be suitable for operation in parallel to provide a fail-safe arrangement.
2. Regulated DC power supplies for instrument loops shall be a redundant pair, arranged such that each power supply can provide the required load and both supplies are equally loaded when on-line. The power supply system shall be designed so that either supply can be removed, repaired, and returned to service without disrupting instrument system operation. A contact closure shall be available to indicate failure of the individual power supplies.
3. Regulated DC power supplies for non-instrument loop service shall be a single supply, sized to accommodate the intended load.

E. Relays

1. Relays shall be of the compact DIN rail mount style, with dustproof plastic enclosures, unless otherwise noted. Relays shall be UL approved and shall have not less than double-pole, double-throw contacts. Control circuit relays shall have silver-cadmium oxide contacts rated 10 amperes at 120 volts AC. Electronic switching-duty relays shall have gold-plated or gold alloy contacts suitable for use with low level signals. Relays used for computer input, alarm input, or indicating light service shall have contacts rated not less than 3 amperes. Time-delay relays shall have dials or switch settings engraved in seconds and shall have timing repeatability of plus or minus 2% of setting. Latching and special purpose relays shall be as required for the specific application. Relays shall be provided with an integral pilot light to indicate an energized state.

F. Electronic Signal Booster/Isolators

1. Electronic signal boosters and isolators shall have all solid-state circuitry and shall have complete electrical isolation between the power supply, the input signal, and the output signal. Accuracy shall be plus or minus 0.15 percent of span. Signal boosters and isolators shall be compact DIN rail mount style, and shall be powered from 24 volts DC or from the instrument loop.
2. Electronic signal boosters/isolators shall be manufactured by Action Instruments, Weidmueller, MTL or Ronan.

2.9 INSTRUMENTATION CONTROL PANEL

- A. The Control Panel section, hereafter referred to as "panel", shall be a free standing NEMA 4 structure, arranged to be an integral part of the control architecture and sized as per drawings.

1. Provide minimum 12 gauge metal for cabinet and 11 gauge for equipment mounting pans.
 2. All seams to be continuously welded.
 3. Door stiffeners as required.
 4. Provide removable lifting means.
 5. Provide maximum height, back pan, left and right side pans.
 6. Provide maximum width door.
 7. Provide single point lockable, automotive type door handle on right side of door.
 8. Provide full height piano hinge on door side.
 9. Layout door and internal components as per drawings.
 10. Finish: Apply as per Section 17120.
 - a. Interior: white, 1 coat of primer and 2 coats of finish, 1.5 mils per coat
 - b. Exterior: Matched to Owners existing color scheme. Field verify existing blue SCADA enclosures.
 11. The panel shall contain the following minimum device and components. It shall be noted however that the contractor shall provide fully featured and fully functional control system. Any items required to meet the requirement must be included.
- B. 24 VDC Power Supply:
1. 120-AC/24-DC 10 Amp Power Supply.
 - a. DIN rail mount in panel and wire as per drawings.
 2. Redundant power supply.
- C. Ethernet Switch:
1. Full IEEE 802.3 Compliance
 2. 50/125 MM Fibre Ports
 3. 10/100BaseTX RJ-45 Ports
 4. 0° to 160° F Operating Temperature
 5. Auto sensing 10/100BaseTX, Duplex, and MDIX
 6. Industrial ready heavy duty
 7. LED's For Link, Speed, Activity & Duplex Status

8. A minimum of 40% spare capacity
- D. PLC Interface Terminal Relays:
1. Terminal Relays: in accordance with drawings.
 2. DIN rail mount in panel and wire as per drawings.
- E. Corrosion Inhibitor (installed in each LCP)
1. Daubrite 5 Disk VCI Emitter for control panels < 5 cu.ft.
 2. Daubrite 10 Disk VCI Emitter for control panels > 5 cu.ft.
- F. Surge Suppressor(s)
1. The power entrance to each panel shall be provided with a surge protection device. Surge protectors shall be nominal 120 volts AC with a nominal clamping voltage of 200 volts. Surge protectors shall be of the non-faulting and non-interrupting design, with a response time not to exceed 5 nanoseconds. Surge protectors shall meet the requirements of IEEE-419. Surge protectors, approved products:
 - a. Tycor "AGS-12010XS".
 - b. Liebert Isatrol Elite IE-120.
 - c. Critec
 2. Continuous Current: 20A
 3. DIN rail mounting.
- G. UPS
1. 120 VAC single Phase 1500VA or larger on line UPS complete with SNMP-WEB card for network connection.
 2. Unit to provide 15 minutes of operation of the maximum load condition.
 3. Mount in Control Panel and as per drawings. Branch circuits shall be isolated/protected using rail mounted miniature circuit breakers.
- H. Surface mounted duplex GFI receptacle
- I. Programmable Controller
1. Programmable Controller shall provide high reliability in industrial applications. The internal wiring of the controller is to be fixed, with the logic functions it must perform in a given application to be programmed into its memory. The controller shall be supplied with the CPU, memory (program and data) input/output modules, DeviceNet scanners, Ethernet TCP/IP modules, power supply, and all power and interface cables necessary to function as a complete, reliable and operable system.
 - a. PLC design is based on the reference product; Allen Bradley Logix 35E series as detailed in drawings

2. Each Programmable Controller shall contain sufficient number of conventional inputs and outputs (digital and analog) and extended local I/O to fulfill the specification requirements.
 - a. Digital Inputs: 120VAC
 - b. Digital Outputs: 24 VDC to Isolated Relays
 - c. Analog Inputs: 4-20mA,
 - d. Analog Outputs: 4-20mA,
 - e. 20% Spare Capacity for both Digital and Analog I/O.
3. The capability shall exist to allow for expansion of the system by the addition of hardware and/or software.
4. The design must prohibit upside down insertion of the modules as well as safeguard against the insertion of a module into the wrong slot or chassis via an electronic method for identifying a module. Electronic keying performs an electronic check to insure that the physical module is consistent with what was configured.
5. All hardware of the Programmable Controller shall operate at an ambient temperature of 0 to 60 degrees C (32 to 140 degrees F), with an ambient temperature rating for storage of - 40 to +85 degrees C (- 40 to +185 degrees F).
6. The Programmable Controller hardware shall function continuously in the relative humidity range of 0% to 95% with no condensation at 60 degrees Fahrenheit.
7. The Programmable Controller system shall be described and tested to operate in a high electrical noise environment.
8. Each input and output module shall be self-contained and housed within a chassis.
9. The Programmable Controller shall include the capability of addressing remote input and output modules.
10. Programmable Controller shall have at least two DeviceNet Scanner modules for connection to associated MCC.
11. Programmable Controller shall have at least one Ethernet port for connection to the main SCADA network and contain embedded web-server for remote web accessibility described in more detail elsewhere in the specification.
12. Provide the Programmable Controller rack sized to accommodate all input and output cards, all interface modules, CPU modules and power supplies required to meet the intent of these specifications.
13. The Programmable Controller power supplies shall be sized to meet the controller power requirements with input voltage of 120VAC.

2.10 SPARE PARTS

- A. For all Control Panel components including network components and with the exception of HMI operator interfaces provide spares equal to 10% of the total installed number (round the

installed number to the nearest multiple of 10), where the installed number is 10 or greater. Where the installed number is between 3 and 9, provide one spare.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Assemble as per plans and specifications.
- B. Provide a list laminated in plastic of all circuit breakers and fuses mounted in each Panel. Locate the list in each Panel.

3.2 FACTORY TESTING

- A. After assembly in the factory, the equipment shall be given standard factory (shop) test such as high potential, continuity and ground tests, and such operational tests as are normally required for equipment of its type and voltage class.
- B. The OWNERS representative shall be notified 48 hours prior to the start of the tests so that they may witness these tests if required. The equipment shall not be delivered until the owner representative has inspected the equipment and has witnessed the testing and is satisfied that the equipment is ready for delivery.
- C. Power distribution, field terminations, and internal wiring shall be fully tested and certified by the panel fabricator. Factory testing procedures shall be submitted to the OWNERS representative for approval prior to commencing the testing. Following testing, test results shall be submitted. Factory testing shall include verification of all relay and hardwired logic.

3.3 SHIPPING

- A. Skid mount the completed panel and wrap with protective cardboard.
- B. Shipping: Include the cost of loading, transportation and off-loading.

3.4 INSTALLATION

- A. Locate Instrumentation Control Panels as indicated on the drawings.
- B. Connect field instrumentation, power and control wires.

END OF SECTION

SECTION 17500

PLC I/O INDEX

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Refer to Section 17010.

1.2 RELATED SECTIONS

- A. 17010 Instrumentation for Process Control General Provisions
- B. 17440 Control Panels – PLC
- C. 17720 Computerized SCADA System
- D. 17800 Testing and Calibration for Instrumentation
- E. 17810 Commissioning and Start-Up

1.3 REFERENCES

- A. Refer to Section 17010.

1.4 PLC I/O INDEX

- A. The I/O information provided on Drawings I-601 thru I-603 (Barton), I-604 – I-606 (South Industrial) gives an itemized list of the input and output data between the Plant Control System (PCS) and the field devices.
- B. The provided I/O information in conjunction with schematic diagrams shall be used for determining the cabling and various component requirements for the work specified in this Division.
- C. The Contractor shall supply and install all cabling between all field devices (instruments, final control elements), various electrical equipment, process equipment supplied under other Divisions, process equipment supplied under other Contracts and marshalling panel(s) as shown on the drawings.
- D. The Contractor shall provide local control panel(s) and all components (power supply, power conditioners, terminals, etc.) inside the local control panel(s) as shown on the instrumentation and control panel schematic.
- E. There are Two (2) groups of I/O points.
 - 1. Conventional (hardwired) I/O points – described in this specification.
 - 2. Bus based I/O points (DeviceNet, Modbus, or Ethernet/IP).
- F. The cabling and component requirements for the conventional (hardwired) I/O points are shown on a typical loop schematic drawing. Typical loop drawings will be provided for tender. The Contractor will observe the drawings to identify the correct number of I/O and instrument power supply requirement from each instrumentation loop. For several instruments using a

multicore instrument cable, the contractor can then estimate the number of wires which require routing to the respective instrumentation and electrical field devices.

- G. All I/O cards installed in the local control panels shall be terminated to the dedicated terminals as indicated on Instrument Standard Details for the cards. It is not allowed to have an I/O card installed in the LCP without termination detail sheet.

PART 2 - PRODUCTS

2.1 MATERIAL

- A. The design reference is based on the Allen Bradley –ControlLogix system (design drawings reference the Allen Bradley PLC structure).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All PLC I/O points shall be terminated to the dedicated terminals.
- B. All spare wires shall be terminated to the dedicated terminals.
- C. All control panels will have at least 20% spare capacity wired to terminal blocks.

END OF SECTION

SECTION 17700

INSTRUMENT LOOP DIAGRAMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Refer to Section 17010.

1.2 RELATED SECTIONS

- A. 17010 Instrumentation for Process Control General Provisions
- B. 17500 Plant Control System - PLC I/O Index
- C. 17701 Instrumentation Specification Sheets

1.3 REFERENCES

- A. Refer to Section 17010.

1.4 SUBMITTALS

- A. Submit product data in accordance with Section 01330, Submittal Procedures.

1.5 INSTRUMENT LOOP DIAGRAMS

- A. The following drawings show typical loop wiring diagrams; I-601 thru I-708
- B. The diagrams are based on typical products used as the basis of design. Contractor will add information to the drawings as it is available and this information will be submitted at project completion as "As-built" record information.
- C. It is the responsibility of the integration contractor to develop and produce on 11x17 sheets individual loop drawings for all the instrument and control functions that are controlled by the waste water treatment plant PLC.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION

SECTION 17701

INSTRUMENT SPEC SHEETS

PART 1 - GENERAL

1.1 REFERENCES

- A. Refer to Section 17010.

1.2 RELATED SECTIONS

- A. 17010 Instrumentation for Process Control General Provisions
- B. 17800 Testing and Calibration for Instrumentation
- C. 17810 Commissioning and Start-Up

1.3 REFERENCES

- A. Refer to Section 17010.

1.4 SUBMITTALS

- A. Submit product data in accordance with Section 01330, Submittal Procedures.

1.5 INSTRUMENT SPECIFICATION SHEETS

- A. The Contractor shall develop specification sheet information for all instruments shown on the Process and Instrumentation Diagrams (P & IDs).
- B. The Contractor shall develop specific sheet information for all existing instruments shown on the Process and Instrumentation Diagram (P & IDs).
- C. Where a list of devices is not shown, the instrument specification sheet is considered generic for all instruments of that type.
- D. All instruments of the same type described in the instrument specification sheets are to be from a single source for new equipment. Design has been based on the first named supplier.
- E. Solenoid valves supplied with pneumatically actuated valves: It is the intention of the specifications that where a solenoid valve is required for the operation of a pneumatically actuated valve then this solenoid should be supplied by the valve/actuator vendor as a complete package of actuator, airset, and solenoid and required piping. Same rule applies to pneumatically operated pumps.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

Not Applicable

END OF SECTION

SECTION 17720

COMPUTERIZED SCADA SYSTEM

PART 1 - GENERAL

1.1 RELATED WORK

- A. Refer to Division 1 for General Requirements related to the general contract.
- B. Refer to Division 11 (Process Mechanical), Division 15 (Mechanical), and Division 16 (Electrical) for Mechanical and Electrical work related to Process Control and Instrumentation.
- C. Refer to Division 9 for Finishes related to Control and Instrumentation.
- D. The following Sections of Division 17 are included in Process Control and Instrumentation.
 - 1. 01820 Demonstration and Training
 - 2. 17010 Instrumentation for Process Control General Provisions
 - 3. 17440 Control Panels – PLC
 - 4. 17360 Control System -- HMI
 - 5. 17800 Testing and Calibration for Instrumentation
 - 6. 17810 Commissioning Plan
- E. This Section cannot be read in isolation. Division-16 is responsible for the supply, installation and setup of Motor Control Centers (MCCs'), and to this end, Division-16 is also responsible for the supply, install, setup, program and commission I/O directly associated to the MCC's and Power Distribution Systems.
- F. The PLC hardware supplied in this contract will be integrated with existing equipment and will function as the distributed controller (front-end) for the existing plant wide SCADA HMI's.

1.2 DESCRIPTION

- A. The contractor shall install the computer control and data acquisition system to provide the monitoring and control functions described herein, including all equipment, and components, required to constitute a complete system. The Contractor shall be responsible for coordinating with the Engineer to verify that the installation constitutes a complete working system according to the Specifications. The Owner will be responsible for all networking, and supplying all the computer hardware.
- B. All the work of installing the computerized Process Instrumentation and Control System shall be carried out by a single firm regularly engaged in the provision of Process Instrumentation and Control Systems.
- C. The following System Manufacturers have been pre-qualified to provide the Process Automation Equipment.
 - 1. Allen Bradley – Logix (ControlLogix) for Control, Netlinx (EthernetIP, ControlNet, DeviceNet) for Communications.

- 2. Factory Talk View ME / SE as operator interface, PanelView Plus 1500.
- D. The Contractor shall be ultimately responsible and shall provide for the installation of all SCADA hardware.
- E. The owner shall obtain, from the Contractor, the required information on those primary elements, valves, valve actuators, other control equipment or devices that are required to be interfaced with, but that are not provided under this section.
- F. The contractor shall coordinate this work with the owner to ensure that:
 - 1. All instruments, wiring, and other components to be provided by the contractor under this section are properly installed and interfaced with other system components.
 - 2. All PLC I/O modules and scanner/controller hardware, power supplies, segment couplers, links, repeaters, network configuration, TCP/IP addressing, DeviceNet electronic data sheet (EDS Files), other device drivers are properly installed and setup, and communicating with the automation systems via an efficient, real time communications system.
 - 3. The proper type, size, and number of control wires with their conduits are provided and installed.
 - 4. Proper electric power circuits are provided for all components and system.
 - 5. All work is coordinated with the work of other Divisions.

1.3 CODES AND STANDARDS

- A. Do the complete installation in accordance with all applicable local, state, and national codes, regulations, directives and standards.
- B. Notwithstanding Item No. 1 above, material or equipment supplied to this specification shall be in accordance with the latest edition of the references listed below, unless otherwise noted.

International Electrotechnical Commission

IEC 60751	Industrial Platinum Resistance Thermometer Sensors	
IEC 61000-4-2, IEC 61000-4-3, IEC 61000-4-4	}	Electromagnetic Compatibility (EMC)
IEC 61499-1, IEC 61499-2	}	Function Blocks for Industrial Process Measurement and Control Systems
IEC 61158-2	Fieldbus Standard for Use in Industrial Control Systems - Physical Layer Specification and Service Definition	
IEC 61131-3	Sequential Function Chart, Function Block, Ladder Diagram, Structured Text, and Instruction List editors.	

- C. National Electrical Code

1.4 COMPLIANCE

- A. Failure to comply with the drawings and specifications shall be cause for rejection and the contractor shall be required to make good at no additional cost to the Owner or their agents.
- B. Where a conflict exists between any applicable code, regulation, directive, standard or manufacturers recommended practice for any item and what is shown on drawings or specified, seek clarification from the Engineer prior to submitting tender or allow for the most expensive alternative.

1.5 DEFINITIONS

- A. Refer to the Glossary of Terms in Section 17010.

1.6 WORK INCLUDED

- A. The work included is the provision and commissioning of complete and operational Process Instrumentation, Monitoring and Control Systems, and any equipment, material or labor not specifically mentioned or detailed, but which is obviously necessary to furnish a complete system, shall be provided as though specifically mentioned and detailed.

A high level of coordination is required with Division 16 for the integration with vendor packages and the supply of miscellaneous hardware and accessories.

- B. The system shall include controller hardware, primary elements for process variable measurements, analog display and control elements, and discrete display and control elements. Any equipment, connections, conductors, or installation, material not specifically mentioned, but clearly required to furnish complete and operational system shall be provided as if specifically detailed. Where there is conflict between specifications or details on the drawings or if additional information is required, obtain clarification form engineer before submitting tender. If clarification is not requested allow for the most expensive alternatives.
- C. The Contractor shall provide a microprocessor-based process control system with the capabilities to satisfy all the functional requirements specified, herein. The Contractor shall include in his proposal an item-by-item response to this Specification stating all exceptions, clarifications, or enhancements that have been made. The Contractor will be responsible for meeting all functional requirements of this Specification, which are not specifically taken as exception.
- D. The Contractor shall name and assign a qualified project manager to coordinate activities with the Engineer from placement of order to completion of project. The project manager will provide a single point of contact between the Contractor and the Engineer.
- E. The contractor shall assemble, interconnect and setup the system components at his shop. The process control system hardware shall be tested prior to shipment using the standard Factory Acceptance Test (FAT). The Contractor shall provide a copy of their standard FAT to the Engineer no more than 5 days following contract award notification.
- F. The system shall be composed of Supplier's standard products (i.e., hardware, systems software and firmware, etc.) which can be configured to meet the stated requirements. Standard products are defined as those products, which have been assigned Supplier product numbers, have product bulletins, installation and user documentation and are readily available.

BARTON AND SOUTH INDUSTRIAL PUMP STATIONS ELECTRICAL IMPROVEMENTS

- G. All hardware, system software and system firmware supplied with the system shall have been field proven prior to placement of order. Field proven is defined as successful operation at a field installation of one (1) year or more. It shall be possible for the Engineer to verify the field proven status of all system equipment.

This requirement does not apply to any application software to be developed for this project or software that is being supplied by the owner.

- H. All equipment provided as part of this system that is not manufactured by the Supplier shall be of current manufacture by the original Supplier at the time of placement of contract or order; that is, it shall be currently available for sale from the original manufacturer at the time of placement of contract or order. All such equipment shall meet all applicable specifications and standards referenced in this specification

- I. Notwithstanding the items above, the work shall include but not be limited to the supply, installation and commissioning of the following at the plant:

1. All instruments, control devices, and controlled equipment not specifically noted as provided by the Owner.
2. All instruments, control devices, and controlled equipment not specifically noted as provided by Division 16.
3. All PLCs, controllers, controller modules, I/O modules not specifically noted as provided by Division 16.
4. Coordinate with Div-16 all requirements for the provision of complete control panels drawings and specifications.
5. Provide specified Optical Switches, Routers, Network Cabinets, Patch Panels for Ethernet connections as detailed and specified.
6. Provide all field wiring and cabling as per drawings and specifications and connect all instruments to the associated control panels.
7. Field commissioning, adjustment and certified manufacturers acceptance reports for all control and instrumentation equipment and systems.
8. As built drawings and Operation and Maintenance Manuals.

- J. The installation methods used for equipment with NEMA or IP rated enclosures shall be consistent with the enclosure type.

1.7 CABLE

- A. Interconnecting cable between control system components shall be provided and installed by the Contractor. This shall include fiber optic cable for Ethernet network connections, unshielded twisted pair cable for Ethernet network connections, and shielded programmable logic controller (PLC) network cabling. Installation shall include termination of all cables at both ends. Installation of fiber cables shall include installation of connectors suitable for the respective device termination.
- B. Fiber optic cable shall have a loose-tube construction and shall be suitable for indoor and outdoor installation. Each cable shall have a minimum of 6 multimode 50 micron fibers. All fibers shall be fitted with appropriate connectors at both ends. Where patch panels or fiber

distribution panels are used, all fibers, including spares, shall be properly terminated in the panel.

- C. Bulk fiber cables entering a building/facility shall be terminated at a fiber distribution panel. Single, unjacketed fibers shall not be routed and terminated to the equipment of final connection. All fibers from the original bulk fiber cable shall be terminated in the distribution panel in a manner where the unjacketed fibers are not normally exposed. Connections to the equipment of final connection shall be made with jacketed "zip-cords" with factory or field installed connectors. Each fiber and zip-cord shall be labeled according to the cable identification requirements specified in the contract documents. Fiber cables run between distribution panels shall contain sufficient lengths to allow at least 18 inches of cable to be coiled and secured inside the distribution panel for re-termination in the event of cable breaks or connector failures
- D. Fiber terminations and connector installation shall be in accordance with the fiber cable manufacturer's recommendations.
- E. A power attenuation test and error rate test shall be performed for each installed fiber cable. The power attenuation test shall be performed at the light wavelength of the transmitter to be used on the circuit. The flux shall be measured at the fiber optic receiver end and compared to the flux injected at the transmitter end. Rotational optimization of the connectors will not be permitted. The circuit loss shall not exceed the calculated circuit loss by more than 2 dB. The bit error rate test shall be a 24-hour test. The data transmission rate shall match that to be used in the final implementation of each circuit. The bit error rate shall not exceed 1 bit error out of each million bits sent during the test period. The Contractor shall submit a written test report, stating the results of both tests. Manufacturers: Belden, Deckoron, or approved equivalent.
- F. Unshielded twisted pair Ethernet cable shall be Category 6e type UTP cable, suitable for duct or plenum mounting. Cable shall be jacketed copper conductors conforming to standard Category 6e cable specifications. Cables shall be rated for 300 volts, minimum. Manufacturers: Belden, or approved equivalent.
- G. DeviceNet cable shall be shielded copper twin-axial cable approved for use with Allen-Bradley DeviceNet (DN) controller networks. Cable shall be jacketed copper conductors suitable for duct or conduit installation. Cables shall be rated for 300 volts, minimum.

1.8 ETHERNET SWITCHES

- A. Pump Station Ethernet Products to be rack mount, stackable type with minimum connection type and quantity to suit requirements with a minimum of 40% spare capacity. Equipment shall be powered from 120 volts AC, 60 Hz, single phase.

1.9 FIBER DISTRIBUTION PANELS

- A. Fiber distribution panels will consist of a wall mount enclosure with a polycarbonate front door. (For installation inside of Main Control Room Panel and at the West High Service Back Panel). The panel shall be designed to allow bulk fiber cables to be routed to the panel and terminated on connector panels. The panel shall be provided with a minimum of one top and one bottom conduit hub for cable entry and exit. The panel shall be sized to allow termination of a minimum of 1 sets of 12 fibers. Panels shall be provided with cable strain relief kits.

PART 2 - AUTOMATION SYSTEMS

2.1 SYSTEM ARCHITECTURE OVERVIEW

- A. The requirement is for an A-B ControlLogix PLC with a Factory Talk View ME / SE HMI as operator interface.
- B. Shall include smart motor control with conventional instrumentation I/O for all new additions to the facility.
- C. The control system shall be based on "open" system architecture. That is, the system has inherent capability to integrate and exchange information with other brand system devices and platforms via industry standard communications, platforms and protocols.
- D. The Ethernet network shall have the following basic characteristics:
 - 1. The supervisory system highway is based upon AB Ethernet IP protocol operating on 100 MB Ethernet.
 - 2. The network utilizes fixed I/P addressing.

2.2 SYSTEM RELIABILITY

- A. Separate isolated power supplies shall be used for system power and field loop power.

2.3 FIELDBUS OVERVIEW

- A. It is the intent of this specification to provide the minimum requirements of the specified Fieldbus networks.
- B. HART Protocol
 - 1. Analog Inputs
 - a. If applicable control system analog inputs may include HART protocol capability for communication with HART smart instruments.
 - 2. Analog Outputs
 - a. If applicable control system analog outputs may include HART protocol capability for communication with HART smart control valves and damper drives.
- C. Modbus
 - 1. If applicable the control system is to be capable of Modbus master/slave applications.
 - 2. The system should have a controller level interface to Modbus.
 - 3. The engineering software must have the ability to import, store and manage the Modbus protocol ADU &/or PDU message. The engineering software must have the ability to modify and read parameter defined in the Modbus message. The system must support the ability to add Modbus devices and make changes to the devices without interrupting process control (powering down the controller).

PART 3 - EXECUTION

3.1 FACTORY ACCEPTANCE TEST

- A. The Contractor shall conduct a Factory Acceptance Test (FAT) at the System Manufacturer's facility prior to delivery of the system to the customer's site. The FAT shall include the complete testing of all enclosures, components, and accouterments provided by the System Manufacturer, at one time to assure communications and control which demonstrates step-by-step conformance with this specification and the functional description herein. The FAT shall be a minimum of four (4) working days in duration and shall demonstrate system function under nominal operating conditions and under simulated failure or malfunction conditions. The FAT procedure shall be submitted to the engineer for review at least 15 working days prior to the scheduled FAT.

3.2 SITE ACCEPTANCE TEST

- A. The Contractor shall also conduct a Site Acceptance Test (SAT) at the customer's facility upon completion of system installation. This test shall not begin until all field instruments, controllers, Master Station, and other accouterments are 100% functional. The SAT shall include complete testing of all panels, controllers, and instrumentation, to assure conformance with this specification and accurate calibration of field instruments.
- B. The SAT shall include testing during bad weather and/or other extreme conditions, to demonstrate functional dependability and robustness. The SAT shall be a minimum of ten (10) days in duration.

3.3 COMPUTER SYSTEM TRAINING

- A. Operator Training (at Plant Site)
 - 1. The system manufacturer shall provide training for the purpose of familiarizing OWNER's personnel with the upgraded process control system. Training shall be conducted in accordance with Section 01820 – Demonstration and Training. All tuition cost related to training courses shall be included in the system Manufacturer's bid price.
 - 2. A series of training courses shall be conducted at the plant after the startup of processes associated with the system equipment. One (1) Operator Training Course for the computer system to provide instruction in equipment operation, both individually and collectively as an operating system, shall be conducted by the System Manufacturer. All procedures required to operate and modify each process shall be covered, including the response to failure occurrences and system alarms. All operator/control system interactions shall be described and demonstrated in conjunction with the use of all process information system functions. The class shall be for a minimum of three (3) days to train up to ten (10) persons. The System Manufacturer shall coordinate training sessions with operations personnel thirty (30) days prior to conducting any classes. Custom training manuals will be included.
 - 3. The training shall be conducted at the Plant Site and shall be conducted using the Owner's system after the equipment has passed the FAT.
- B. Plant Operator/Maintenance Training
 - 1. One Maintenance Training Course for the system to provide instruction in maintaining system equipment, both individually and collectively as an operating

system. All maintenance procedures required to operate and maintain the system shall be described. The Maintenance Training shall be designed for and attended by individuals who are primarily responsible for system maintenance and repair, including on-line problem analysis and diagnosis. The Contractor shall coordinate training sessions with Owner personnel thirty (30) days prior to conducting any classes.

2. The Contractor shall supply a training submittal and outline for all system training. All literature, O&M's and equipment required for this training shall be supplied to each student. The Contractor is to submit the resume of the person who will be doing the training. This person must be factory trained and well versed in the equipment, set-up, trouble shooting, and programming. (A SALESMAN IS NOT ACCEPTABLE).

3.4 SYSTEM DOCUMENTATION

A. Operations and Maintenance Manuals

1. Submit O&M Manuals in accordance with the requirements of Section 01781, Operations and Maintenance Data.
2. In addition to the requirements of Section 01781, include the following additional information in the O&M Manuals for the Computerized SCADA System:
 - a. General description of the overall purpose of each program with any assumptions or restrictions fully explained. Format for any input and/or output messages shall be included.
 - b. Abstracts describing the operational objectives of each major program section together with an explanation of its relationship to other major program sections.
 - c. A complete listing of all hardware devices which comprise the control system. The listing shall include manufacturer, model number, physical location, and hardware address.
 - d. A complete listing of all the tag numbers in the control system along with associated description information and hardware addresses.
 - e. A complete listing of all specialized interface functions that are associated with each system function, tag, or operator function.
 - f. Complete documentation on all system and process displays including a graphical depiction of the hierarchy with linkages shown, definition of security levels associated with each display, a listing and hard copy of all displays and formats.
 - g. Complete copy of system database.
 - h. Complete set of all software configurations implemented for data acquisition, control, and alarming purposes.

END OF SECTION

SECTION 17800

ACCEPTANCE TESTING AND CALIBRATION

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. The Work includes the provision of all necessary testing, instrument calibration, and installation verification, for each system and piece of equipment complete with written reports prior to system completion. After system completion (or part thereof), the Contractor shall commence commissioning and start-up activities as specified in this section.
- B. Conform to the general requirements of Division 1 regarding testing of the instrumentation and control equipment and coordinate instrumentation and control work to facilitate testing of other equipment.
- C. Refer to Section 17010 for general instrumentation and control requirements related to testing, calibration, and installation verification.
- D. Refer to Section 17810, Commissioning and Startup for additional information and requirements.

1.2 RELATED SECTIONS

- A. 01781, Operations and Maintenance Data
- B. 01810, Commissioning
- C. 17010, Instrumentation for Process Control General Provisions
- D. 17810, Commissioning and Start-Up

PART 2 – PRODUCTS

Not Applicable

PART 3 – EXECUTION

1.3 INSTALLATION TESTING

- A. Prior to the completion of the Work, perform comprehensive testing of the installation. Include the following activities:
 - 1. Wire insulation tests.
 - 2. Wire continuity tests including associated terminations.
 - 3. Grounding system continuity and isolation tests.
 - 4. Any other testing necessary to verify the operation of equipment and installation work.

- B. Provide the services of a manufacturer's representative for equipment to assist with any of the equipment tests to be performed. Any components, incorrect wiring, or systems found to be defective or deficient during the tests shall be repaired or replaced.
- C. Coordinate test schedules with the Engineer.
- D. The participation in testing activities and use of the equipment during testing periods by the Owner is to be allowed provided it does not adversely affect specified testing requirements. Such participation shall not relieve the Contractor of any of the obligations stipulated herein.
- E. Prior to the commencement of any testing, the Contractor shall ensure that all spare parts, expendables, and test equipment pertinent to the system being tested are on site. Test equipment shall include all necessary multi-meters, process instrument calibrators for 4-20 mA, 24 VDC devices and signal generators or simulators. Test equipment shall be provided by the Contractor and shall remain the property of the Contractor at the end of all testing.

1.4 VERIFICATION CHECKS

- A. When the system installation has been completed (or part thereof), perform detailed verification checks for all systems supplied and installed as part of the Work. In the checks and reviews, include the following:
 - 1. Certify that the equipment has been installed as per the Contract drawings and recommended installation procedures, reporting any discrepancies to the Engineer.
 - 2. Certify that the equipment power and grounding requirements have been satisfied, reporting any discrepancies to the Engineer. For the grounding system, include an itemized check of each instrument circuit to verify the correct isolation of all shields and instrument grounds.
 - 3. Certify that all terminations to the equipment are properly installed. Report any discrepancies to the Engineer.
 - 4. Certify that all wiring continuity (whether new or existing) has been verified.
 - 5. Certify that all process taps and instrument connections have been performed according to the requirements detailed herein and shown on the drawings.
 - 6. Certify that the installation (or part thereof as completed) is ready for commissioning and start-up.
 - 7. Witnessed Functional Acceptance Test shall be done on the complete control system. During this test, the contractor has to execute component by component and loop by loop tests. The correct results have to be verified in the field, on the associated PLCs and PCS applications. The test shall be performed using approved procedures and shall be signed off upon satisfactory completion.
- B. Undertake any corrective action found to be necessary during the course of the verification checkout and review.
- C. Report any discoveries of defects or deficiencies in writing to the Engineer for any equipment supplied by the Owner.
- D. Allow for the participation of the Owner's personnel in the verification checks. Such participation shall not relieve the Contractor of any of the obligations.

- E. Prepare the various reports and certificates described herein. Forward three (3) copies of each report or certificate to the Engineer. Clearly identify any discrepancies which require action on the part of the Engineer.

1.5 CALIBRATION AND CONFIGURATION

- A. In situ, calibrate and adjust all instrumentation to verify correct operation, range adjustment, compensation, scaling, etc. Provide instrument calibration services for all individual components such as signal transmitters, analyzers, transducers, power supplies, and like equipment where appropriate.
- B. Test equipment for calibration must have been certified and valid at time of calibration.
- C. Provide certified calibration reports for each instrument. In the reports, include, but do not limit to, such information as:
 - 1. Device tag number
 - 2. Equipment description
 - 3. Service application
 - 4. Process variable measurement range
 - 5. Description of calibration equipment used
 - 6. "As found" calibration data
 - 7. "As left" calibration data
 - 8. Date, name, and signature of technician.
- D. Include calibration reports in the Operating and Maintenance manuals described in Section 01781, Operations and Maintenance Data.
- E. Where applicable, instruments shall be factory pre-calibrated and the calibration verified in-place after installation. Provide a printed record of the factory calibration parameters for "smart" devices.
- F. Prior to calibration completely program and configure all "intelligent" instruments including entries of the appropriate range and tag number e.g., HART instruments. Tags are as shown on the P&IDs. Where specific loop configurations are required a block loop schematic will be provided for input prior to commissioning. Provide a printed record of device serial numbers against their assigned tag number and record all block assignments and configurations.
- G. Verify that devices respond to the assigned address, label each device with the address and maintain a permanent record of the addressing scheme.
- H. Instrument set up and calibration is to be conducted by a qualified technician working under the approval of the instrument manufacturer and with qualifications as described in this section.
- I. Calibrate all instruments to an accuracy of 1/2 of one percent of reading, or to the manufacturer's stated accuracy for the instrument.

- J. Calibrate all instruments in accordance with the manufactures recommendations. In addition perform applicable calibration checks for each instrument and its associated signal conditioning equipment.
- K. Internal software of Fieldbus instruments should be configured by the manufacturer, including at least the following information:
 - 1. Serial number
 - 2. Tag name
 - 3. Process use description
- L. After all devices within a loop have been connected, check the loop for correct functioning and interaction with other loops, where applicable.
- M. Check the operation of all final control elements such as solenoid valves, actuators, and the like by manual control before checking with automatic control.
- N. Check the electrical and pneumatic failsafe operations of all final control elements such as solenoid valves, actuators, and the like.
- O. Test all tubing for leaks in compliance with ISA RP 7.1. Isolate all instruments when tubing is being tested to protect against over-pressure.
- P. Provide two weeks written notice to the Owner prior to energizing any system to allow for inspection by the Engineer of the following:
 - 1. Proper mounting
 - 2. Proper connections
- Q. The Contractor is to provide a qualified instrument technician at times suitable to the Engineer, to remove covers for inspection and to perform such tests as the Engineer shall require to confirm proper mounting and connection of all equipment.
- R. Demonstrate to the Owner proper calibration and correct operation of a selected number of instruments and gauges.

1.6 TEST FORMS

<u>Form No.</u>	<u>Title</u>
LCR	Loop Check Report
ITR	Instrument Test Report

END OF SECTION

LOOP CHECK REPORT

- CHECKED OUT OK
- NOT APPLICABLE
- FURTHER ACTION REQUIRED

	INSTRUMENT TAG NO.									
LOOP NO. _____										
SHEET NO. _____										
P & I DWG. NO. _____										
INSTALLATION COMPLETE										
Primary Element										
Impulse Lines										
Block and Drain Valves										
Air Supply/Filter/Reg.										
Wiring										
Tracing/Insulation/Housing										
Mounting and Location										
PLC I/O & Status										
CALIBRATED										
Impulse Lines Press. Tested										
LOOP CHECKED										
Element To Receiver										
X Mtr. to Receiver										
X Mtr./Trans. to Receiver										
X Mtr./Trans. to Switches										
Switches to Annunciator										
Interlocking Circuit										
Controller to Valve										
Controller Action D or R										

REMARKS:

READY FOR START-UP

DATE: _____

Installed by: _____

Checked by: _____

INSTRUMENT TEST REPORT

SYSTEM: _____ TAG NO.: _____
 SERVICE: _____
 LOCATION: _____ MODEL: _____
 MAKE: _____ UL: _____
 SERIAL NO.: _____ RANGE: _____
 ELEMENT: _____ CONTACT TO: _____ ON: _____
 DESIGN SETTING/RANGE: _____ ASSOCIATED INSTRUMENT: _____
 SIGNAL IN: _____ OUT: _____ CONFORM TO SPEC: _____
 INSTRUMENT CONDITION: _____ DATA SHEET: _____
 PROJECT NO.: _____

TEST METHOD	TEST 1				TEST 2			
	INPUT		OUTPUT		INPUT		OUTPUT	
	INC.	DEC.	INC.	DEC.	INC.	DEC.	INC.	DEC.
TEST POINT 1								
TEST POINT 2								
TEST POINT 3								
TEST POINT 4								
TEST POINT 5								
COMMENTS								
GRAPHS								

SECTION 17810

COMMISSIONING AND STARTUP

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. In cooperation with the Engineer and Plant Control System (PCS) System Integrator shall perform extensive commissioning and start-up functions to verify the operation of all of the systems described herein as the installation is completed. Cooperation will be required to facilitate the timely performance of these activities. The Contractors System Integrator Team, under the direction of the Engineer, will coordinate and schedule all activities associated with commissioning and start-up, and the Contractor shall cooperate and arrange its schedule of the Work to facilitate the timely performance and completion of this work.
- B. Commissioning and handover of the facilities will comply with the requirements of Division 1.
- C. It is the responsibility of General Contractor and Plant Control System (PCS) System Integrator to provide a coordinated and detailed commissioning and start-up program. The overall program will be presented to the owner and Engineer for approval.

1.2 RELATED SECTIONS

- A. Section 01810, Commissioning Plan
- B. Section 17010, Instrumentation for Process Control General Provisions
- C. Section 17800, Acceptance Testing and Calibration

1.3 COMMISSIONING

- A. Refer to the requirements of Division 1 for additional commissioning requirements.
- B. Inspections:
 - 1. Provide two (2) weeks' written notice to the Engineer prior to energizing any system to allow for inspection by the Engineer.
- C. During commissioning demonstrate to the Engineer or the Engineer's representative proper calibration and correct operation of instruments and gauges.
- D. Commissioning of the instrumentation and control system to include but not be limited to the following:
 - 1. Verify instrument calibration and provide written report.
 - 2. Verify signal levels and wiring connections to Marshalling Panel(s) and Local Control Panels for all instrumentation and control equipment.
 - 3. Function check and adjust under operational conditions the instruments and control equipment.

4. Coordinate instruments and control equipment supplier's service personnel as required for complete system testing.
5. The Contractor shall make provision to be available and coordinate with the Plant Control System programming team, and the commissioning team to check the sensor signals from source to destination.
6. Instruct plant personnel in correct method of operation of instruments and control equipment.
7. Direct plant personnel at hand-over as to final adjustment of the system for correct operation of plant.

PART 2 - PRODUCTS

Not Applicable

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Prior to commissioning and start-up activities, a series of operational tests will be performed by the Contractor, including, but not be limited to:
 1. Verification of correct transmission of signals from field instrument to the receiving device (controller I/O modules and DeviceNet communication ports).
 2. Verification of correct transmission of signals from smart overloads, variable frequency drives (VFDs), power monitor and communication gateways.
 3. On completion of installation:
 - a. Check all controlling inputs and controlled outputs for individual correctness prior to activation of any line equipment
 - b. Perform all equipment function operation and interlock checks prior to activation of any line equipment (dry run check)
 - c. Place all equipment on line and energize for an actual controlled operation cycle
 4. Complete any corrective action necessary that has been identified as part of the checkout procedure, on an ongoing basis.
- B. Control System commissioning will be considered complete when, in the opinion of the OWNERS representative, the control system hardware or designated portion has properly operated for fourteen (14) continuous days, 24 hours per day without interruption. This 14-day period is in addition to any test periods or operational demonstrations specified elsewhere. The objective will have been achieved once it has been demonstrated that all systems are operating and have complied with the specified performance requirements herein.

- C. The complete system will be “challenged tested”. Multiple modes of operation will be testing including various pump combinations and operation condition. Testing will also include failure testing and recovery. If during the “challenge test” an unexpected result/problem is observed, the Contractor will be given an opportunity to correct the unexpected result/problem. If the unexpected result/problem can’t be correct (Major Failure) within 24 hours, the Contractor will suspend the test, fully document the issue and propose a solution. Once this solution is accepted by Owner/Engineer and implemented, the “challenge test” will start over from original stating point. “Challenge testing” will occur during 14-day commissioning period as described in specification 17810 3.01 B, any Major Failure during test will reset the 14-day test period.
- D. Complete and submit the “Loop Check Commissioning Sheet” for each device. Include all completed forms in the instruction books.

3.2 GENERAL INSTRUMENTATION CHECK LIST

- A. Instrument cables and the individual conductors are tagged and identified.
- B. Instrument cables are terminated on approved termination blocks.
- C. Conductors are terminated in an approved manner on termination blocks and at connection points on the instrument.
- D. Conductors are terminated on identified blocks.
- E. Termination boxes and junction boxes are identified and tagged.
- F. Instrument cables are supported and strapped.
- G. Instruments (flow meter, level transmitter, etc.) are tagged and identified.
- H. Instruments are bonded to ground.
- I. Instruments are adequately supported.
- J. Instruments are located free of mechanical damage.
- K. Instruments are new.
- L. Instruments are free of dents, scratches, cracks, breaks, defects and damage.
- M. Instruments are rated for the environment in which they are placed (indoor, corrosive, classified, outdoor, etc.)
- N. Flexible connections or fittings are used to connect to the instruments.
- O. Fittings for connections are water tight and secure.
- P. Instrument control wiring is separated from power wiring.
- Q. Instrument control cable is shielded, twisted or configured in an approved manner to minimize electromagnetic and electrostatic interference.

- R. Instruments are tested, calibrated and adjusted to operate within prescribed parameters.
- S. 'Loop check sheets' and 'instrument calibration sheets' have been completed for each device.
- T. All equipment will bear the UL label.
- U. Wiring at different voltage levels within the same panel or termination box are segregated by an effective barrier.
- V. A minimum clearance of 1 ½ inch is provided between the wireway and any point of wire termination.

END OF SECTION

TECHNICAL DATA

	Specified	Shop Drawing	Installed	Verified By
Supplier	_____	_____	_____	<input type="checkbox"/>
TRANSMITTER:	_____	_____	_____	<input type="checkbox"/>
Manufacturer	_____	_____	_____	<input type="checkbox"/>
Model No.	_____	_____	_____	<input type="checkbox"/>
Serial No.	_____	_____	_____	<input type="checkbox"/>
Class/Division.	_____	_____	_____	<input type="checkbox"/>
EEMAC Enclosure Rating	_____	_____	_____	<input type="checkbox"/>
Accuracy	_____	_____	_____	<input type="checkbox"/>
Ambient Temperature Limit	_____	_____	_____	<input type="checkbox"/>
Calibration	_____	_____	_____	<input type="checkbox"/>
Max. Load	_____	_____	_____	<input type="checkbox"/>
Max. Output current	_____	_____	_____	<input type="checkbox"/>
Output Signal	_____	_____	_____	<input type="checkbox"/>
Power Supply	_____	_____	_____	<input type="checkbox"/>
Measurement Range	_____	_____	_____	<input type="checkbox"/>
-Conductivity	_____	_____	_____	<input type="checkbox"/>
-Temperature	_____	_____	_____	<input type="checkbox"/>
Transmission Signal	_____	_____	_____	<input type="checkbox"/>
SENSOR:	_____	_____	_____	<input type="checkbox"/>
Model No.	_____	_____	_____	<input type="checkbox"/>
Class/Division	_____	_____	_____	<input type="checkbox"/>
Cable Length	_____	_____	_____	<input type="checkbox"/>
Measurement Range	_____	_____	_____	<input type="checkbox"/>
Process Temperature Range	_____	_____	_____	<input type="checkbox"/>
-Peak	_____	_____	_____	<input type="checkbox"/>
-PFA	_____	_____	_____	<input type="checkbox"/>
Process Connection	_____	_____	_____	<input type="checkbox"/>

STATIC CHECK

Media in Line:	_____	Water Temp. in Line	_____
Mounting Type (Panel/Wall):	_____		_____

OPERATION CHECK

Flow Rate to Analyzer:	_____	Pressure in Process Line:	_____
Number of Samples to Analyzer:	_____		_____

WARRANTY

Start:	_____		_____
Expire:	_____		_____

Signature _____ Commissioning Agent

Signature _____ Contractor

Appendix A

Geotechnical Report



February 8, 2013

Mr. Glen Wiczorek, P.E.
Stantec
3754 Ranchero Drive
Ann Arbor, Michigan 48108-2771

**RE: Geotechnical Investigation
Storage Building –
Barton Pump Station
Ann Arbor, Michigan
CTI Project No. 3132040004**

Dear Mr. Wiczorek:

CTI and Associates, Inc. (CTI) has completed a geotechnical investigation for the proposed storage building project at the Barton Pump Station in Ann Arbor, Michigan. The purpose of our investigation was to determine the general subsurface conditions at the proposed development area and to provide recommendations for foundation support. Our investigation was performed in general accordance with the scope of services outlined in CTI Proposal No. 113PRO2040-018 dated January 25, 2013 and authorized by Mr. Glen Wiczorek, P.E. of Stantec on January 25, 2013.

In general, the geotechnical investigation revealed near-surface fill, underlain by alternating layers of fine and coarse aggregate containing varying amounts of silt and clay. The encountered aggregate layers were underlain by clay to the final explored depth of the boring. Groundwater was encountered during drilling at a depth of 3½ feet below the existing ground surface. Care should be taken during foundation excavation to avoid encountering the groundwater table. Excavations should not extend to depths greater than 2 feet below the existing site grades, or approximately Elevation 779.5 feet. The overall stability of the subgrade will depend highly on the prevailing moisture content of the subgrade soils. For this reason, special precautions should be taken throughout the construction activities to limit disturbance of the subgrade soils, especially if they are wet. In order to give greater relief between the encountered groundwater and the anticipated foundation invert elevation, consideration should be given to raising the finished floor elevation to greater than Elevation 783 feet.

SITE AND PROJECT DESCRIPTION

The proposed development area is located at the Barton Pump Station, on the east side of Huron River Drive, approximately 200 feet north of Bird Road in Ann Arbor, Michigan. The proposed development site is situated between the pump station building and an existing storage building. A portion of the development area is currently covered by a reinforced concrete slab, while the remaining development area is vacant and covered by grass and/or a gravel driveway.

The proposed project consists of the construction of a new storage building. The proposed building will be approximately 3,200 square feet in plan area. We anticipate the building will be a single story, pre-engineered metal structure with timber framing, slab-on-grade construction

and no basement. We understand that the finished floor elevation has been set at Elevation 783 feet. Accordingly, we anticipate up to 1½ feet of fill will be required to achieve finished grade.

Structural loads were not provided to CTI. For the purpose of this report, and based on our experience with similar structures, we anticipate that the structure will have a maximum wall load of 2 kips per lineal foot.

INVESTIGATION PROCEDURES

Field Investigation

As requested due to the access limitations and anticipated underground utilities at the site, CTI performed one soil boring to a depth of 20 feet below grade. The boring location was selected and marked in the field by Stantec personnel. The approximate boring location is shown on the Boring Location Plan, included with this report.

Prior to the drilling operations, Mr. Jim Meehle of CTI located and marked the existing underground electrical lines in the vicinity of the proposed boring. The drilling operations were performed by Stearns Drilling on February 1, 2013. The soil boring was drilled with a rotary head drilling rig using continuous flight hollow-stem augers. Within the test boring, split spoon samples were obtained at intervals of 2½ feet to a depth of 10 feet and at 5-foot intervals thereafter. The soils samples were obtained by the Standard Penetration Test Method (ASTM D1586), whereby a 2-inch outside- diameter split-barrel sampler is driven into the soil with a 140-pound weight falling freely through a distance of 30 inches. The sampler is generally driven three successive 6-inch increments, with the number of blows for each increment being recorded. The number of blows required to advance the sampler the second and third 6-inch increment is termed the Standard Penetration Resistance, N. The soil samples obtained with the split-barrel sampler were sealed in glass jar containers and transported to our laboratory for further classification and testing. After completion of the drilling operations, the borehole was backfilled with excavated soil. Selected soil samples were tested in the laboratory.

The laboratory testing program determined the general soil classification and physical properties of recovered samples. All laboratory testing was performed in general accordance with applicable ASTM test method standards. The laboratory testing program consisted of visually classifying each collected soil sample in general accordance with the Unified Soil Classification System (USCS), and natural moisture content testing of selected samples. The unconfined compressive strength of selected cohesive samples was also estimated based on the resistance to a calibrated spring-loaded hand penetrometer. The results of all laboratory tests are indicated on the boring log at the depths from which the samples were obtained.

Soil and groundwater conditions observed in the test boring have been evaluated and are presented on the boring log included with this report. To aid in understanding the data presented on the boring log, “General Notes for Soil Classification,” describing nomenclature used in soil descriptions, are also included. The soil descriptions reported on the boring log are based upon the field log prepared by experienced drillers with modifications made by experienced engineers based on supplemental classification and on the results of laboratory testing.

SUBSURFACE CONDITIONS

Soil Conditions

Approximately 4 inches of topsoil fill was encountered at the boring location. The topsoil fill was underlain by gravel fill to a depth of about 1½ feet below the existing grade. Below the gravel fill, sandy clay identified as “possible fill” was encountered to a depth of about 3½ feet below the existing grade. In the absence of foreign debris it is difficult to distinguish between native soil and “clean” fill in a relatively small diameter borehole. Loss-on-Ignition testing indicated that the clay fill had an organic content of approximately 1.7 percent.

The possible clay fill layer was underlain by alternating layers of fine and coarse aggregate (sand and gravel) containing varying amounts of silt and clay to a depth of approximately 14 feet. Below the aggregate layers, clay with occasional wet silt seams and sand partings were encountered to the final explored depth of the boring.

Standard Penetration Test (SPT) resistance values (N-values) within the sand and gravel layers ranged from 17 to 31 blows per foot, indicating medium dense to dense relative densities. The sand and gravel samples appeared to be in a wet condition when examined in the laboratory.

N-values recorded within the native clay ranged from 8 to 17 blows per foot. The unconfined compressive strength of the tested clay samples ranged from 3,000 pounds per square foot (psf) to 7,000 psf, indicating stiff to very stiff consistencies. The moisture contents of representative native clay samples ranged from approximately 13 to 15 percent. The clay samples generally appeared to be in a moist condition when examined in the laboratory.

The stratification depths shown on the soil boring log represent the soil conditions at the specific boring location. Variations in the soil conditions may occur at locations other than the boring location.

Groundwater Conditions

Groundwater seepage was encountered within Boring B-1 during drilling at a depth of about 3½ feet, or approximately Elevation 778 feet. Collapse of the test boring upon auger removal precluded accurate measurement of the groundwater level upon completion of the drilling operations.

The groundwater conditions discussed herein and indicated on the soil boring log represent those encountered at the time of the field investigation. The groundwater levels, including perched groundwater accumulations, should be expected to fluctuate seasonally, based on variations in precipitation, evaporation, surface run-off, river management, and other factors not evident at the time of our investigation.

The above soil and groundwater conditions represent a generalized summary of the subsurface conditions and material characteristics. The individual boring log and Boring Location Plan should be reviewed for specific information and details relating to specific areas of the site.

ANALYSIS AND RECOMMENDATIONS

In general, the geotechnical investigation revealed near-surface fill, underlain by alternating layers of native fine and coarse sand and gravel containing varying amounts of silt and clay. Groundwater was encountered at a depth of 3½ feet below the existing grade. Due to the proximity of the Huron River, removal of the existing fill would require an extensive dewatering effort that may not be entirely adequate to allow for construction to progress. Care should be taken during foundation excavation to avoid encountering the groundwater table. Excavations should not extend to depths greater than 2 feet below the existing site grades, or approximately Elevation 779.5 feet. In order to give greater relief between the encountered groundwater and the anticipated foundation invert elevation, consideration should be given to raising the finished floor elevation to greater than Elevation 783 feet.

The overall stability of the subgrade will depend highly on the prevailing moisture content of the subgrade soils. For this reason, special precautions should be taken throughout the construction activities to limit disturbance of the subgrade soils, especially if they are wet

Site Preparation

Approximately 3½ feet of uncontrolled fill materials fill with trace amounts of organics intermixed were encountered at the test boring location. The presence and thickness of fill is anticipated to vary across the proposed development area. The Owner may elect to support the foundation and floor slab over the existing fill materials in order to avoid potential issues with dewatering the site, which would be required if the fill is removed. The Owner should realize that the recommendations presented below will reduce but not entirely eliminate the risk of foundation and slab distress if the existing fill soils are to remain below the proposed structure.

At the start of earthwork operations, the existing slab, all existing topsoil and any other deleterious materials should be removed in their entirety from the proposed building area. The presence and thickness of unsuitable soils may vary across the site. The depth of unsuitable soil to be removed should be determined by CTI at the time of stripping and rough grading. A CTI representative should also be on-site during the subgrade preparation operations to determine the suitability of the subgrade for floor slab and/or engineered fill support.

After rough grade has been achieved in cut areas and prior to fill placement in fill areas, the exposed subgrade should be thoroughly proofrolled. Proofrolling should be performed with a heavily loaded front-end loader, tandem-axle dump truck or other suitable rubber-tired vehicle. The purpose of proofrolling operations is to locate areas of excessively loose, soft or weak subgrade soils which may be present at the time of construction. Soils that are observed to rut or deflect excessively during proofrolling should be stabilized by conventional methods such as disking, drying and re-compacting.

If it is not feasible to dry and re-compact the unsuitable subgrade soils due to unfavorable weather conditions, scheduling, etc., it may be necessary to remove such soils and replace them with engineered fill. The thickness of the undercut will depend on the severity of the unstable soils encountered at specific locations. If significant subgrade instability is observed, a layer of crushed aggregate may be necessary to stabilize the subgrade before placement of the selected engineered fill material. The use of a woven geotextile material below the crushed aggregate layer could also be considered to provide additional subgrade stability.

Engineered Fill

After subgrade preparation and observation have been completed, engineered fill placement may begin. Any fill placed below the proposed foundations should be an approved material that is free of topsoil, organics, frozen soil or any other unsuitable material. The existing soils are not considered suitable for re-use as engineered fill.

If clay soils or granular soils containing greater than 12 percent clay are used as fill, close moisture content control will be required to achieve the recommended degree of compaction. Cohesive fill materials should be low to medium in plasticity, with a liquid limit less than 40 and plasticity index less than 20. It should be noted that wet cohesive soils are difficult to compact and that the specified compaction may not be achieved. Wet cohesive soils may require drying or mixing with dry soil to facilitate compaction. If water must be added to dry soil, it should be uniformly applied and thoroughly mixed into the soil by disking or scarifying.

The engineered fill should be placed in uniform horizontal layers not exceeding 8 to 12 inches in loose thickness for clean granular soils and 4 to 6 inches in loose thickness for clay soils (or clayey granular soils exhibiting cohesive characteristics), depending on the type and size of compaction equipment used. The lift thickness for sands that have an appreciable amount of fines should be decreased accordingly. The engineered fill should be compacted to achieve a density of not less than 95 percent of the maximum dry density as determined by the Modified Proctor Compaction Test (ASTM D1557). Also, the upper 12 inches of the subgrade soils should be compacted, prior to any fill placement, to achieve a density of not less than 95 percent of the maximum dry density as determined by the Modified Proctor test. The as-compacted moisture content of the engineered fill should be within 2 to 3 percent of the optimum moisture content for the soil, as determined by the Modified Proctor test. The placement and testing of engineered fill should be observed and properly documented in the field by CTI.

If site grading or other construction activity is planned during cold weather, it is recommended that proper winter construction practices are followed. All snow and ice should be removed from cut and fill areas prior to grading. Frozen materials should not be used as engineered fill and no fill, footings or slabs should be placed on soils that are frozen or contain frozen material.

Foundation Support

Based on the subsurface conditions encountered during our drilling operations, adequate foundation soils are available at this site on which to support conventional foundations at a low allowable bearing pressure. Due to the relatively shallow groundwater lever at this site, we recommend that the foundations bear on the stiff, sandy clay and be designed for a maximum allowable bearing pressure of 2,000 psf. All footings should be suitably reinforced to reduce the effects of differential settlement associated with local variations in subsoil conditions.

If the Owner is unwilling to accept increased risk of settlement (both total and differential) associated with designing the foundations to bear on the near-surface clay fill, he may elect to support the foundations on helical piers or similar deep foundation system.

The foundation should be founded a minimum of 42 inches below exterior finished grade for protection against frost penetration during normal winters. If foundation construction occurs during the winter, the foundations must be protected from frost action beneath the footings and

freezing of concrete by embedment and/or thermal heaters and proper insulation.

The foundation excavation should be observed and concrete placed as quickly as possible to avoid exposure of the foundation bearing soil to wetting and drying. Surface runoff water should be drained away from the excavations and not be allowed to pond. The foundation concrete should be placed during the same day the excavation is made. If it is required that footing excavations be left open for more than one day, they should be protected to reduce evaporation or entry of moisture.

We recommend the foundation construction and concrete placement be observed by a CTI representative. Our representative will perform the appropriate type and number of field tests in order to verify that the foundation bearing materials are suitable and ensure overall compliance with the construction specifications.

Based on the anticipated structural loads and the building foundations being designed and constructed in accordance with the recommendations of this report, total and differential settlement should be within tolerable limits. Total settlement on the order of 1-inch or less is estimated for the footings. Differential settlements are estimated to be about 75% of the total settlement (however, a complete settlement analysis was not possible based on the limited information available). The anticipated settlements provided herein are only estimates based on the available soil boring information, the assumed structural loads and our experience with similar soil conditions. Careful field control will contribute significantly in controlling the settlements.

Floor Slab Support

The subgrade soils for support of the floor slab should be prepared as described in the Site Preparation section of this report. Following site preparation activities, it appears the existing soils will be adequate to support the floor slab. Proper evaluation of the subgrade soils should be performed during construction to verify that suitable soil conditions exist for support of the floor slab.

If soft, loose or unsuitable soils are encountered at the subgrade level, we recommend that these materials be undercut to an adequate depth and replaced with properly compacted granular fill soil. Proofrolling, as discussed earlier in this report, should be performed to identify any soft or unsuitable soils, which should then be removed from the floor slab area prior to fill placement and/or floor slab construction.

The floor slab should be supported on a minimum 4 inch layer of clean granular material to help distribute concentrated loads and equalize moisture conditions beneath the slab. MDOT Class II sand, a dense-graded aggregate or other similar granular engineered fill is recommended for this purpose. A thicker layer of the granular or aggregate material may be required to provide a stable surface, depending on the condition of the subgrade soils and the type of construction equipment to traffic the building pad area.

Following the site preparation techniques described in this report, a modulus of subgrade reaction, k-value, of 120 pounds per square inch per inch of deflection (pci) can be used for floor slab design with engineered fill placed over the suitable soils. The floor slab subgrade soils should be protected from frost during winter construction. Any frozen soils should be thawed and re-compacted or removed and replaced prior to the placement of additional fill, floor slabs or pavement.

It is recommended that the floor slab be suitably reinforced and isolated from the elements of the structure that are supported on the foundations. This practice minimizes the possibility of cracking and displacement of the floor slab due to differential movements between the slab and foundation.

Groundwater Control

The finished floor elevation has been set at Elevation 783 feet, which is approximately 1½ feet above the existing ground surface at the boring location. The foundation is anticipated to bear at Elevation 779.5 feet. As indicated previously, groundwater was encountered within B-1 during the drilling operations at a depth of 3½ feet below the existing ground surface, or approximately Elevation 778 feet. Due to the proximity of the Huron River, removal of the existing fill would require an extensive dewatering effort that may not be entirely adequate to allow for construction to progress.

Based on the anticipated finished floor and foundation bearing elevations, we anticipate that excavations will extend to approximately Elevation 779.5 feet. Excavations should not extend to depths greater than this elevation, or about 2 feet below the existing ground surface. If signs of upheaval failure or instability of the bearing soils are observed, a qualified geotechnical engineer should be retained so that the best remedial measures can be determined.

GENERAL COMMENTS

The evaluations and recommendations discussed in this report are based on the anticipated design and the soil conditions encountered in the test boring performed at the approximate location indicated on the attached Boring Location Plan and on the date indicated on the boring log.

We appreciate the opportunity to be of service to you on this project. If we can be of further assistance, please contact our office.

Sincerely,

CTI and ASSOCIATES, INC.

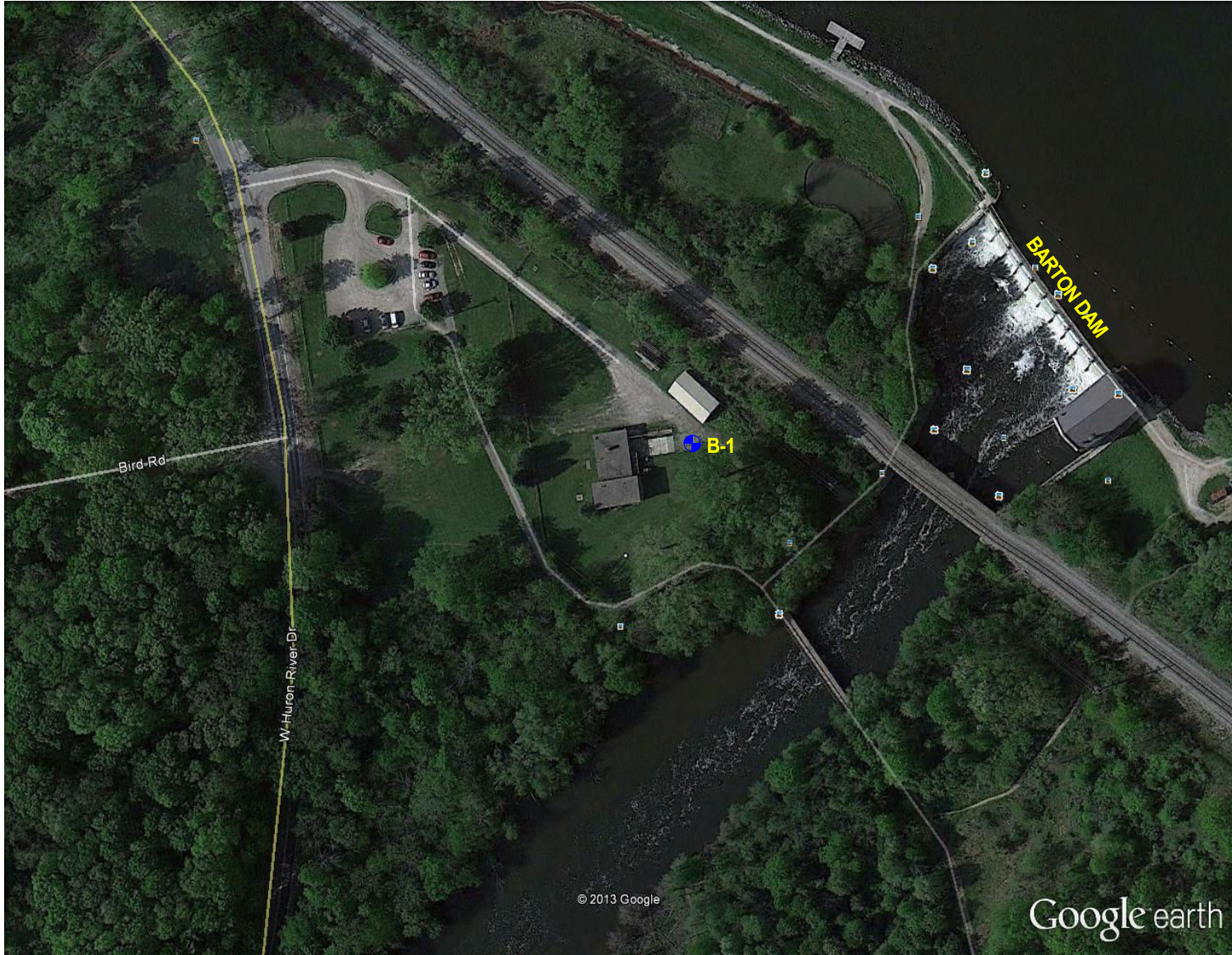


Theresa M. Marsik, P.E., LEED AP
Senior Project Engineer



Kevin Foye, Ph.D., P.E.
Project Engineer

Attachments – Boring Location Plan
Boring Log (B-1)
Summary of Laboratory Results
General Notes for Soil Classification



NOTE: IMAGE REPRODUCED FROM GOOGLE EARTH.

LEGEND:
● - APPROXIMATE BORING LOCATION

SCALE:	As Shown
PROJECT NUMBER:	313204004
FILE NAME:	BORINGPLAN.CAD
DATE:	1-29-13

BORING LOCATION PLAN
PROPOSED STORAGE BUILDING -
BARTON PUMP STATION
ANN ARBOR, MICHIGAN

PLATE:
1

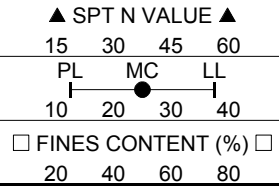




CLIENT Stantec
PROJECT NUMBER 3132040004
DATE STARTED 2/1/13 **COMPLETED** 2/1/13
DRILLING CONTRACTOR Stearns Drilling
DRILLING METHOD 4-1/4-inch HSA
LOGGED BY D. Merideth **CHECKED BY** T. Marsik
NOTES Boring backfilled with auger cuttings.

PROJECT NAME Proposed Storage Building - Barton Pump Station
PROJECT LOCATION Ann Arbor, Michigan
GROUND ELEVATION 781.5 ft +/-
GROUND WATER LEVELS:
DURING DRILLING 3' 6"
AFTER DRILLING 3'
COLLAPSE DEPTH 4' 6"

DEPTH (ft)	GRAPHIC LOG	MATERIAL DESCRIPTION	SAMPLE TYPE NUMBER	RECOVERY % (RQD)	BLOW COUNTS (N VALUE)	POCKET PEN. (tsf) UNC. STRENGTH (psf)	NATURAL MOISTURE CONTENT (%)	▲ SPT N VALUE ▲									
								15	30	45	60						
0		4 inches of dark brown moist silty TOPSOIL FILL															
		Brown moist fine GRAVEL with sand - (FILL)															
		Dark gray moist stiff sandy CLAY with silt and traces of gravel and organics - (CL/Possible FILL) Loss-on-Ignition (Organic Content) = 1.7%	SS 1	67	8-5-6 (11)			15									
		Brown wet medium dense silty fine to medium silty SAND with some gravel - (SM)	SS 2	67	2-7-14 (21)												
5		Brown wet dense fine to coarse GRAVEL with sand and some clay - (GP-GC)	SS 3	67	9-14-17 (31)												
		Brown wet silty fine to coarse SAND with gravel and occasional cobbles - (SM)	SS 4	89	10-8-9 (17)												
10		Brown wet fine SAND with some silt - (SP-SM)															
		Gray moist stiff CLAY with silt and traces of gravel and sand - (CL)	SS 5	67	5-7-10 (17)	1.5		15									
15		Gray moist to wet SILT with some sand - (ML)															
		Gray moist very stiff silty CLAY with traces of gravel and sand and occasional wet sand partings - (CL-ML)	SS 6	89	4-4-4 (8)	3.5		13									
20		Bottom of borehole at 20.0 feet.															





CTI and Associates Inc

SUMMARY OF LABORATORY RESULTS

PAGE 1 OF 1

CLIENT Stantec

PROJECT NAME Proposed Storage Building - Barton Pump Station

PROJECT NUMBER 3132040004

PROJECT LOCATION Ann Arbor, Michigan

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Classification	Water Content (%)	Dry Density (pcf)	Unc. Strength (tsf)	Loss-on-Ignition (%)
B-1	2.5						FILL	15			1.7
B-1	15.0						CL	15		1.5	
B-1	20.0						CL-ML	13		3.5	



GENERAL NOTES FOR SOIL CLASSIFICATION

STANDARD PENETRATION TEST: Driving a 2” outside diameter, 1-3/8” inside diameter sampler a distance of 18 inches into undisturbed soil with a 140 pound hammer free falling a distance of 30 inches. The sampler is driven three successive 6-inch increments. The number of blows required for the last 12 inches of penetration is termed the Standard Penetration Resistance (N).

GROUNDWATER: Observations are made at the times indicated on logs. Porosity of soil strata, weather conditions and site topography may cause changes in the water levels.

SOIL CLASSIFICATION PROCEDURE: Classification on the logs is generally made by visual inspection. For fine-grained soils (silt, clay and combinations thereof), the classification is primarily based upon plasticity. For coarse-grained soils (sand and gravel), the classification is based upon particle size distribution. Minor soil constituents are reported as “trace” (0-5%), “some” (5-12%) and “with” (15-29%). Where the minor constituents are in excess of 29%, an adjective is used preceding the major constituent name (i.e. for sands containing 35% silt, the soil is classified as silty sand).

PARTICLE SIZE DISTRIBUTION

Boulders	-	Greater than 12 inches average diameter
Cobbles	-	3 inches to 12 inches
Gravel –		
Coarse	-	¾ inches to 3 inches
Fine	-	No. 4 (4.75mm) to ¾ inches
Sand –		
Coarse	-	No. 10 (2.00mm) to No. 4 (4.75mm)
Medium	-	No. 40 (0.425mm) to No. 10 (2.00mm)
Fine	-	No. 200 (0.075mm) to No. 40 (0.425mm)
Silt and Clay	-	Less than 0.075mm, Classification based upon plasticity. Generally silt particles size ranges from 0.005mm to 0.075mm and clay particle size is less than 0.005mm.

CONSISTENCY OF FINE GRAINED SOILS IN TERMS OF UNCONFINED COMPRESSIVE STRENGTH AND N-VALUES

<u>Consistency</u>	<u>Unconfined Compressive Strength (Tons per square foot)</u>	<u>Approximate range of N</u>
Very Soft	Less than 0.25	0 - 2
Soft	0.25 to 0.5	3 - 4
Medium Stiff	0.5 to 1.0	5 - 8
Stiff	1.0 to 2.0	9 - 15
Very Stiff	2.0 to 4.0	16 - 30
Hard	over 4.0	over 31

RELATIVE DENSITY OF COARSE GRAINED SOILS ACCORDING TO N-VALUES

<u>Density Classification</u>	<u>Relative Density, %</u>	<u>Approximate Range of N</u>
Very Loose	0 – 15	0 – 4
Loose	16 – 35	5 – 10
Medium Dense	36 - 65	11 - 30
Dense	66 - 85	31 – 50
Very Dense	86 – 100	over 50

Relative density of cohesionless soils is based upon an evaluation of the Standard Penetration Resistance (N), modified as required for overburden pressure.

Appendix B

Lead Paint Analysis

CORROSION CONTROL CONSULTANTS & LABS, INC. a GPI company

ANALYTICAL LABORATORY REPORT

Tuesday, February 5, 2013

Page 1 of 2

CUSTOMER: Stantec
3754 Ranchero Drive
Ann Arbor, MI 48108

DATE RECEIVED: Thursday, January 31, 2013
PO/PROJECT #: 2075117304
SUBMITTAL #: 2013-01-31-010

LAB NUMBER: AB44361

Sampled By: Chris Elenbaas
Job Location: Ann Arbor, MI
Sample Identification: 1 - Barton Pump Station Process Piping Paint
Flagged Data: Substrate could not be completely removed.

Date Sampled: Wednesday, January 16, 2013
Sample Description: Paint Chips

Preparation Method: EPA 3050B-P-M (Acid Digestion for Paints)
Analysis Method: EPA 6010C (ICP-AES Method for Determination of Metals)
Date Analyzed: Friday, February 1, 2013

<u>ELEMENT</u>	<u>RESULT (by weight)</u>	<u>REPORTING LIMIT (RL)</u>
Lead	1.5 %	0.0025 %

LAB NUMBER: AB44362

Sampled By: Chris Elenbaas
Job Location: Ann Arbor, MI
Sample Identification: 2 - Barton Pump Station Ceiling Paint

Date Sampled: Tuesday, January 29, 2013
Sample Description: Paint Chips

Preparation Method: EPA 3050B-P-M (Acid Digestion for Paints)
Analysis Method: EPA 6010C (ICP-AES Method for Determination of Metals)
Date Analyzed: Friday, February 1, 2013

<u>ELEMENT</u>	<u>RESULT (by weight)</u>	<u>REPORTING LIMIT (RL)</u>
Lead	< RL	0.0025 %

CCC&L has obtained accreditation under the programs detailed on the final page of the laboratory report. The accreditations pertain only to the testing performed for the elements, and in accordance with the test methods, listed in the scope of accreditation table. Testing which is performed by CCC&L according to other test methods, or for elements which are not included in the table fall outside of the current scope of laboratory accreditation.

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CORROSION CONTROL CONSULTANTS & LABS, INC. a GPI company

ANALYTICAL LABORATORY REPORT

Tuesday, February 5, 2013

Page 2 of 2

CUSTOMER: Stantec
3754 Ranchero Drive
Ann Arbor, MI 48108

DATE RECEIVED: Thursday, January 31, 2013
PO/PROJECT #: 2075117304
SUBMITTAL #: 2013-01-31-010

Unless otherwise noted, the condition of each sample was acceptable upon receipt, all laboratory quality control requirements were met, and sample results have not been adjusted based on field blank or other analytical blank results. Individual sample results relate only to the sample as received by the laboratory.

Tests Reviewed By: Jason Kraai, Senior Analyst *Jason Kraai* 2013.02.05 15:44:33
Jason Kraai

CCC&L has obtained accreditation under the following programs:

- **National Lead Laboratory Accreditation Program (NLLAP)**
ELLAP: AIHA Laboratory ELLAP Accreditation Program Laboratory, ID#101030 (www.aiha.org)
OH: Ohio Department of Health Lead Poisoning Prevention Program, Approval #E10013 (www.odh.ohio.gov)
- **AIHA Laboratory IHLAP Accreditation Program** (www.aiha.org)
IHLAP: Laboratory ID#101030
- **National Environmental Laboratory Accreditation Program (NELAP)**
NY: State of New York Department of Health, Laboratory ID#11609 (Serial # 46417 through 46421) (518-485-5570)
LA: State of Louisiana Department of Environmental Quality, Laboratory ID#180321 (Certificate 05036) (www.deq.louisiana.gov)
OK: Oklahoma Department of Environmental Quality, Laboratory ID#9993 (Certificate 2012-034) (www.deq.state.ok.us)

The accreditations pertain only to the testing performed for the elements, and in accordance with the test methods, listed in the table below. Testing which is performed by CCC&L according to other test methods, or for elements which are not included in the table below fall outside of the current scope of laboratory accreditation. Customers are encouraged to verify the current accreditation status with the individual accreditation programs by calling or visiting the appropriate website for the applicable program.

SCOPE OF ACCREDITATION

Air and Emissions

<u>Element/Test</u>	<u>Method</u>	<u>Accreditation(s)</u>
Particulates (PM10)	40 CFR 50 Appendix J	NY, LA
Total Suspended Particulates (TSP)	40 CFR 50 Appendix B	NY, LA
Lead in Airborne Dust	NIOSH 7300	ELLAP, OH, NY, LA
Lead in Airborne Dust	EPA600/R-93/200	ELLAP, OH
Metals in Airborne Dust	NIOSH 7300/ EPA 6010B or EPA 6010C	IHLAP
Metals in Airborne Dust	EPA600/R-93/200/ EPA 6010B or EPA 6010C	IHLAP

Solid Chemical Materials

<u>Element/Test</u>	<u>Method</u>	<u>Accreditation(s)</u>
TCLP	EPA 1311(Sample Preparation Method)	NY, LA, OK
Acid Digestion	EPA 3050B	NY, LA
Lead in Soil	EPA 3050B/EPA 6010C	NY, LA, OK
Lead in Soil	EPA 3050B/EPA 6010B or EPA 6010C	ELLAP, OH, NY, LA
Lead in Paint	EPA 3050B/EPA 6010B or EPA 6010C	ELLAP, OH, NY, LA
Lead in Dust Wipes	EPA 6010B or EPA 6010C	NY, LA
Lead in Dust Wipes	EPA600/R-93/200/EPA 6010B or 6010C	ELLAP, OH

Non-Potable Water / Analysis by ICP

<u>Element/Test</u>	<u>Method</u>	<u>Accreditation(s)</u>	<u>Method</u>	<u>Accreditation(s)</u>
Arsenic	EPA 6010B	NY	EPA 6010C/ EPA 200.7 Rev 4.4	NY, LA, OK
Barium	EPA 6010B	NY	EPA 6010C/ EPA 200.7 Rev 4.4	NY, LA, OK
Cadmium	EPA 6010B	NY	EPA 6010C/ EPA 200.7 Rev 4.4	NY, LA, OK
Chromium	EPA 6010B	NY	EPA 6010C/ EPA 200.7 Rev 4.4	NY, LA, OK
Copper	EPA 6010B	NY	EPA 6010C/ EPA 200.7 Rev 4.4	NY, LA, OK
Lead	EPA 6010B	NY	EPA 6010C/ EPA 200.7 Rev 4.4	NY, LA, OK
Mercury	EPA 245.1 Rev.3	NY, LA, OK		
Mercury	EPA 7470A	NY, LA, OK		
Nickel	EPA 6010B	NY	EPA 6010C/ EPA 200.7 Rev 4.4	NY, LA, OK
Selenium	EPA 6010B	NY	EPA 6010C/ EPA 200.7 Rev 4.4	NY, LA, OK
Silver	EPA 6010B	NY	EPA 6010C/ EPA 200.7 Rev 4.4	NY, LA, OK
Zinc	EPA 6010B	NY	EPA 6010C/ EPA 200.7 Rev 4.4	NY, LA, OK
Acid Digestion	EPA 3010A	NY, LA		

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CHAIN OF CUSTODY FORM

Send To:

Corrosion Control Consultants & Labs, Inc. a GPI company

4403 Donker Ct Kentwood MI 49512-4054

ph: 616-940-3112 fx: 616-940-8139 web-sites: www.ccclabs.com www.gpinet.com

FOR LAB USE ONLY		
Property Contained	YES	NO N/A
ASTM E1792 wipes	YES	NO N/A
Adequate Ph Adjust	YES	NO N/A
Lab acidified: By/Date:	WA	
P.O./Proj #: 2075117304		Job Location: Ann Arbor, MI

Company: Stantec Consulting Michigan Inc.	Address: 3754 Ranchero Drive Ann Arbor, MI 48108	Company Contact: Chris Elenbaas	P.O./Proj #: 2075117304
		Telephone: 734-368-3104	Job Location: Ann Arbor, MI
		E-Mail: chris.elenbaas@stantec.com	

MATRIX	TOTAL CONCENTRATION	MISC. TESTS	Special Instructions:
<input checked="" type="checkbox"/> PAINT CHIPS <input type="checkbox"/> SOIL <input type="checkbox"/> SPENT ABRASIVE <input type="checkbox"/> WIPE brand _____ <input type="checkbox"/> WASTEWATER <input type="checkbox"/> 37 mm CASSETTE <input type="checkbox"/> TSP FILTER <input type="checkbox"/> PM 10 FILTER <input type="checkbox"/> OTHER _____	<input checked="" type="checkbox"/> LEAD <input type="checkbox"/> LEAD, CAD, CHROME <input type="checkbox"/> RCRA (8) METALS <input type="checkbox"/> OTHER _____ <hr/> WASTE CHARACTERIZATION <input type="checkbox"/> LEAD TCLP <input type="checkbox"/> RCRA (8) METALS TCLP <input type="checkbox"/> OTHER _____	<input type="checkbox"/> pH (Corrosivity) <input type="checkbox"/> Ignitability <input type="checkbox"/> VOC (Method 24) <input type="checkbox"/> Other _____ <hr/> TURNAROUND TIME <input type="checkbox"/> Same Day* <input type="checkbox"/> 1 Day (24 Hour)* <input type="checkbox"/> Standard (2-4 days) <input type="checkbox"/> Other _____	Call contact for credit card billing info. *Same Day and 1 Day turn around not available for TCLP or PM10; additional fees may apply, contact lab for pricing.

CCC&L accepts Visa, MasterCard, and American Express. Please call for information.						WIPES	AIR SAMPLES				
CCC&L Lab No.	Sample Number	Date/Time Sampled	Sample Identification/Location	Area wiped (sq.ft.)	TIME		FLOW RATE				
					START	STOP	START	STOP	UNITS		
1344361	1	1/16/13	Barton Pump Station Process Piping Paint								
44362	2	1/29/13	Barton Pump Station Ceiling Paint								

Sampled By (Please print) : Chris Elenbaas Date Submitted: 1/29/13 Signature: _____
 Received by: _____ Date/Time: _____ Relinquished Date/Time: _____
 Received by: _____ Date/Time: _____ Relinquished Date/Time: _____
 Method of Shipment: _____
 Received for Laboratory by: JWR Gidex Date/Time: 1/30/13 12:47 Submittal #: 2013-01-31-010 12/22/11 Rev. 9

347
241

Appendix C
Primary Services Standards
by DTE Energy

SECTION 11**GENERAL**

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PRIMARY SERVICE INSTALLATIONS**PRIMARY METERED PRIMARY, SECONDARY METERED PRIMARY
AND INDUSTRIAL SUBSTATION INSTALLATIONS****A. General****1. Purpose.**

The following instructions are intended to set forth the general practices and procedures to be followed in connection with customer primary and high voltage installations. These instructions define the areas in which assistance may be given a primary customer to coordinate the customer's and the Detroit Edison Company's (DECo) electrical systems and to increase the operating safety of high voltage equipment.

2. Definition of Primary Installation.

A Primary Customer is one who takes service directly from Detroit Edison's primary lines (4800v and above) through primary facilities located on his own premises (Primary Supply Rate D.6). The character and arrangement of these facilities vary according to the location of the customer, the size and type of load, and the number of lines from DECo's system. The facilities that must be provided by the customer could include any or all of the following elements:

- (a) Primary service connections to overhead or underground lines.
- (b) Primary circuit breakers or fused load break interrupters.
- (c) Primary step down transformers, motors, and other primary equipment.
- (d) Primary meter compartment to house DECo revenue instrument transformers.

These facilities on the customer's premises, including all associated Detroit Edison and customer owned equipment and parts involved in maintaining primary service up to the point of direct utilization or transformation make up what is known as the *Primary Installation*.

3. Definition of High Voltage Industrial Substation.

In addition to the Primary Installation, there may be a Detroit Edison or customer owned high voltage substation (Class "I") on the customer's premises to reduce the utility service voltage to the customer's utilization voltage. The high voltage substation and the high voltage lines feeding the substation are not considered part of the Primary Installation and are treated separately in these instructions.

B. General Policy

1. Customer Responsibilities.

The customer will design, build, own, and maintain the complete Primary Installation except line breakers or any switchgear that is part of the Edison system. Generally, Detroit Edison will design, build, own, operate, and maintain any associated high voltage substation and high voltage lines feeding the substation except for those customers taking service under the Alternative Primary Supply Rate D6.1. As a general rule, customer installations shall not affect the reliability of service furnished to other customers. The general policy is as follows:

(a) Primary Installations:

- (1) The customer's electrical system and its installation shall conform to the latest version of the National Electrical Code, local municipal codes along with Detroit Edison's requirements.
- (2) **New installations.** The customer will design, build, own, operate, and maintain the complete Primary Installation.
Detroit Edison will furnish, own, and maintain such revenue metering .
The design of the Primary Installation, including the characteristics of all primary switchgear and associated equipment, must be acceptable to Detroit Edison. Maintenance of primary switchgear by the customer will be in accordance with the recommendations of the switchgear manufacturer.
- (3) **Existing installations.** The adequate short circuit current interrupting capability of the primary switchgear is the customer's responsibility..
- (4) **Primary fuses.** Primary fuses will be owned and maintained by Detroit Edison if located on a Detroit Edison owned pole; otherwise, they will be owned and maintained by the customer.

(b) High Voltage Industrial Substations.

The general policy for Primary Installations shall apply to all customer-owned high voltage substations.

(c) Generation Facilities.

The general policy and requirements for the interconnection of generation on the Detroit Edison system are contained in the “**Michigan Electric Utility Generation Interconnection Requirements**”, which can be found on the MPSC (Michigan Public Service Commission) or DTE Energy websites.

MPSC – “http://www.michigan.gov/mpsc/0,1607,7-159-16377_43420---,00.html”
Detroit Edison’s – “<http://www.my.dteenergy.com/business/commercial/generator.html>”.

Any generator or regenerative (e.g. fuel cell, windmill, dynamometer) source that operates in parallel with Detroit Edison’s electrical system must adhere to these guidelines. The primary installation requirements contained in this Chapter also apply. No generation facility shall be allowed to connect to the Detroit Edison system until all requirements are met and final installation approval is granted by Primary Services.

(d) Codes.

The customer’s electrical system and it’s installation shall conform to the latest version of the National Electrical Code (NEC), local municipal codes along with Detroit Edison’s requirements.

2. Company Responsibilities.

The Account Manager is responsible for all negotiations with the Primary Customer pertaining to high voltage and primary installations on customer premises. Primary Services will follow matters of design, acceptance, inspection, and testing, as well as customer operation and maintenance of the installation. The Account Manager will see that the designated parties properly carry out all steps in these instructions in accordance with the prescribed procedure.

C. Primary Installations**1. Design.**

The general design of a new Primary Installation is to be coordinated by Primary Services and the customer’s representatives. Detailed drawings of the installation including site plan and electrical one-line diagram along with detailed load information are to be prepared by the customer’s electrical consultant. Primary Services will approve the design and installation of any private overhead or underground line that is extended from the Detroit Edison point of service to the main primary equipment. Detailed equipment shop drawings (one-line, three-line, schematic & wiring) are to be furnished by the manufacturer (IEEE device numbers should be used) and submitted to Detroit Edison for review and approval (3 sets). All drawings and designs are to be approved through Primary Services.

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2. Control Equipment.

The size and class of primary switchgear or fused load break interrupters and the characteristics of the primary fuses are to be specified by Primary Services. In the interest of safety and service continuity to the customer, the equipment furnished must be acceptable to Detroit Edison. Relays, fuses, and control equipment will be designed so that their operation is coordinated with that of the protective equipment on the Detroit Edison system. This is subject to approval by the Detroit Edison Relay Engineering Group. DECo required control scheme interlocks must be hard wired breaker contacts not via interposing relays. A ground detection scheme should be installed when connecting to the 4800v delta system. If requested by Primary Services, Relay Engineering shall specify relay types and settings for the customer's equipment at a charge to the customer. Provision will be made for protective tagging and lockout points subject to Primary Services approval.

3. Supervision.

Detroit Edison Primary Services group will follow the construction of all Primary Installations to see that all details are in accordance with the approved drawings, and all Detroit Edison requirements and specifications.

4. Inspection.

Before the installation is placed in commission, Primary Services will determine that the unmetered overhead and underground lines on the customer's premises are completed and ready to be energized. Until the lines are ready to be energized, the rules and procedures established for lines in the out-of-commission state must be observed.

Primary Services will be responsible for inspection of the primary switchgear, metered overhead and underground lines, transformers, and generator before they are energized. Detroit Edison System Engineering will test and inspect this equipment if requested by the Primary Services representative. Where unsatisfactory conditions exist on the load side of the main breaker or load break disconnect, Primary Services will make recommendations to the customer as to which changes or modifications are required.

5. Connecting Service.

When the installation has been accepted for connection, Primary Services will notify the customer that the installation is to be energized and will request the System Supervisor or the Lines Department to make the connection to the Detroit Edison system. The operation of the installation is the customer's responsibility. Primary Services will be available, in an advisory capacity, to inform and instruct the customer as to the correct operation and maintenance of the equipment.

6. Periodic Maintenance.

The maintenance of customer-owned switchgear and control equipment is the customer's responsibility. Primary Services will ask the customer to set up a maintenance schedule based on recommendations of the equipment manufacturer. In addition, where a customer-owned breaker is the separation point between the customer's equipment and the Detroit Edison system, Primary Services will require the customer to provide proper maintenance of the breaker.

The Detroit Edison Maintenance Organization will carry out the maintenance of Detroit Edison owned switchgear and control equipment. This maintenance will be performed at the request of Primary Services according to a schedule that will insure proper operation.

7. Testing.

Automatic throwover equipment will be tested according to the following schedule:

- (a) **Customer-Owned.** Primary Services recommends that the customer operate the primary or secondary throwover equipment once a year unless it has operated automatically during that period. Certain types of loads such as hospitals require more frequent testing.
- (b) **Detroit Edison-Owned.** All Company-owned throwover equipment will be maintained and operated by Detroit Edison.
- (c) **Loop Power Lines.** Detroit Edison Relay Test will test the operation of loop power line breakers, pilot cables, and control equipment. The Detroit Edison Maintenance Organization will perform maintenance of loop power line breakers. All equipment is owned and maintained by the customer including master breaker.

D. High Voltage Substations (Detroit Edison-Owned)

1. New Installations.

- (a) **Construction Coordination.** The routine followed in connection with any Detroit Edison-owned substation will apply where the Detroit Edison-owned substation is to be located on the customer's premises. The Account Manager and Primary Services will coordinate the arrangements between the customer and Detroit Edison for the installation of the high voltage lines feeding the substation and for the termination of the customer-owned lines in the substation.

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- (b) **Detroit Edison and Customer Responsibilities.** The high voltage substation (Detroit Edison owned) serving one customer and located on customer premises is to be designed, built, owned, operated, and maintained by Detroit Edison. The customer must lease the substation site to Detroit Edison and provide access to the site for Detroit Edison employees and equipment.

The customer must also provide rights-of-way across his property for the lines feeding the substation. If these are overhead lines, Detroit Edison will install, own, and maintain them. If underground construction is used, the customer will do all trenching and install, own, and maintain all conduit and manholes on his property to the substation site. Detroit Edison will install, own, and maintain the cables to feed the substation.

The customer will install, own, and maintain the conductors from the secondary make-up bus (Detroit Edison owned) of the substation to his Primary Installation. At the customer's expense, Detroit Edison will provide and install all conduit, racks, or supports required for these conductors within the substation site and will make up the terminations at the substation.

- (c) **Energizing.** When the substation has been given final approval by System Engineering, Primary Services will notify the customer and, at the same time, make certain that energizing the equipment up to the primary breaker or equivalent will not cause a hazard on any part of the installation. When all safety precautions have been attended to, Primary Services will request the System Supervisor to have the substation energized.

2. Existing Installations.

Maintenance. Detroit Edison will maintain at its expense all overhead lines and all underground cables on the customer's property feeding the high voltage substation. The customer will maintain the conduit and manhole system for the underground cables.

E. High Voltage Substations (Customer-Owned)

Some high voltage substations are customer-owned to meet the requirement of certain rate applications:

1. Alternative Primary and Bulk Power Supply.

Customers operating on the Alternative Primary Supply Rate D6.1 will own the supply lines and high voltage substations on their premises. The design, supervision, testing, and operation shall be as described in paragraphs 1 through 7 beginning on page 11-1-3.

If the installation of a Detroit Edison-owned switching station is required on the customer's premises to facilitate connection to DECo's high voltage system, the customer will then own the supply lines between the switching station and his high voltage substation.

2. Municipal Pumping Rate and Special Rate Applications.

Customer-owned high voltage substations are required for some applications of the Primary Pumping Rate E4 and under some other special conditions. Contact the assigned account representative for specifics.

3. New Installations.

(a) **Construction Coordination.** The design of customer-owned high voltage substations shall be as described in paragraphs 1 and 2 under *C. Primary Installations*. The Account Manager and Primary Services shall coordinate the arrangements between the customer and DECo for the installation of the high voltage lines feeding the substation.

(b) **Customer and Detroit Edison Responsibilities.** The customer must provide right-of-way across his property for the lines feeding the substation. If these are overhead lines, Detroit Edison will install, own, and maintain them. If underground construction is used the customer will do all trenching and install, own, and maintain all conduit and manholes on his property. Detroit Edison will install, own, and maintain the cables to feed the substation.

(c) **Supervision.** Primary Services shall follow the construction of the substation to see that all details are in accordance with the approved drawings and that the workmanship is according to acceptable standards.

(d) **Inspection.** Detroit Edison shall make only such inspections, as it deems necessary for the protection & safety of other customers and the public. Additional tests may be requested by Primary Services.

(e) Service Connection.

When the installation has been approved for connection, Primary Services will request the System Supervisor to have the substation energized. The same precautions regarding hazards taken with Detroit Edison owned substations shall be observed. The operation and maintenance of the installation is the customer's responsibility. Primary Services will be available, in an advisory capacity, to inform and instruct the customer as to the correct operation and maintenance of the equipment.

F. Primary Installations Built for 13.2 kV

All new primary installations are to be built for 13.2 kV operations, even though the installation may be operated initially at 4.8 kV. A letter from the Assigned Account Representative must confirm any exception to this policy.

Any questions pertaining to the above or other primary metered installations should be directed to the Primary Services Group at 313.235.6471.

PRIMARY SERVICE CABLE INSTALLATION
TO DETROIT EDISON CABLE POLE OR MANHOLE

Contractors are *not allowed* to work on Detroit Edison poles and they are *not allowed* to enter a Detroit Edison manhole.

A Detroit Edison representative *must* designate location of cable and duct. The customer is responsible for all conduit to the pole and the 90 degree sweep at the pole. The duct should be 4" minimum.

Following is the procedure to be followed when installing customer-furnished Primary Service cable.

1. Installation of Cable on Cable Pole.

(a) Pole in Energized Lead or Public Thoroughfare.

The contractor will install the cable to the pole and leave enough cable to reach the top of the fuse carriers plus 2 feet. The cable end shall be left 3-foot diameter coil at the base of the pole and protected from damage. Detroit Edison Underground Lines Crew will furnish and install the u-guard and necessary terminations on the cable pole.

(b) Pole on Private Property without Energized Conductors.

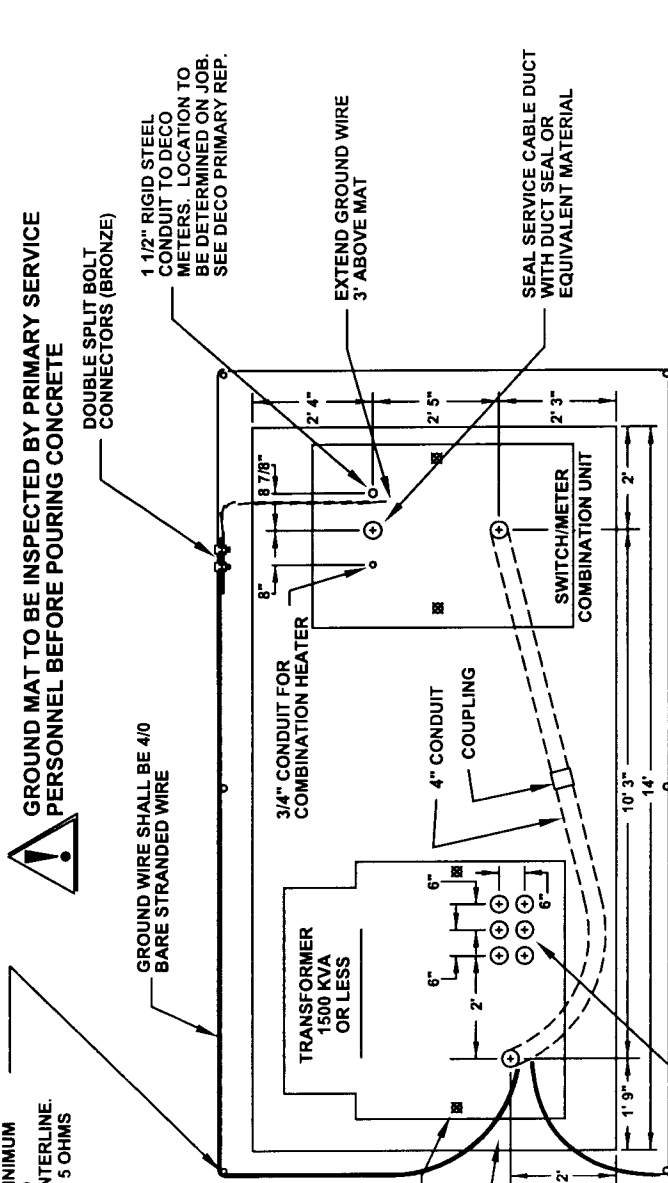
The contractor will install the cable to the pole and furnish and install the U-guard and necessary terminations on the cable pole.

2. **Installation of Cable in a Detroit Edison Manhole**

- (a) **Responsibilities.** The Detroit Edison Crew will rig the Detroit Edison manhole and the contractor will pull cable between that manhole and the first private manhole or vault. The contractor will furnish all reels, jacks, lines, cable grips, and all labor and equipment necessary to pull the cable. The contractor will cut the cable off reels and the Detroit Edison Crew will train the cable in the Detroit Edison manhole. The Detroit Edison Crew will furnish labor and material for splicing. A steel pulling line will be permitted for pulling cable between manholes. Cable ends should be sealed before installation. The Detroit Edison Crew will reseal the ends in the Detroit Edison manhole if necessary.

- (b) **Scheduling.** Primary Services will schedule the pulling and terminating of the cable with the contractor and the Detroit Edison Underground Line Crew for primary metered installations. ***Five working days should be allowed for crew scheduling and the contractor should be ready on the scheduled date.***

OUTDOOR PRIMARY COMBINATION UNIT & PAD MOUNTED TRANSFORMER
FOR USE WITH TRANSFORMERS OF 1500 KVA OR LESS
EXAMPLE 1



GROUND MAT TO BE INSPECTED BY PRIMARY SERVICE PERSONNEL BEFORE POURING CONCRETE

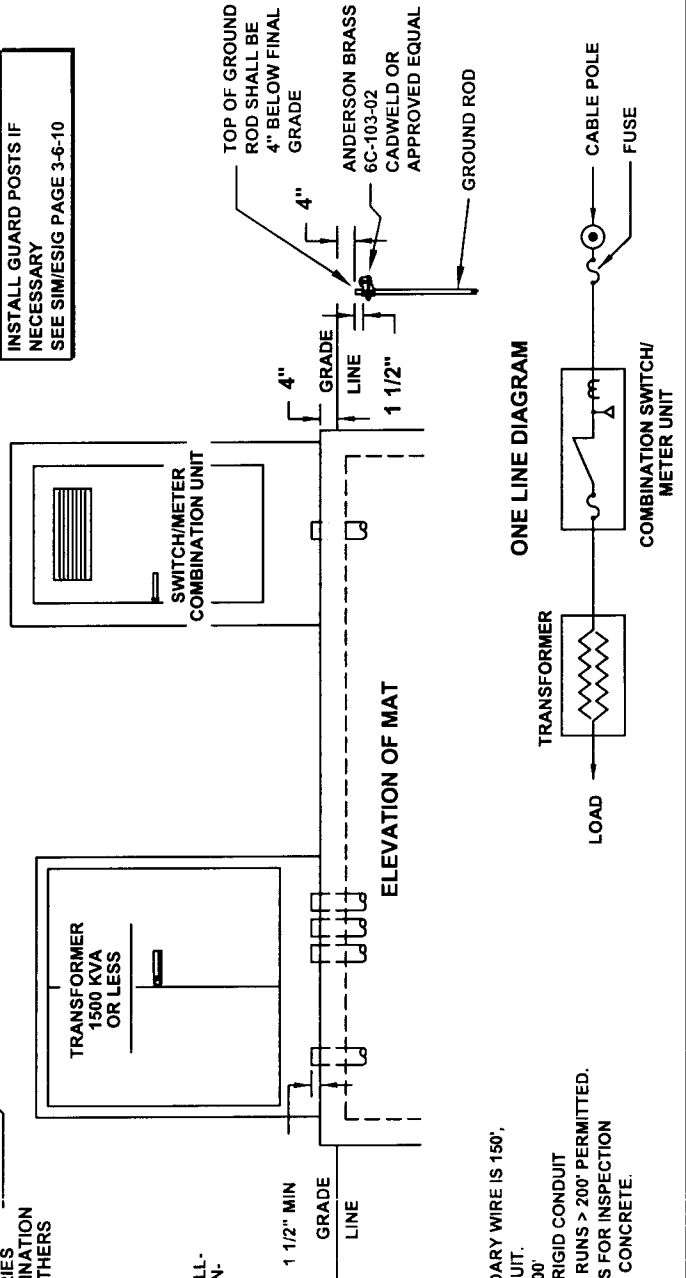
6 COPPERWELD GROUND RODS MINIMUM 5/8" DIAMETER X 8' LONG SPACED 10" MAXIMUM CENTERLINE TO CENTERLINE. MAXIMUM GROUND RESISTANCE - 5 OHMS

GROUND RODS ARE TO BE INSTALLED OUTSIDE CONCRETE PAD. ANY DEVIATIONS MUST BE APPROVED AND INSPECTED BEFORE POURING CONCRETE PAD.

INSTALL 1/2" ANCHORS TO SUIT TRANSFORMER MOUNTING LUGS AND OUTDOOR METERING UNIT AFTER EQUIPMENT IS DELIVERED. EXTEND GROUND CONDUCTORS (2) 3' ABOVE MAT. REINFORCED CONCRETE MAT. DESIGNED BY OTHERS TO CARRY WEIGHT OF TRANSFORMER WITHOUT TIPPING OR CRACKING. THE USE OF "PIERS" MAY BE NECESSARY.

CONDUIT FOR SECONDARIES SIZE, NUMBER AND TERMINATION TO BE DETERMINED BY OTHERS

INSTALL GUARD POSTS IF NECESSARY SEE SIM/ESIG PAGE 3-6-10



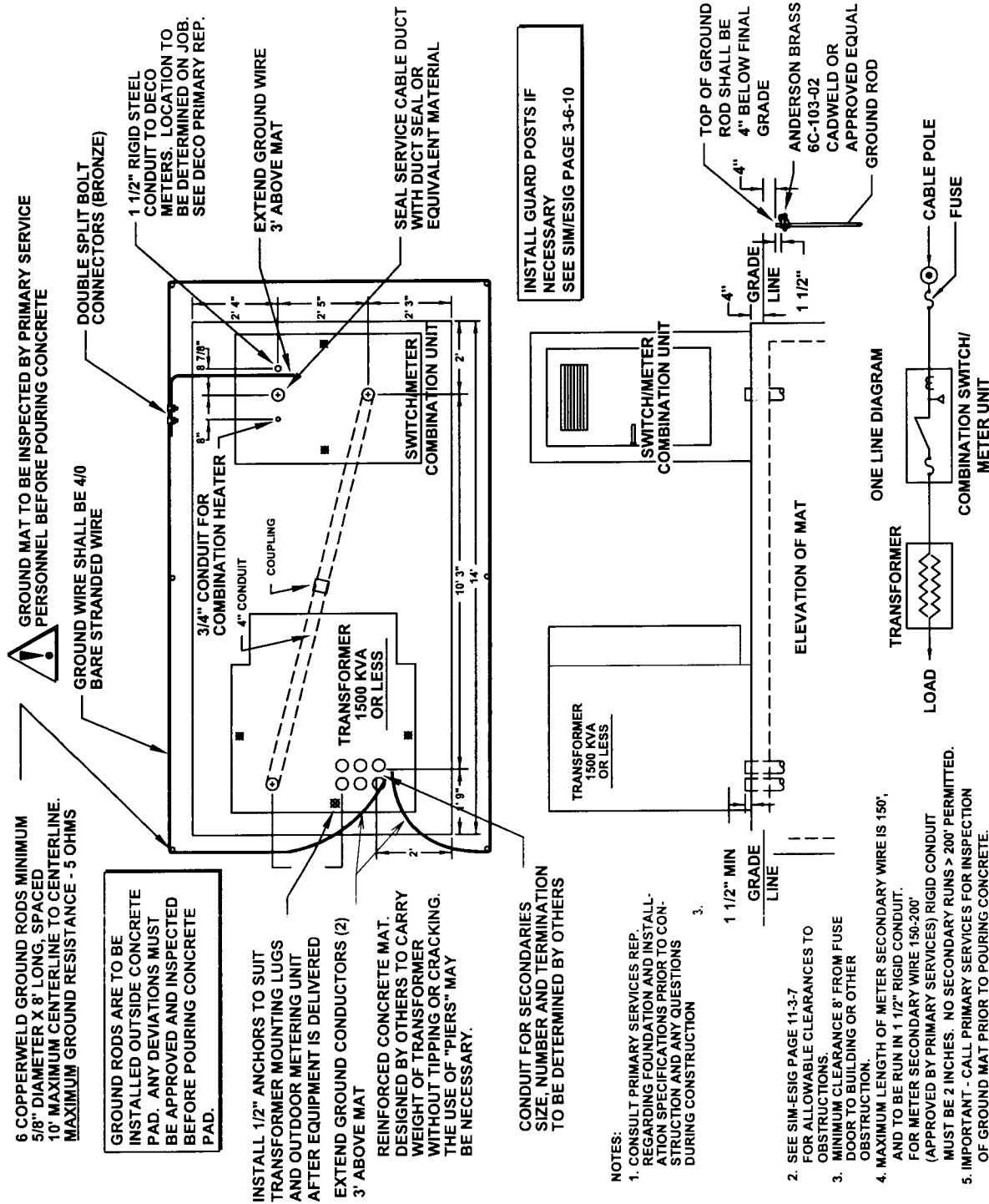
NOTES:

1. CONSULT PRIMARY SERVICES REP. REGARDING FOUNDATION AND INSTALLATION SPECIFICATIONS PRIOR TO CONSTRUCTION AND ANY QUESTIONS DURING CONSTRUCTION
2. SEE SIM-ESIG PAGE 11-3-7 FOR ALLOWABLE CLEARANCES TO OBSTRUCTIONS.
3. MINIMUM CLEARANCE 8' FROM FUSE DOOR TO BUILDING OR OTHER OBSTRUCTION.
4. MAXIMUM LENGTH OF METER SECONDARY WIRE IS 150', AND TO BE RUN IN 1 1/2" RIGID CONDUIT. FOR METER SECONDARY WIRE 150-200' (APPROVED BY PRIMARY SERVICES) RIGID CONDUIT MUST BE 2 INCHES. NO SECONDARY RUNS > 200' PERMITTED.
5. IMPORTANT - CALL PRIMARY SERVICES FOR INSPECTION OF GROUND MAT PRIOR TO POURING CONCRETE.

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

OUTDOOR PRIMARY COMBINATION UNIT & PAD MOUNTED TRANSFORMER FOR USE WITH TRANSFORMERS OF 1500 KVA OR LESS

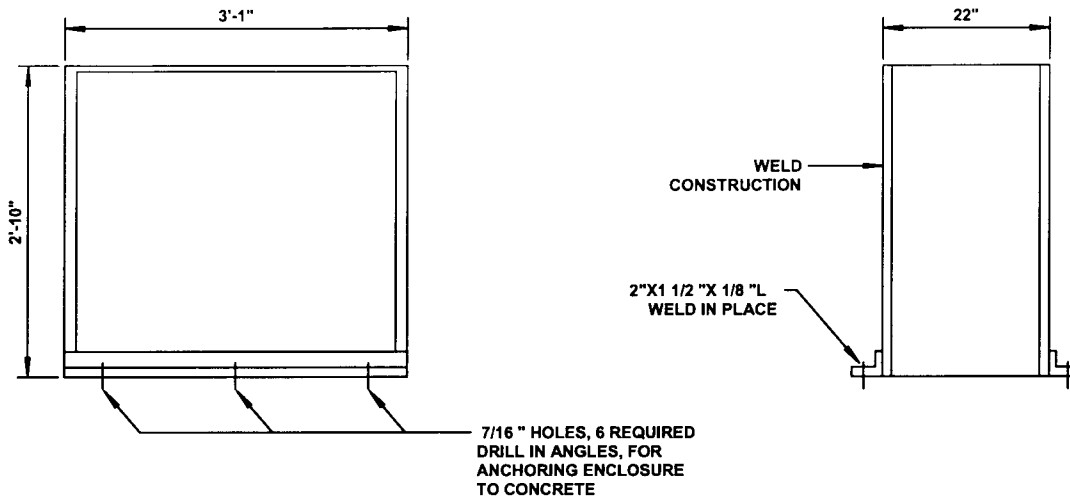
EXAMPLE 2



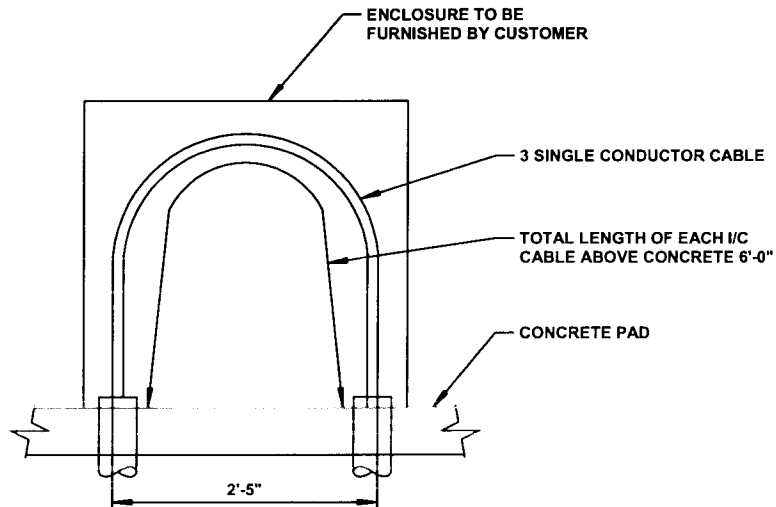
THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

OUTDOOR PRIMARY CABLE ENCLOSURE

FOR USE ON SECONDARY METERED PADMOUNT SERVICE
(SECONDARY INSTALLATION PREPPED FOR FUTURE PRIMARY INSTALLATION)



ENCLOSURE TO BE CONSTRUCTED OF 11-GA SHEET STEEL



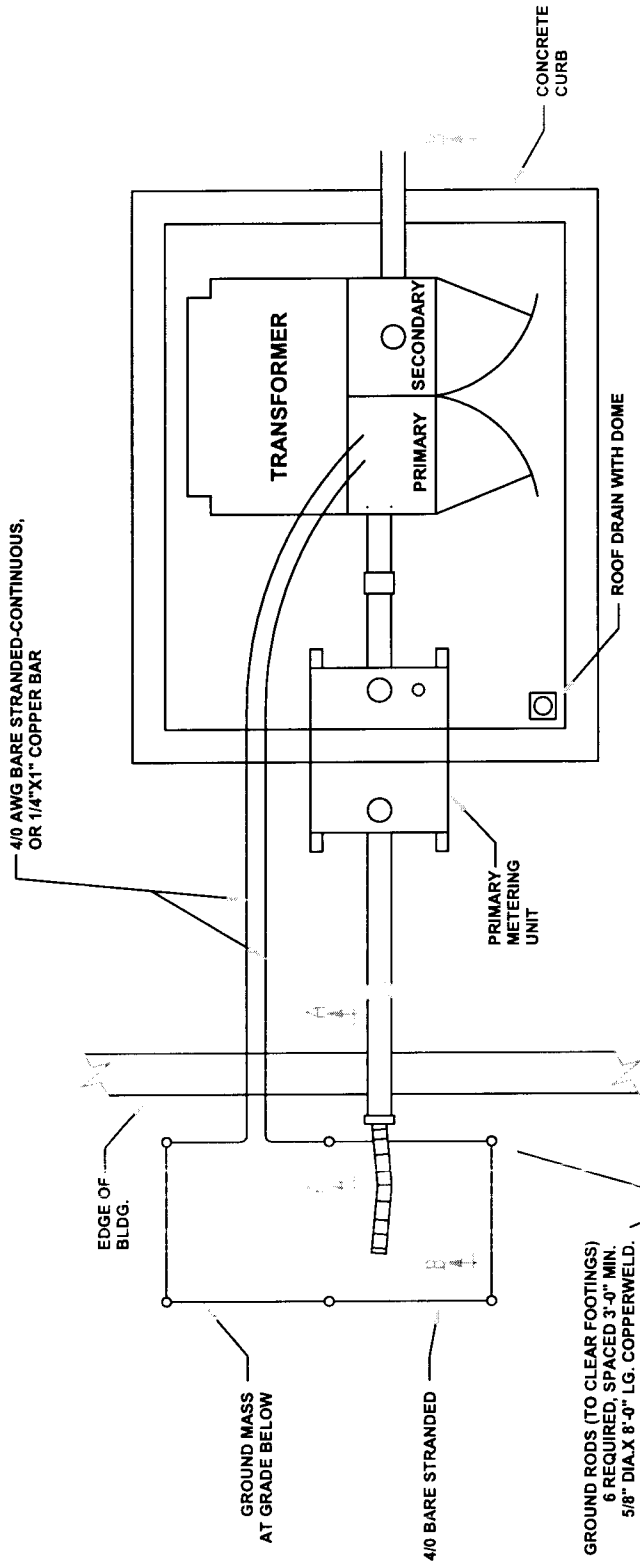
ELEVATION

NOTE:

1. TO BE USED IN LIEU OF PRIMARY METERING UNIT.
(SEE PAGE 11-3-1,-2)
2. GROUND MAT TO BE INSPECTED BY PRIMARY SERVICES PERSONNEL PRIOR TO POURING CEMENT.
4/0 BARE COPPER GROUND RISER TO BE CONNECTED TO ENCLOSURE.

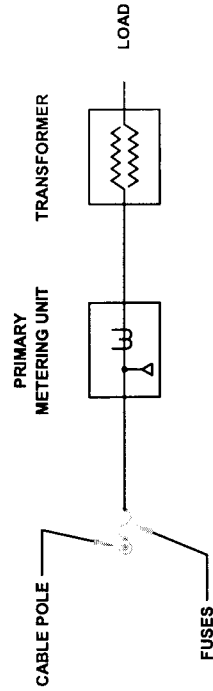
THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

**OUTDOOR PRIMARY METERING UNIT PAD
MOUNTED TRANSFORMER ON ROOF
AERIAL CABLE SERVICE (TOP VIEW)**
(FOR MAINTENANCE OF EXISTING INSTALLATIONS ONLY.)

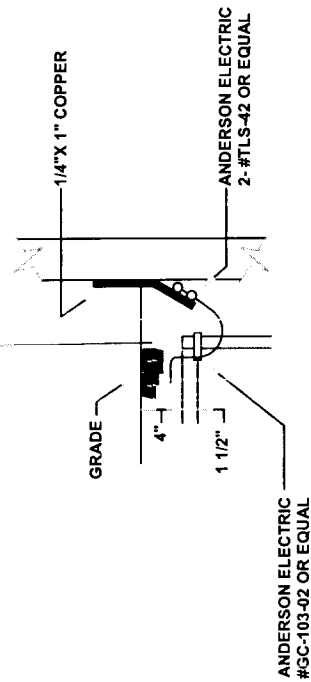


PLAN OF EQUIPMENT

METERING UNIT, TRANSFORMER & CONDUITS
MAY BE REARRANGED TO MEET JOB CONDITIONS.



ONE LINE DIAGRAM

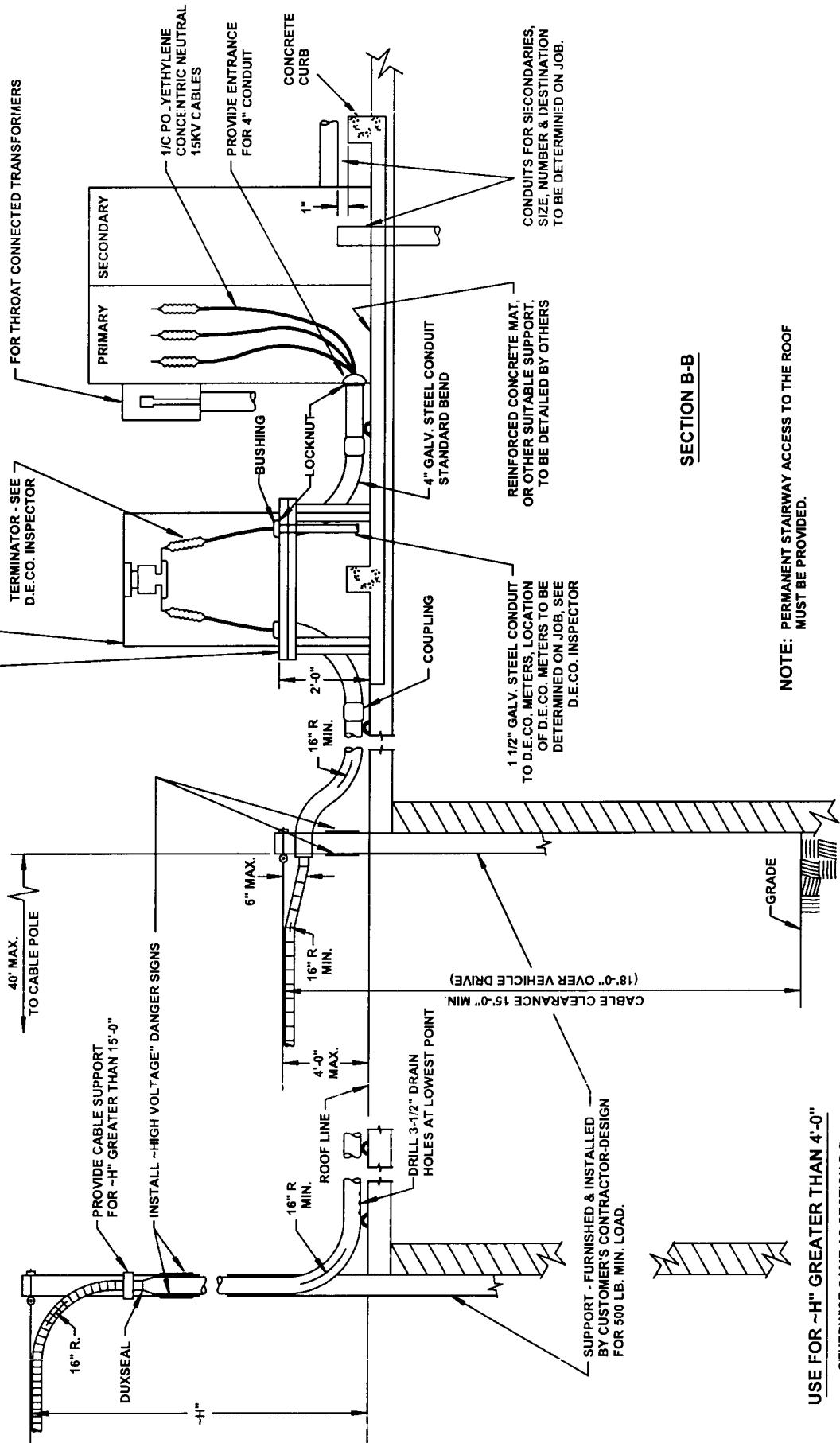


SECTION A-A

SECTION B-B (SEE PAGE 11-3-8)

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY
OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

OUTDOOR PRIMARY METERING UNIT, PAD MOUNTED TRANSFORMER ON ROOF-AERIAL CABLE SERVICE (SIDE VIEW)
 (FOR MAINTENANCE OF EXISTING INSTALLATIONS ONLY)



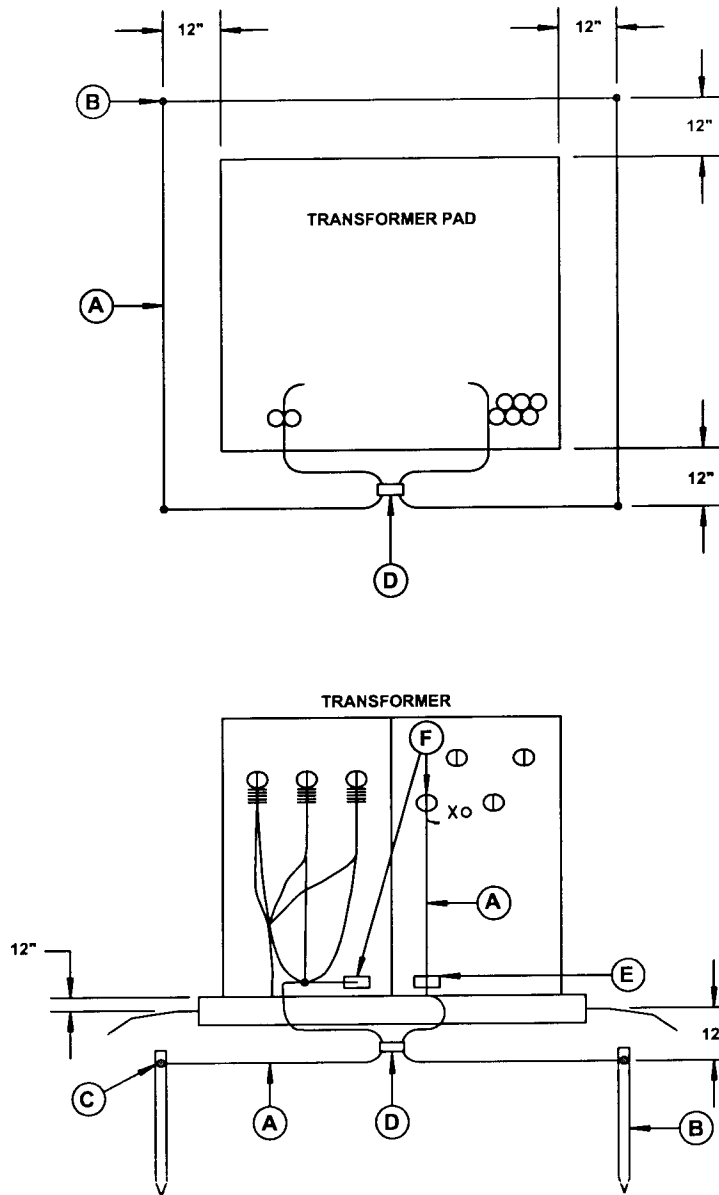
SECTION B-B

NOTE: PERMANENT STAIRWAY ACCESS TO THE ROOF MUST BE PROVIDED.

USE FOR ~H" GREATER THAN 4'-0" OTHERWISE SAME AS SECTION B-B

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

GROUNDING SPECIFICATION CUSTOMER OWNED TRANSFORMER INSTALLATION

**BILL OF MATERIAL:**

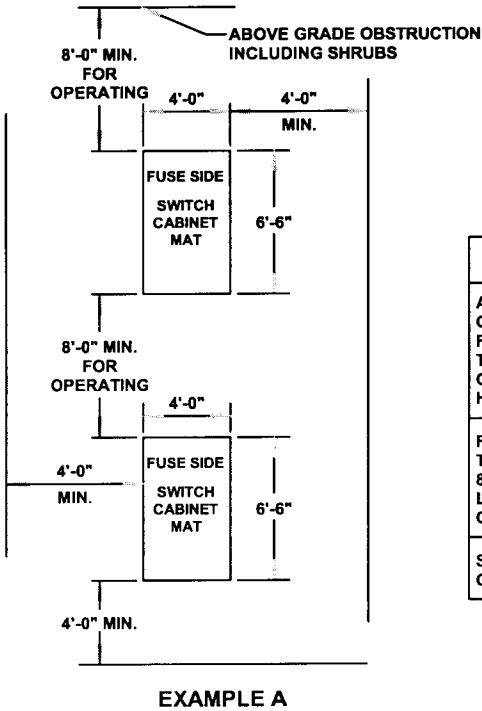
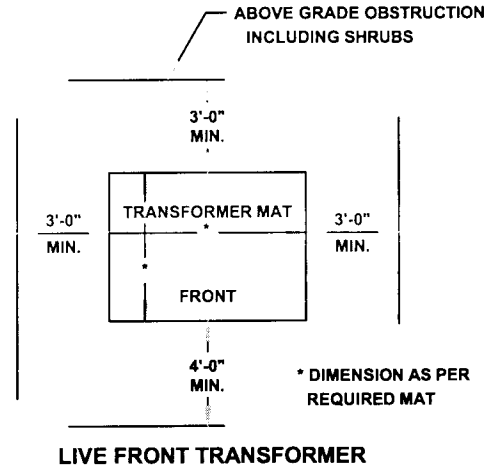
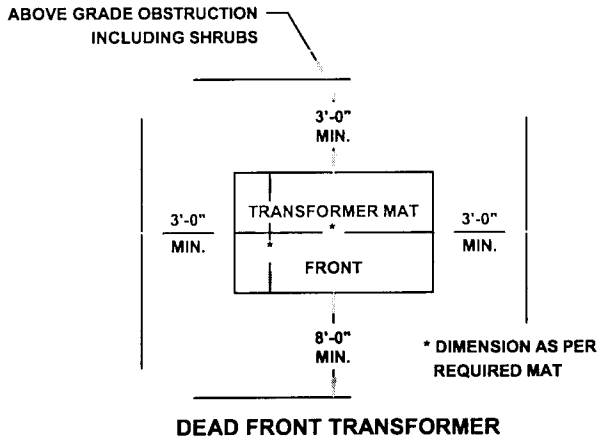
- (A) 4/0 7-STRAND HARD DRAWN COPPER CONDUCTOR
- (B) 5/8"x10' COPPER-CLAD GROUND ROD. GALVANIZED RODS UNACCEPTABLE (QTY 3, 5/8"x4' COPPER-CLAD GROUND RODS COUPLED WITH "DENMARK-58" CONNECTORS ACCEPTABLE AS SINGLE GROUND ROD)
- (C) ANDERSON CATALOG NO. GC-103-02 CONNECTOR (CADWELD ACCEPTED AS ALTERNATIVE)
- (D) ANDERSON CATALOG NO. K-3 CONNECTOR (4/0 BRONZE SPLIT BOLT ACCEPTABLE)
- (E) ANDERSON CATALOG NO. GTCS-41 TRANSFORMER TANK CONNECTOR
- (F) 4/0 2-HOLE COPPER COMPRESSION LUG (ANDERSON VHCL-4/0-12BN, OR BURNDY EQUIVALENT) SET SCREW LUGS UNACCEPTABLE

NOTES:

1. GROUNDING CONDUCTOR TO BE ENTIRELY CONTINUOUS.
2. CONDUCTOR TO FEED THROUGH ITEM (E).
3. TRANSFORMER GROUND STRAP TO REMAIN.
4. GROUND MAT TO MEGGER 5 OHMS OR LESS.
5. PRIMARY SERVICE REPRESENTATIVE TO INSPECT FINISHED MAT PRIOR TO BURIAL.

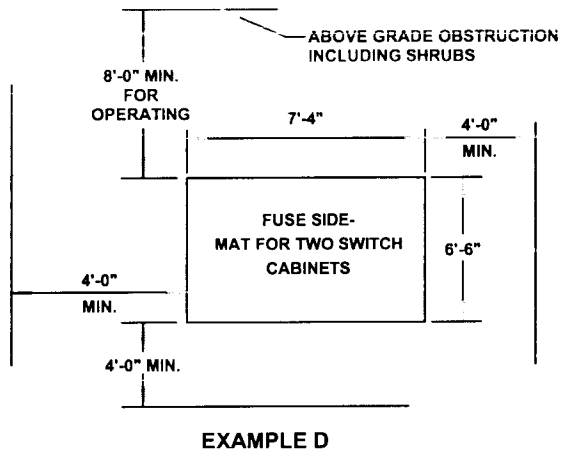
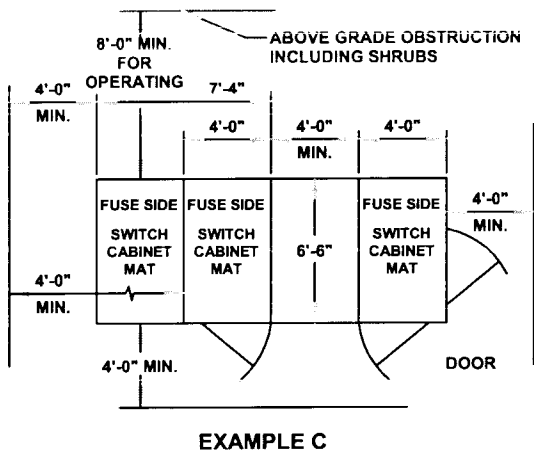
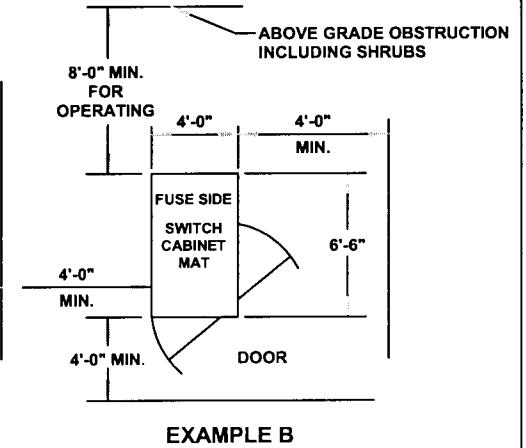
THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY
OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

**CUSTOMER OWNED
PADMOUNT TRANSFORMER OR SWITCH CABINET
MINIMUM CLEARANCE REQUIREMENTS**



NOTE:
FOR SIDE CLEARANCES
(OTHER THAN OPERATING)
SEE NEC 110-34a

CLEARANCES
A VERTICAL CLEARANCE OF 8' IS REQUIRED FROM THE TOP OF THE TRANSFORMER OR SWITCH CABINET TO ANY OVERHANG.
FENCE OR WALL AROUND TRANSFORMER MUST HAVE 8'-0" MIN. GATE OR LIFT-OFF SECTION FOR CHANGEOUT.
SEE NATIONAL ELECTRIC CODE 110-34a.



THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

LOCATION OF PRIMARY METERING EQUIPMENT

1. Meters

Meters should be located at the main incoming switchgear (which may be indoors or outdoors). This location shall be clean and reasonably secure from damage, and not subject to shock or vibration. Meters shall be readily accessible for reading, testing, and maintenance. A five (5) foot clearance should be maintained in front of the meters

When meters are located on balconies, mezzanines, or other floor levels, **a permanent stairway shall be provided for access.**

The meters shall be located as close as practical to the metering transformers, but not to exceed 150 feet. If it is necessary to exceed 150 feet, approval by Primary Services personnel will be necessary prior to the start of construction. Primary Services personnel will consult Meter Services for recommendations.

2. Meter Box

The meter box shall be supplied, installed & wired by the customer's contractor. See 11-4-4, 11-4-5 & 11-4-6 for mounting and 11-4-10B & 11-4-12B for wiring. Manufacturer's catalog numbers are listed in Sec. 11-4-1A.

3. Instrument Transformers

Primary current and voltage metering transformers are furnished by Detroit Edison and installed/wired by the customer's contractor on primary metering installations.

4. Wire

Detroit Edison provides the wire (9-conductor #12) between the revenue metering instrument transformers and the meter box and the potential transformer primary wire. The customer's contractor pulls and wires the metering per Detroit Edison Spec's., reference section 11-4-10B or 11-4-12B.

5. Outdoor Meter House

The meter(s) may be located in an outdoor meter house. See Primary Services Representative for location and Detroit Edison specifications.

METER BOX MANUFACTURER'S CATALOG NUMBERS

Meter boxes should be obtained from local supply houses using the manufacturer's catalog numbers listed below:

ZS3-20 METER BOX (3-PHASE, 4-WIRE) – WYE SYSTEMS

Example: 480V, 8.3kV, 13.2 kV, 24 kV & 40 kV

Cutler-Hammer	1007003B-CH
Durham	1007003B
Square-D	1007003B-SQD
Midwest Electric Products	1007003B-MEP
Milbank	U7445-O
Meter Devices	602-3010A13-588

ZS3-20-5S METER BOX (3-PHASE, 3-WIRE) – DELTA SYSTEM

Example: 4.8 kV

Cutler-Hammer	1007361B-CH
Durham	1007361B
Square-D	1007361B-SQD
Midwest Electric Products	1007361B-MEP
Milbank	U7444-0
Meter Devices	602-3010A8-589

AC-10 AUXILIARY CONTACT ENCLOSURE

Cutler-Hammer	1006630A-CH
Durham	1006630A
Square-D	1006630A-SQD
Midwest Electric Products	1006630A-MEP

FUSING OF DETROIT EDISON METERING VOLTAGE TRANSFORMERS

Fusing of Detroit Edison metering voltage transformers must be a consideration when designing the revenue-metering cubicle.

In order to protect the integrity and safeguard personnel and equipment, fusing of Detroit Edison revenue metering voltage transformers at Primary Customers is required using the following criteria:

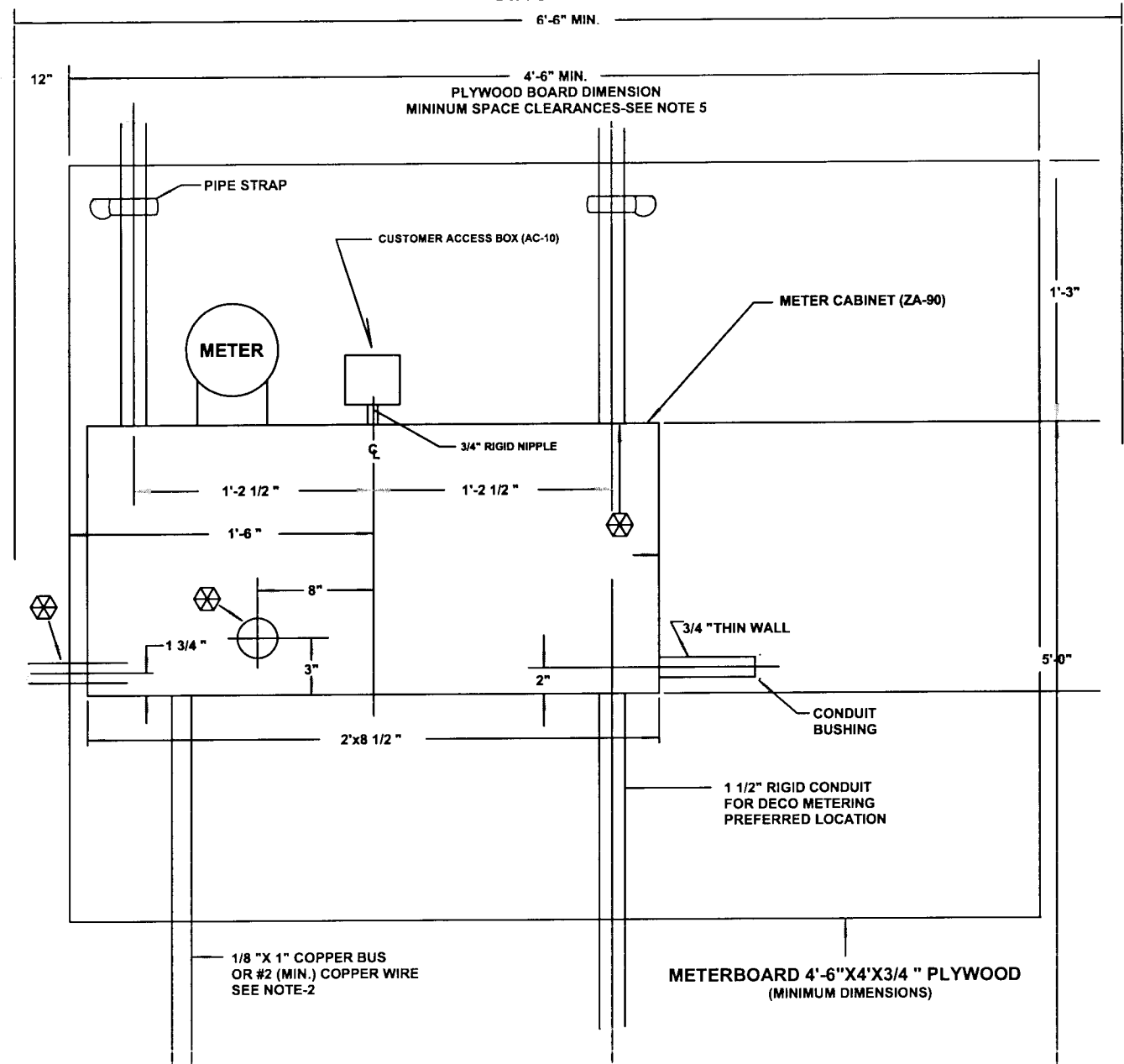
1. All industrial substations
2. Services from transmission or subtransmission lines (includes 24 kV and above).
3. Where present or immediate future fault currents are:
 - 7,000 amperes at 13.2 kV
 - 10,000 amperes at 4.8 kV
4. All underground T-tap power lines.

All fuses shall be: G.E. Type EJ-1, 15kv class, Size 2E.

The customer will furnish and install the metering cubicle, including fuses with spares. Fuses shall not be mounted directly on the voltage transformers.

Contact the Primary Services Representative to determine whether the above conditions are present at a site-specific location.

LAYOUT 1
 PRIMARY METERING BOX TYPE ZA-90
 (FOR MAINTENANCE PURPOSES ONLY)
 SINGLE LINE



LEGEND:



OPTIONAL LOCATIONS FOR CONDUIT FROM METERING TRANSFORMERS. (1-1/2" DIAMETER RIGID CONDUIT UNLESS OTHERWISE SPECIFIED BY PRIMARY SERVICES.

CONNECT TO DRIVEN GROUND MAT

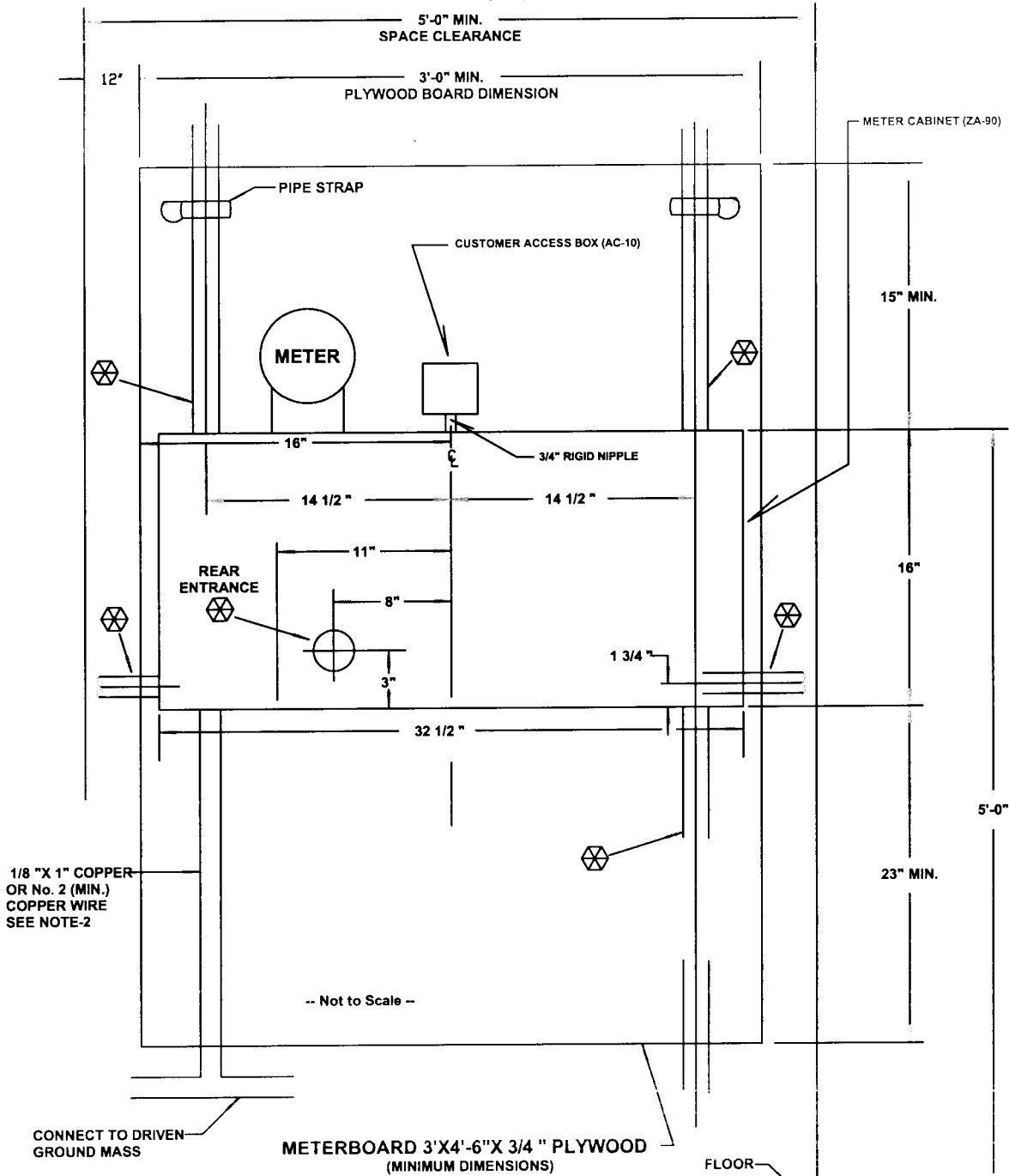
NOTES:

1. THIS IS THE PREFERRED ARRANGMENT. IF SPACE DOES NOT ALLOW, SEE PAGE 11-4-5 OF THE S.I.M.
2. IF GROUND WIRE IS CARRIED THROUGH THE METER CONDUIT TO THE DRIVEN GROUND MAT IT MUST BE INSULATED FOR 600 VOLTS.
3. A 4'-6" X 4' CLEAR AREA MUST BE PROVIDED IN FRONT OF THE METERS FOR METER TESTING, MAINTENANCE AND DEMAND METER SERVICING.

FLOOR

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

LAYOUT 2
 PRIMARY METERING BOX TYPE ZA-90
 (FOR MAINTENANCE PURPOSES ONLY)
 SINGLE LINE



LEGEND:

TO BE USED WHEN SPACE LIMITATIONS DO NOT ALLOW THE ARRANGEMENT SHOWN ON PAGE 11-4-3.

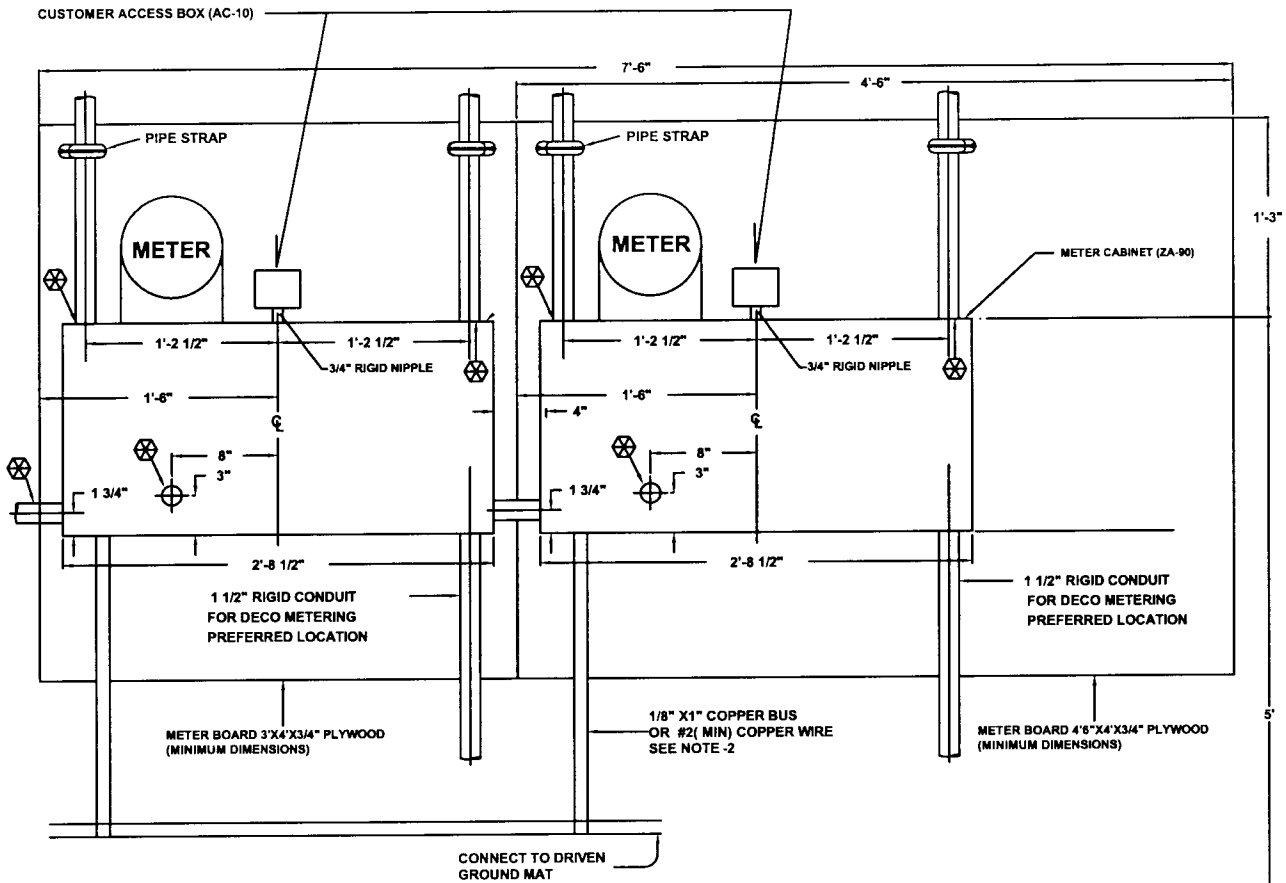
- OPTIONAL LOCATIONS FOR CONDUIT FROM METERING TRANSFORMERS. (1-1/2" DIA. RIGID STEEL UNLESS OTHERWISE SPECIFIED BY MARKETING & METER SERVICES, METER ENGINEERING).

NOTES:

1. PLYWOOD METER BOARD IS FOR DETROIT EDISON EQUIPMENT ONLY.
2. IF THE GROUND WIRE IS CARRIED THROUGH THE METER CONDUIT TO THE "DRIVEN GROUND MASS", IT MUST BE INSULATED FOR 600 VOLTS.
3. A 5' X 4' CLEAR AREA MUST BE PROVIDED IN FRONT OF THE METER FOR METER TESTING, MAINTENANCE AND DEMAND TAPE CHANGES.
4. A ONE FOOT CLEARANCE MUST BE MAINTAINED ON EACH SIDE OF THE METER CONNECTION CABINET (ZA-90).

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

**LAYOUT 3
PRIMARY METERING BOX TYPE ZA-90
(FOR MAINTENANCE PURPOSES ONLY)
2 OR MORE LINES**



ZA-90 CONNECTION CABINET (2 LINE INSTALLATION INSTRUCTIONS)

LEGEND

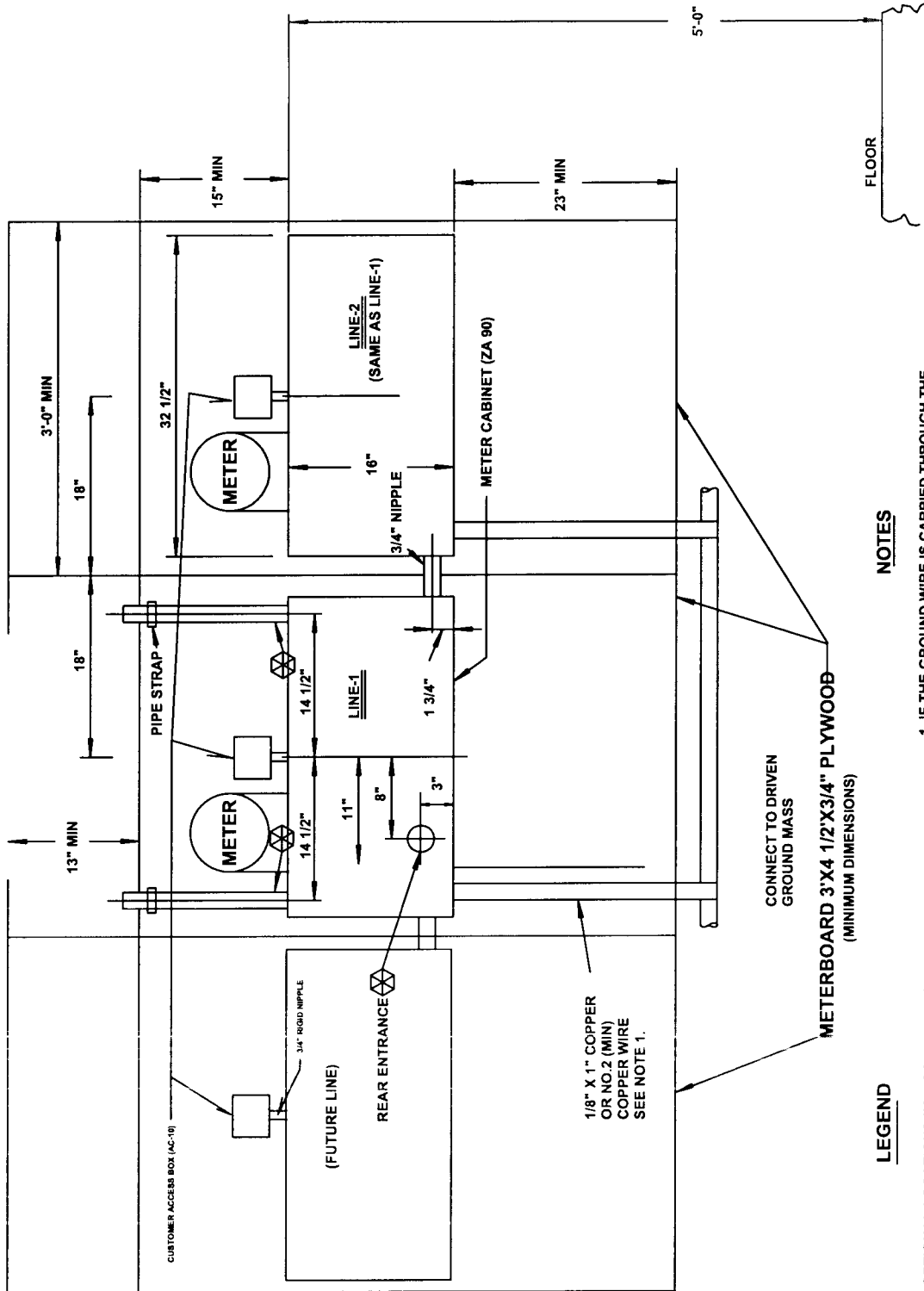
⊗ OPTIONAL LOCATIONS FOR CONDUIT FROM METERING TRANSFORMERS. (1 1/2" DIAMETER RIGID CONDUIT UNLESS OTHERWISE SPECIFIED BY PRIMARY SERVICES)

NOTES:

1. THIS IS THE PREFERRED ARRANGEMENT, IF SPACE DOES NOT ALLOW, SEE PAGE 11-4-6 OF THE S.I.M.
2. IF GROUND WIRE IS CARRIED THROUGH THE METER CONDUIT TO THE DRIVEN GROUND MAT IT MUST BE INSULATED FOR 600 VOLTS.
3. A 7'6"X4' CLEAR AREA MUST BE PROVIDED IN FRONT OF THE METERS FOR METER TESTING, MAINTENANCE AND DEMAND METER SERVICING.

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

**LAYOUT 4
PRIMARY METERING BOX TYPE ZA-90
(FOR MAINTENANCE PURPOSES ONLY)
2 OR MORE LINES**



NOTES

1. IF THE GROUND WIRE IS CARRIED THROUGH THE METER CONDUIT TO THE "DRIVEN GROUND MASS", IT MUST BE INSULATED FOR 600 VOLTS.
2. A 4 FOOT CLEAR AREA MUST BE PROVIDED IN FRONT OF THE METERS FOR METER TESTING, MAINTENANCE AND DEMAND TAPES CHANGES. THIS AREA MUST EXTEND 6" BEYOND EACH SIDE OF THE MOUNTING BOARD FOR THE METERS.

LEGEND

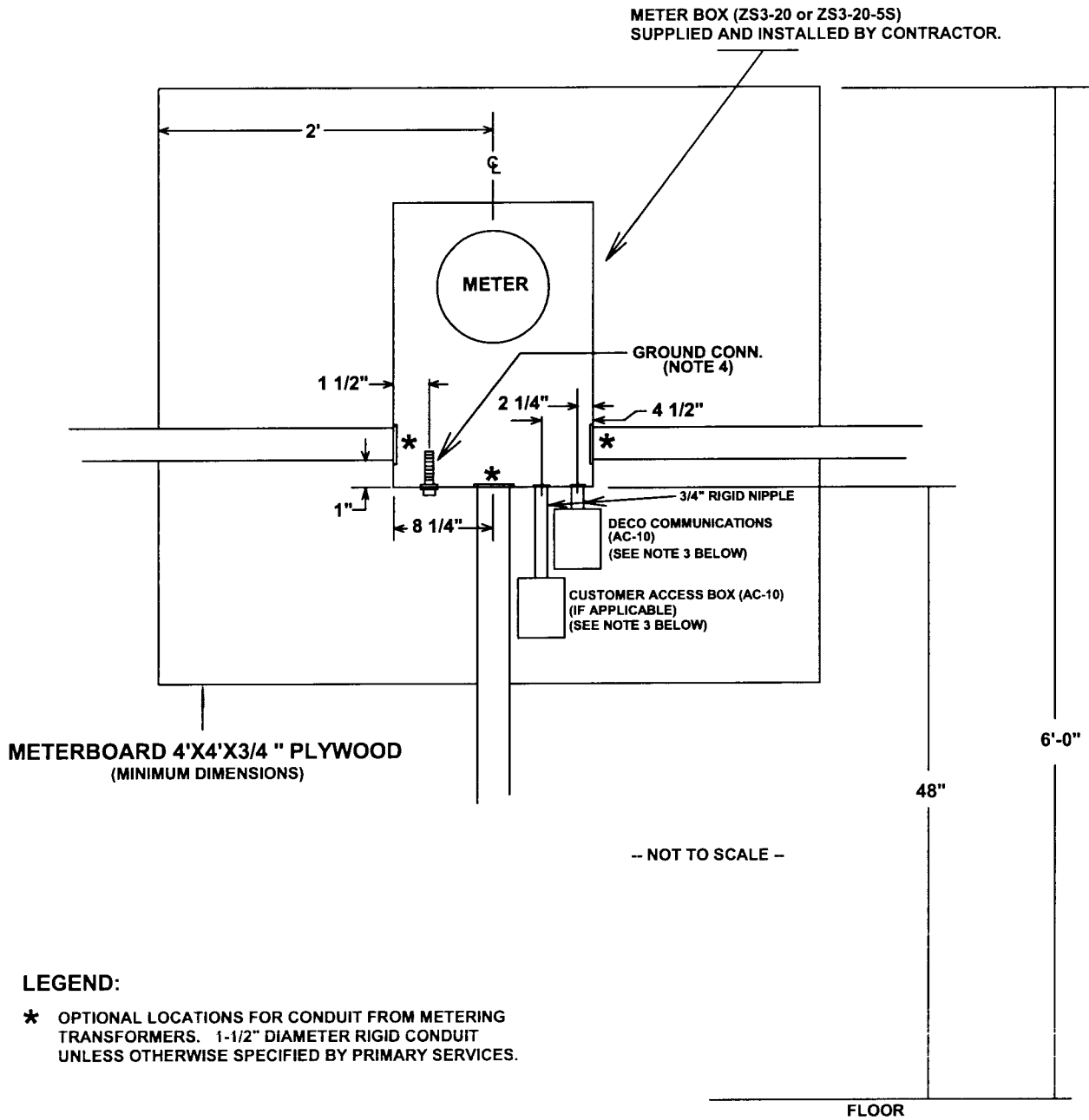
OPTIONAL LOCATIONS FOR CONDUIT FROM METERING TRANSFORMERS, 1 1/2" DIA. UNLESS OTHERWISE SPECIFIED BY PRIMARY SERVICES PERSONNEL.



THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

**INDOOR LAYOUT ARRANGEMENT
PRIMARY METERING BOX TYPE ZS3-20 or ZS3-20-5S**

SINGLE LINE



LEGEND:

- * OPTIONAL LOCATIONS FOR CONDUIT FROM METERING TRANSFORMERS. 1-1/2" DIAMETER RIGID CONDUIT UNLESS OTHERWISE SPECIFIED BY PRIMARY SERVICES.

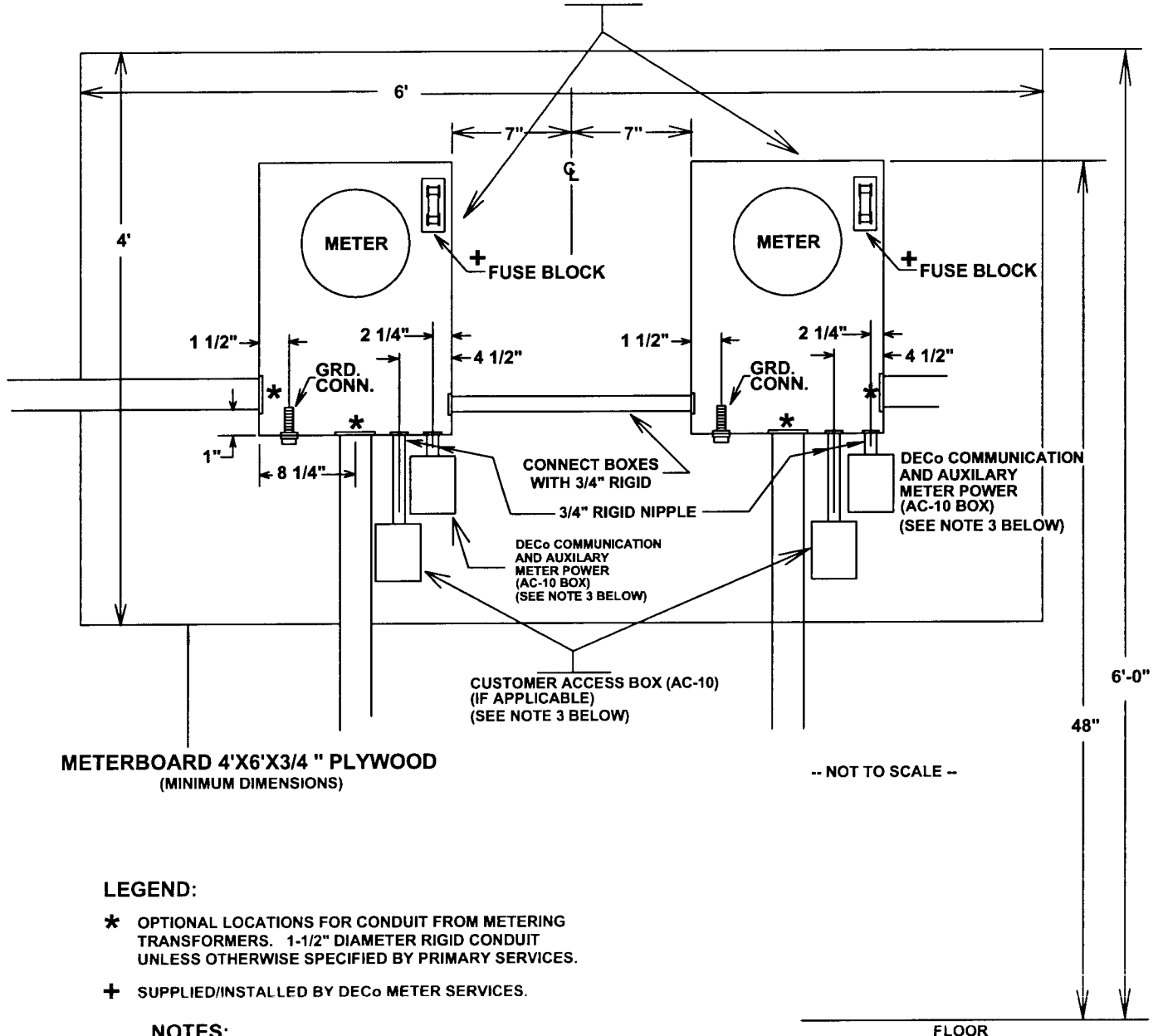
NOTES:

1. IF GROUND WIRE IS CARRIED THROUGH THE METER CONDUIT TO THE DRIVEN GROUND MAT IT MUST BE INSULATED FOR 600 VOLTS.
2. A 4' CLEAR AREA MUST BE PROVIDED IN FRONT OF THE METERS FOR METER TESTING AND MAINTENANCE.
3. ONE AC-10 BOX IS REQUIRED FOR DECO COMMUNICATIONS AND IF APPLICABLE ONE AC-10 BOX IS REQUIRED FOR CUSTOMER ACCESS. BOTH BOXES ARE SUPPLIED AND INSTALLED BY CUSTOMER'S CONTRACTOR.
4. GROUND CONNECTION - 3/8" x 1 1/2" BOLT, FLAT WASHER & LOCK WASHER (SILICON BRASS)

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

**INDOOR LAYOUT ARRANGEMENT
PRIMARY METERING BOX TYPE ZS3-20 or ZS3-20-5S
TWO OR MORE LINES**

METER BOX (ZS3-20 or ZS3-20-5S)
SUPPLIED AND INSTALLED BY CONTRACTOR.



METERBOARD 4'X6'X3/4 " PLYWOOD
(MINIMUM DIMENSIONS)

-- NOT TO SCALE --

LEGEND:

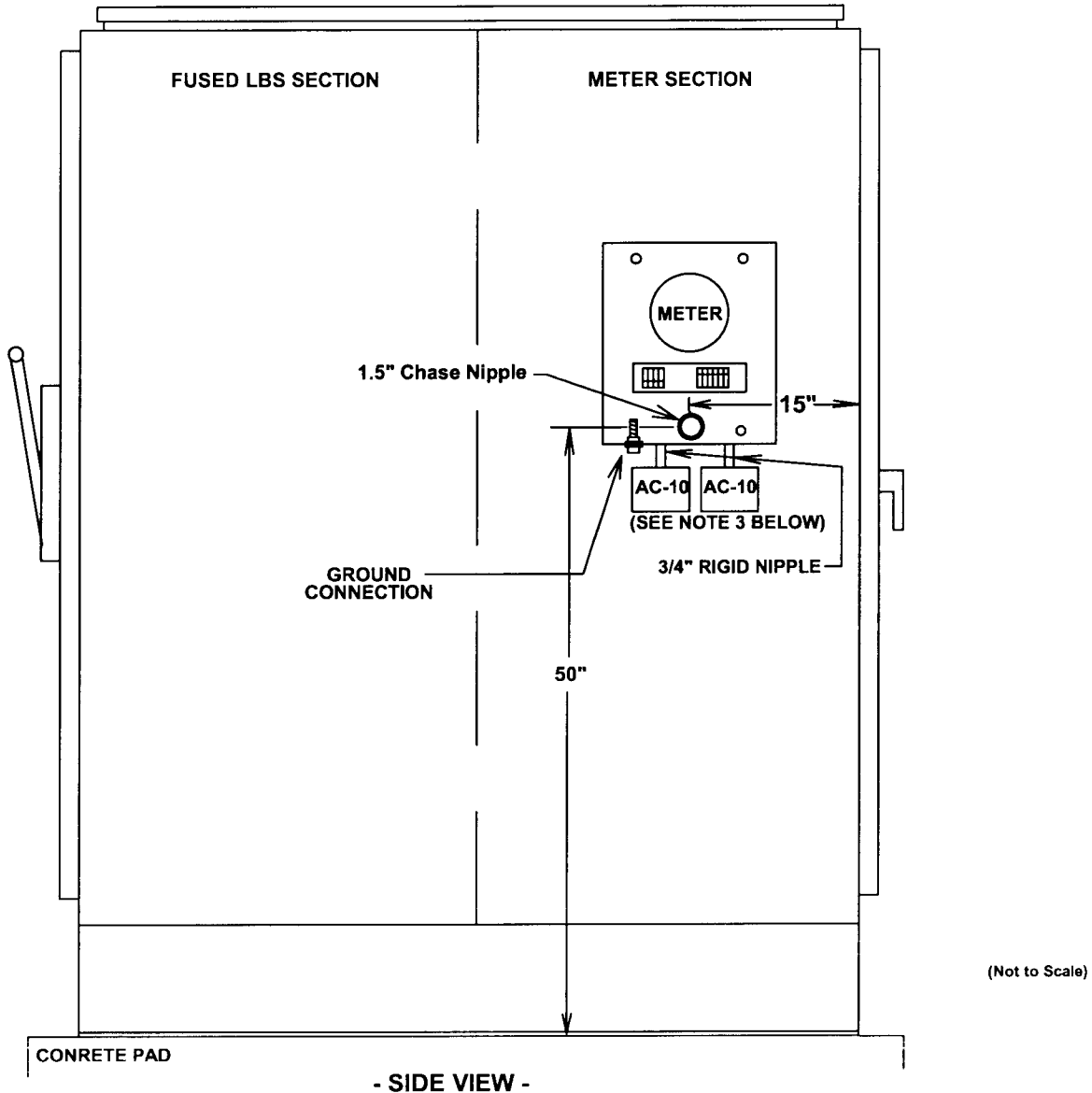
- * OPTIONAL LOCATIONS FOR CONDUIT FROM METERING TRANSFORMERS. 1-1/2" DIAMETER RIGID CONDUIT UNLESS OTHERWISE SPECIFIED BY PRIMARY SERVICES.
- + SUPPLIED/INSTALLED BY DECo METER SERVICES.

NOTES:

1. IF GROUND WIRE IS CARRIED THROUGH THE METER CONDUIT TO THE DRIVEN GROUND MAT IT MUST BE INSULATED FOR 600 VOLTS.
2. A 4' CLEAR AREA MUST BE PROVIDED IN FRONT OF THE METERS FOR METER TESTING AND MAINTENANCE.
3. TWO SEPARATE AC-10 BOXES ARE REQUIRED FOR CUSTOMER CONTACTS TWO(2) ADDITIONAL AC-10 BOXES ARE REQUIRED FOR DECo COMMUNICATIONS & AUXILIARY POWER. ALL BOXES ARE SUPPLIED/INSTALLED BY CUSTOMER'S CONTRACTOR.
4. THIS TWO LINE ARRANGEMENT COULD BE USED OUTDOORS MOUNTED ON SWITCHGEAR. DIMMENSIONS APPLY, SEE PRIMARY SERVICE REPRESENTATIVE PRIOR TO INSTALLATION FOR MOUNTING LOCATION.
5. GROUND CONNECTION - 3/8" x 1 1/2" BOLT, FLAT WASHER & LOCK WASHER (SILICON BRASS)

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

**OUTDOOR INSTALLATION LAYOUT
FOR
COMBINATION FUSED LOADBREAK DISCONNECT SWITCH/METER UNIT
UTILIZING A ZS3-20 METER BOX (4-Wire)
OR
UTILIZING A ZS3-20-5S METER BOX (3-Wire)**



(Not to Scale)

NOTES:

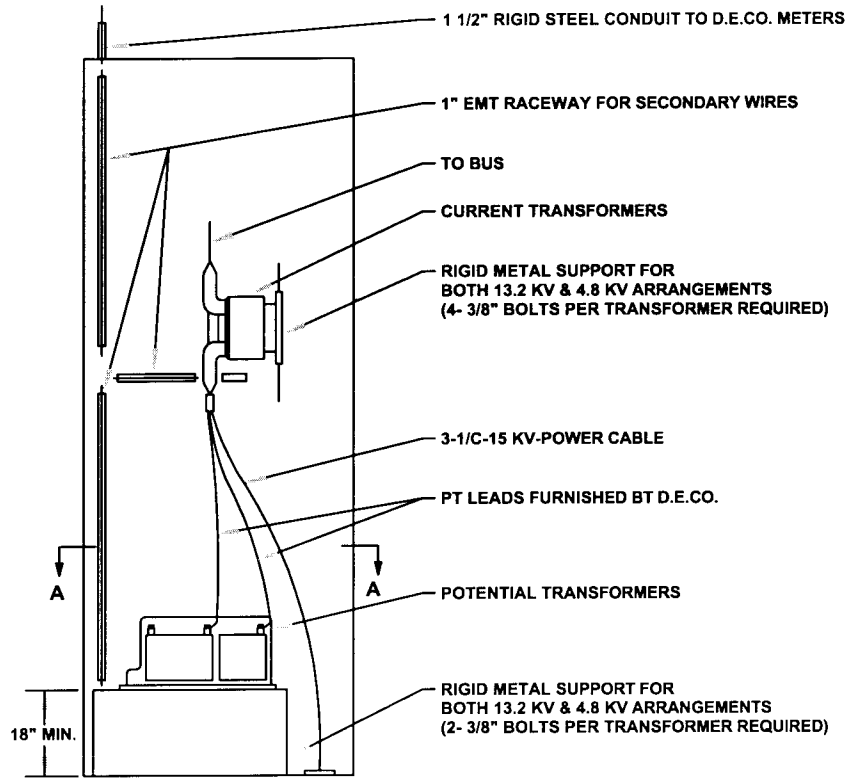
1. THE ZS3-20 (or ZS-20-5S) METER BOX WILL BE MOUNTED ON THE OUTDOOR SWITCHGEAR WITH FOUR 1-INCH .25 x 20 RUSTPROOF BOLTS, FLAT WASHERS AND LOCK WASHERS (STAINLESS STEEL, SILICON BRASS, ETC.). A 1 1/2 - INCH BOLT, FLAT WASHERS & LOCK WASHERS (SILICON BRASS) WILL BE USED IN THE LOWER LEFT HAND CORNER TO PROVIDE A GROUND CONNECTION POINT IN THE BOX. A ONE-HOLE COMPRESSION LUG IS TO BE INSTALLED ON THE END OF THE 600 VOLT #2 COPPER GROUND CONDUCTOR, THEN ENTER THE METER BOX THROUGH THE 1.5" CHASE NIPPLE.
2. A FOUR(4) FOOT CLEAR AREA MUST BE PROVIDED IN FRONT OF THE METER.
3. IF AN AC-10 IS TO BE INSTALLED FOR CUSTOMER ACCESS OR DECo COMMUNICATIONS, THE CONNECTING CONDUIT (3/4" RIGID) MUST ENTER THE ZS3-20 FROM BOTTOM PLATE. BOTH BOXES SUPPLIED AND INSTALLED BY CUSTOMER'S CONTRACTOR.
4. THIS LAYOUT CAN BE USED FOR OUTDOOR FREE STANDING SWITCHGEAR. SEE PRIMARY SERVICE REPRESENTATIVE FOR METER BOX LOCATION/INSTALLATION REQUIREMENTS.

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

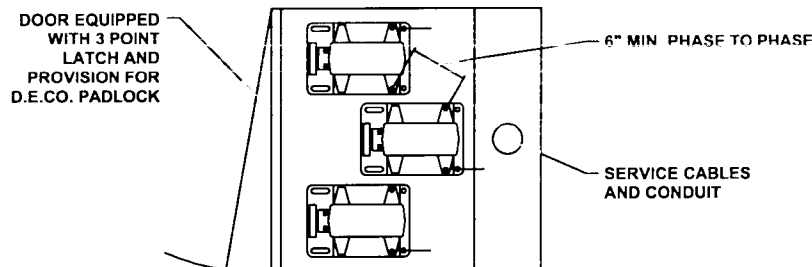
**DETROIT EDISON GENERAL SPECIFICATIONS FOR METERING CUBICLE
USED WITH METAL-CLAD LOAD BREAK DISCONNECT SWITCHGEAR**

**SUGGESTED EQUIPMENT ARRANGEMENT FOR 13.2 KV SERVICE-95 KV BIL.
MANUFACTURER TO PROVIDE MOUNTING AND BUS CONNECTIONS FOR
D.E.CO. INSTRUMENT TRANSFORMERS IN CUBICLE. D.E.CO. WILL SPECIFY
THE TYPE AND NUMBER OF TRANSFORMERS REQUIRED.**

(FOR DIMENSIONS, SEE PAGES 11-4-14 through 11-4-17)



**ELEVATION
13.2 KV**



**PLAN VIEW A-A
13.2 & 4.8 KV**

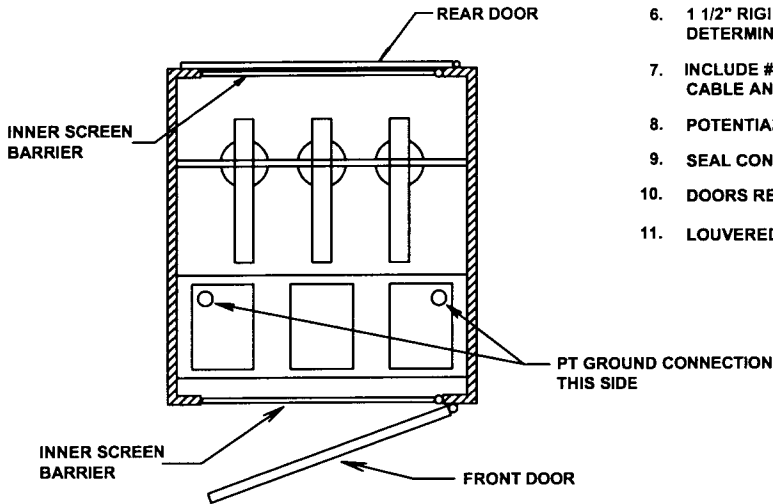
3-POTENTIAL TRANSFORMERS FOR 13.2 KV
2-POTENTIAL TRANSFORMERS FOR 4.8 KV
PROVIDE MOUNTING HOLES FOR 3 TRANSFORMERS

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

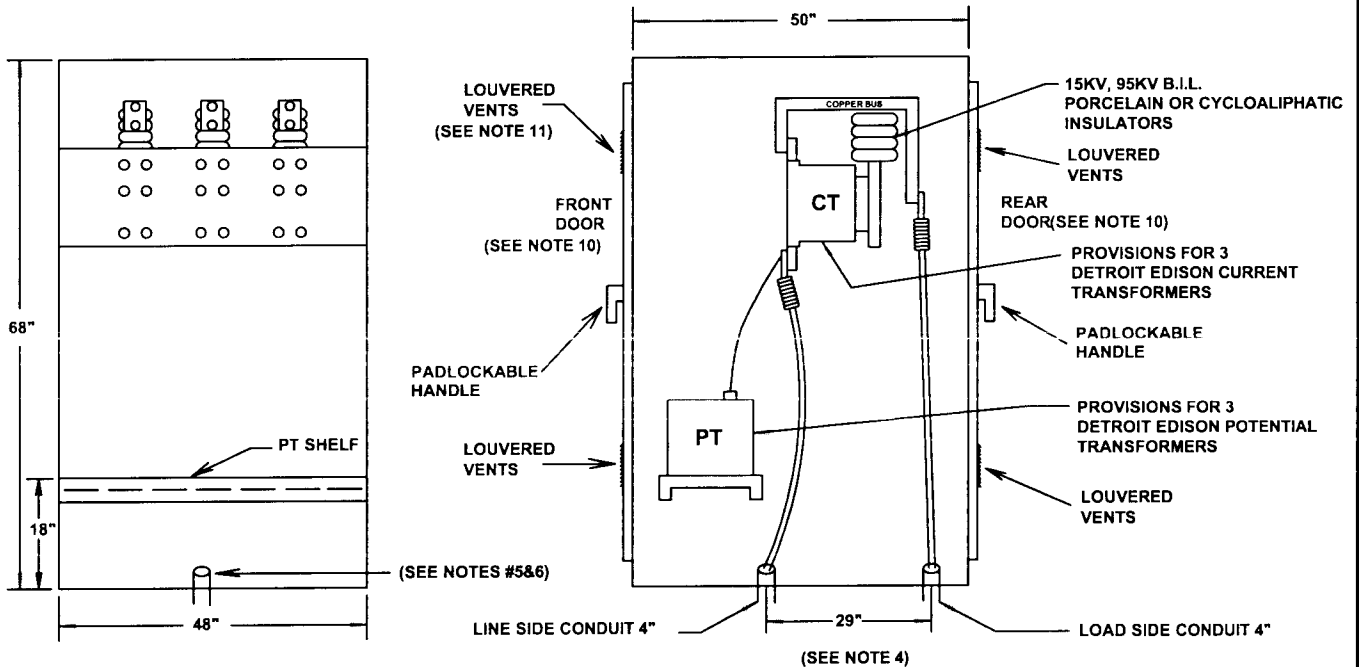
**OUTDOOR METER UNIT
13.2KV OR 4800V**

NOTES:

1. KIT REQUIRED FOR 4800V USE.
2. SEE PAGES 11-4-10 AND 11-4-12 FOR WIRING INSTRUCTIONS.
3. POTENTIAL AND CURRENT TRANSFORMERS PROVIDED BY DETROIT EDISON.
4. SECONDARY METER WIRE PROVIDED BY DETROIT EDISON.
5. UNIT IS INTERCHANGEABLE WITH TYPE PM-123 UNIT - MUST MAINTAIN 29" CONDUIT SPACING.
6. 1 1/2" RIGID STEEL CONDUIT TO DETROIT EDISON METERS. LOCATION TO BE DETERMINED ON JOB SITE - SEE PRIMARY SERVICES REPRESENTATIVE.
7. INCLUDE #2 COPPER WIRE (600V INSULATION) IN SAME CONDUIT WITH METER CABLE AND CONNECT TO UNIT GROUND MASS.
8. POTENTIAL TRANSFORMER SHELF IS REMOVABLE.
9. SEAL CONDUIT WITH DUCT SEAL.
10. DOORS REQUIRE 3-POINT LATCHING
11. LOUVERED VENTS NEED TO BE RAINPROOF.



TOP VIEW

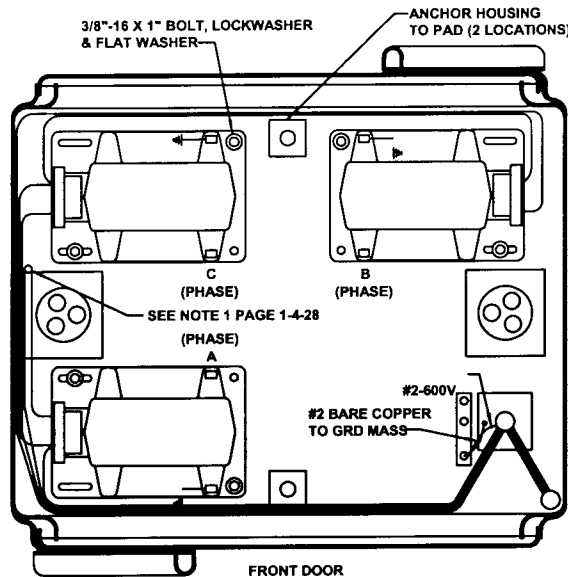


FRONT VIEW

SIDE VIEW

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

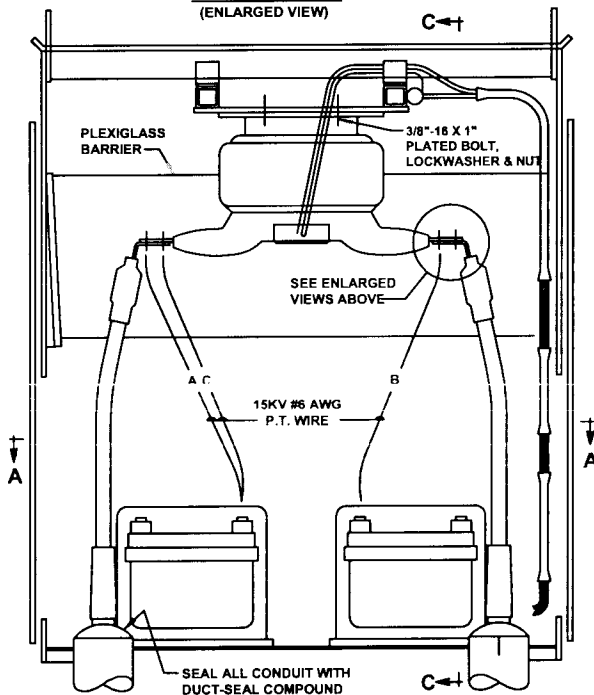
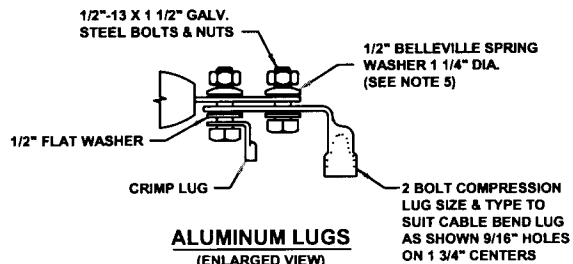
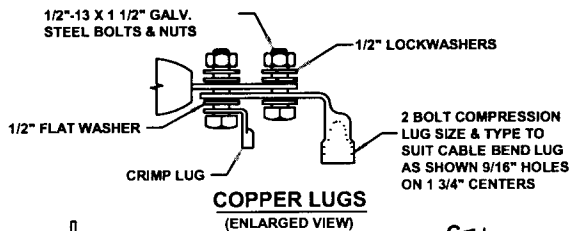
INSTALLATIONS INSTRUCTIONS 13.2KV OLD TYPE KU OUTDOOR METER UNIT (MAINTENANCE ONLY)



PLAN VIEW AT A-A (OF B-B)

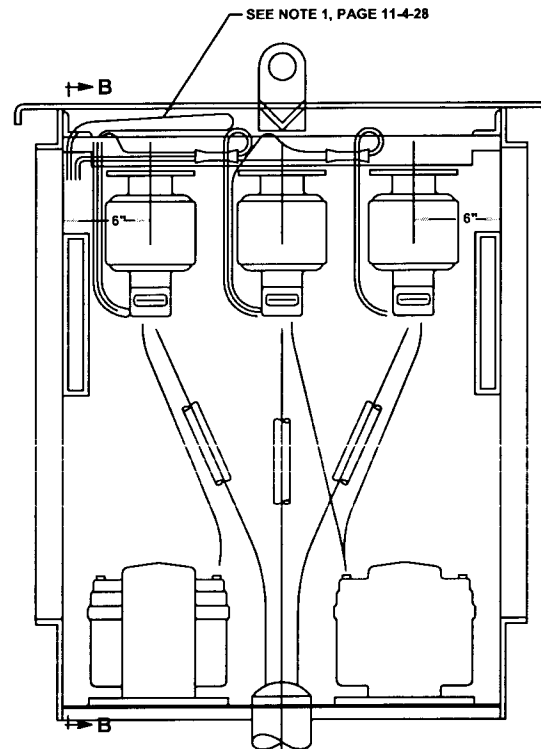
NOTES:

1. WATERPROOF ENTIRE PAD UNDER HOUSING. EXTEND COMPOUND 2" BEYOND ALL SIDES. A COMPLETE SEAL MUST BE FORMED BETWEEN HOUSING AND PAD.
2. SEE PAGE 11-4-28 FOR WIRING INSTRUCTIONS.
3. STRIP 15 FOOT OF JACKET OFF METER CABLE. WIRES MAY BE CUT, BUT SEE NOTE 1, PAGE 11-4-12.
4. FOR RACK MOUNTING, PLATES ARE FURNISHED TO COVER THE PRIMARY AND METER CONDUIT OPENINGS. UNIT MUST BE FASTENED TO THE RACK AT THE FOUR CORNERS. CLOSE THE TWO ANCHOR HOLES WITH THE SQUARE WASHERS PROVIDED.
5. FOR ALUMINUM LUGS, COAT WITH NO-OX-ID, TIGHTEN NUTS UNTIL BELLEVILLE SPRING WASHER FLATTENS. SEE ALUMINUM DETAIL BELOW.
6. ALL EQUIPMENT FURNISHED BY DETROIT EDISON COMPANY EXCEPT KU UNIT, PRIMARY CABLE, TERMINATIONS AND COMPRESSION LUGS.



B-B (OF C-C)

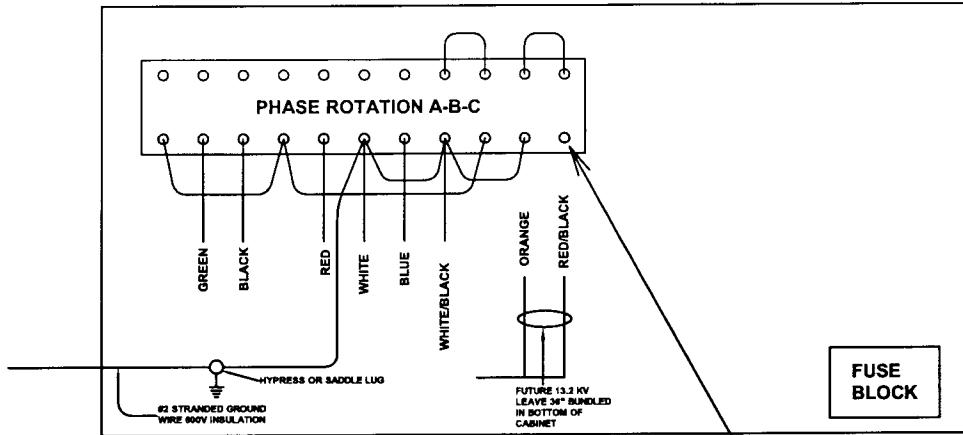
NO CUTTING OR DRILLING OF METER UNIT PERMITTED



C-C (OF B-B)

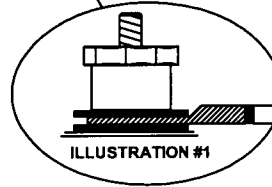
THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

**WIRING INSTRUCTIONS
4.8KV METER UNIT
(2 CURRENT TRANSFORMERS)
(FOR MAINTENANCE OF EXISTING INSTALLATIONS ONLY)
METER CONNECTION CABINET (ZA-90)**

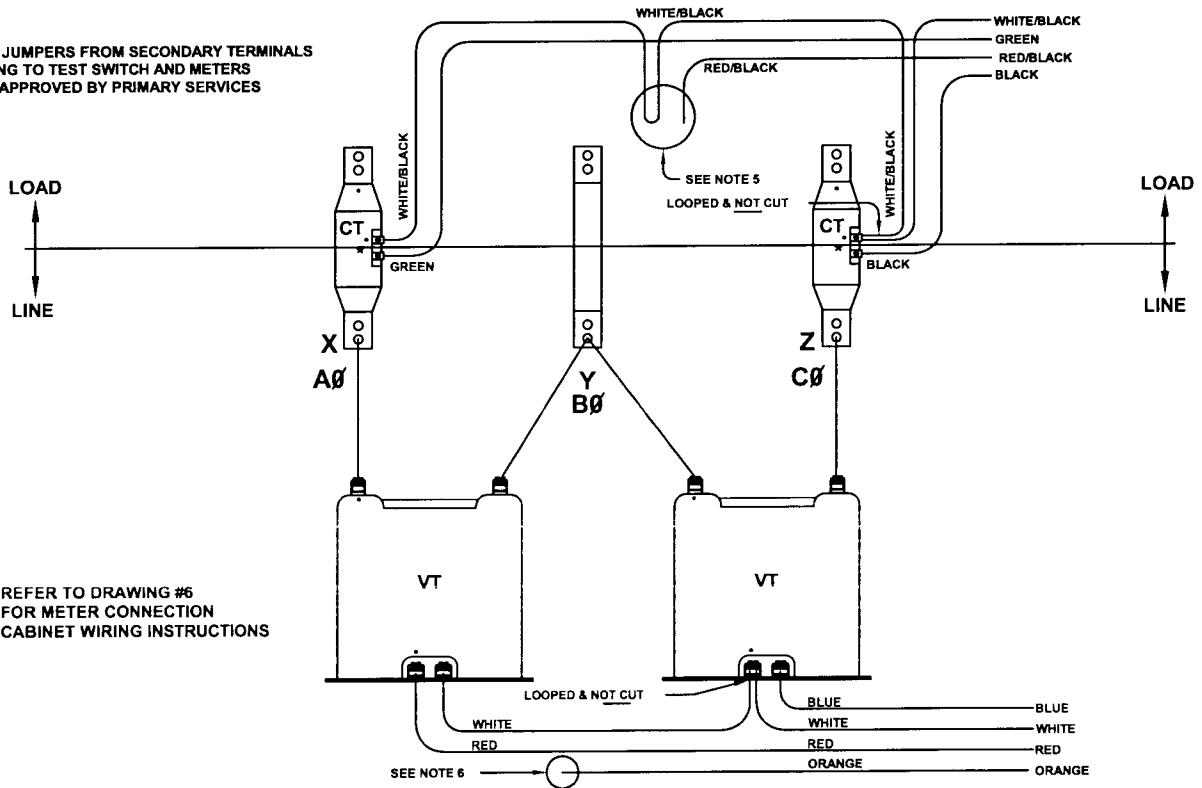


NOTE:

1. DECO METER WIRE TO BE TERMINATED WITH LOOP OR RING TYPE STAKE ON LUGS. FORK TYPE STAKE ON LUGS SHALL NOT BE PERMITTED
2. THE STAKE ON LUGS SHALL BE INSTALLED BETWEEN THE TWO FLAT WASHERS ON THE TERMINAL POST. SEE INSET ILLUSTRATION #1



- * REMOVE CT JUMPERS FROM SECONDARY TERMINALS AFTER WIRING TO TEST SWITCH AND METERS HAVE BEEN APPROVED BY PRIMARY SERVICES



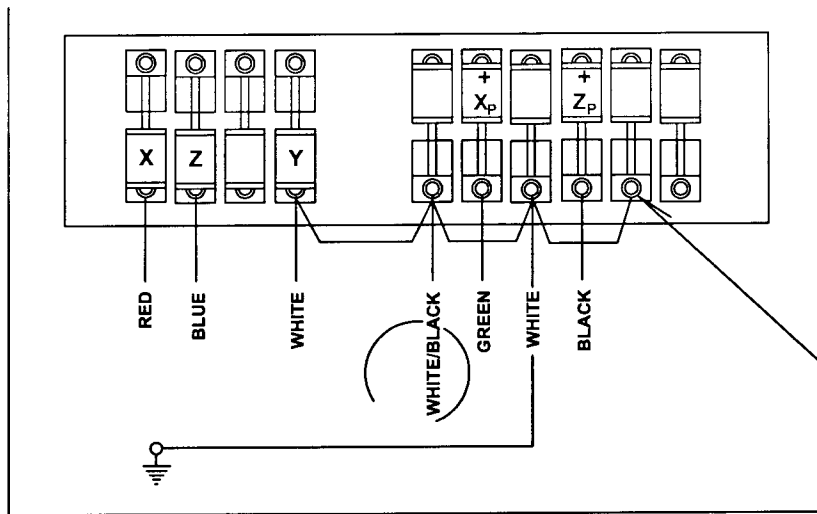
REFER TO DRAWING #6 FOR METER CONNECTION CABINET WIRING INSTRUCTIONS

NOTES:

1. CT WIRES BLACK AND GREEN SHALL BE LONG ENOUGH TO REACH EITHER CT TERMINAL.
2. VT WIRES RED AND BLUE SHALL BE LONG ENOUGH TO REACH EITHER VT TERMINAL.
3. VT AND CT WIRES SHALL BE CONTINUOUS TO THE POINT OF CONNECTION. CUTTING OR SPLICING TO THAT POINT SHALL NOT BE PERMITTED.
4. A #2 600 VOLT INSULATED GROUND CONDUCTOR (FURNISHED BY CUSTOMER) SHALL BE PULLED IN WITH THE 9 CONDUCTOR METER CABLE. ALTERNATIVES MUST BE APPROVED, PRIOR TO INSTALLATION, BY PRIMARY SERVICES.
5. FOR FUTURE 3RD CT.
6. FOR FUTURE 3RD VT (13.2 KV CONVERSION ETC.)
7. THE TOTAL LENGTH OF THE DECO 9 CONDUCTOR METER CABLE SHALL NOT EXCEED 150 FEET

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

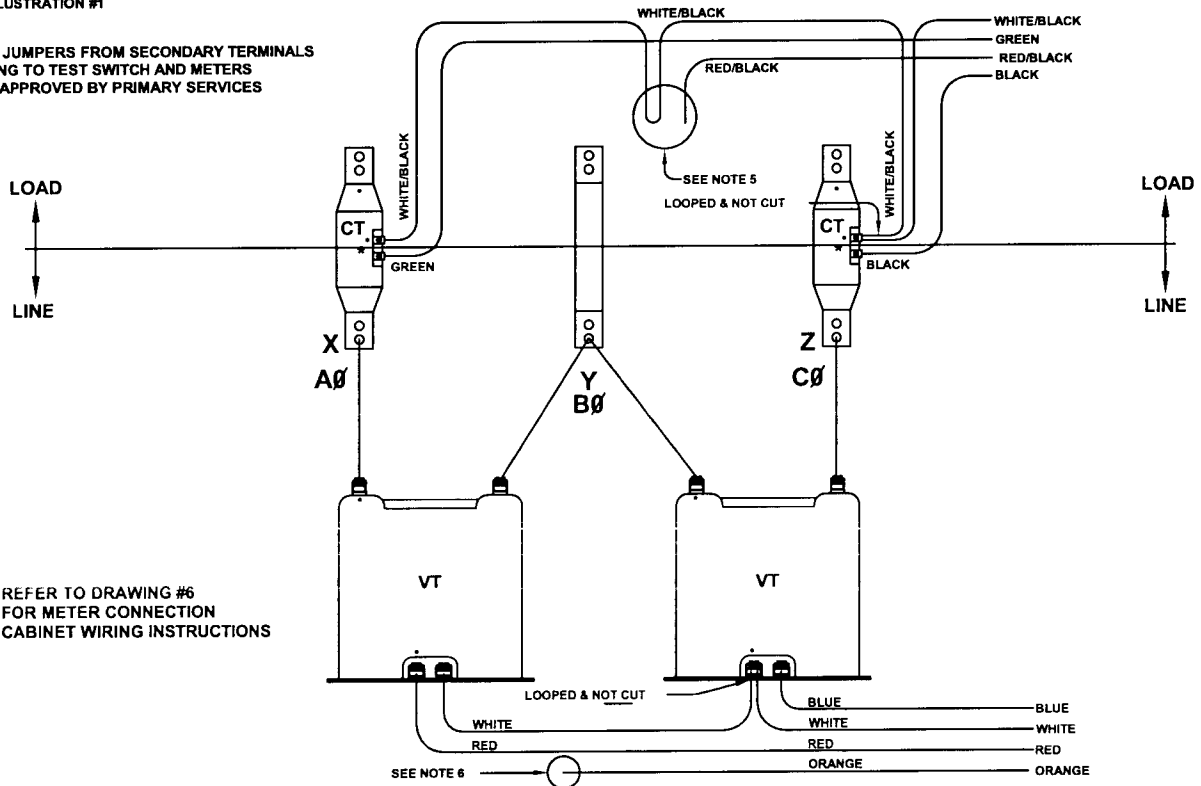
**WIRING INSTRUCTIONS
4.8KV DELTA SYSTEM
(2 CURRENT TRANSFORMERS)
METER CONNECTION CABINET (ZS3-20-5S)**



NOTE:

1. DECO METER WIRE TO BE TERMINATED WITH LOOP OR RING TYPE STAKE ON LUGS. FORK TYPE STAKE ON LUGS SHALL NOT BE PERMITTED
2. THE STAKE ON LUGS SHALL BE INSTALLED BETWEEN THE TWO FLAT WASHERS ON THE TERMINAL POST. SEE INSET ILLUSTRATION #1

* REMOVE CT JUMPERS FROM SECONDARY TERMINALS AFTER WIRING TO TEST SWITCH AND METERS HAVE BEEN APPROVED BY PRIMARY SERVICES



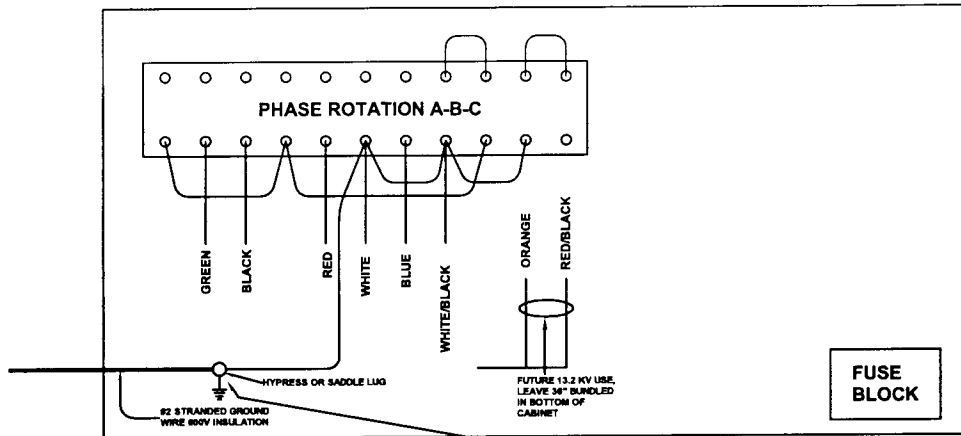
REFER TO DRAWING #6 FOR METER CONNECTION CABINET WIRING INSTRUCTIONS

NOTES:

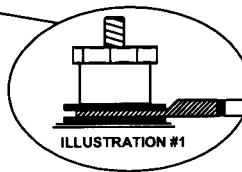
1. CT WIRES BLACK AND GREEN SHALL BE LONG ENOUGH TO REACH EITHER CT TERMINAL.
2. VT WIRES RED AND BLUE SHALL BE LONG ENOUGH TO REACH EITHER VT TERMINAL.
3. VT AND CT WIRES SHALL BE CONTINUOUS TO THE POINT OF CONNECTION. CUTTING OR SPLICING TO THAT POINT SHALL NOT BE PERMITTED.
4. A #2 CU 600 VOLT INSULATED GROUND CONDUCTOR (FURNISHED BY CUSTOMER) SHALL BE PULLED IN WITH THE 9 CONDUCTOR METER CABLE. ALTERNATIVES MUST BE APPROVED, PRIOR TO INSTALLATION, BY PRIMARY SERVICES.
5. FOR FUTURE 3RD CT.
6. FOR FUTURE 3RD VT (13.2 KV CONVERSION ETC.)
7. THE TOTAL LENGTH OF THE DECO 9 CONDUCTOR METER CABLE SHALL NOT EXCEED 150 FEET

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

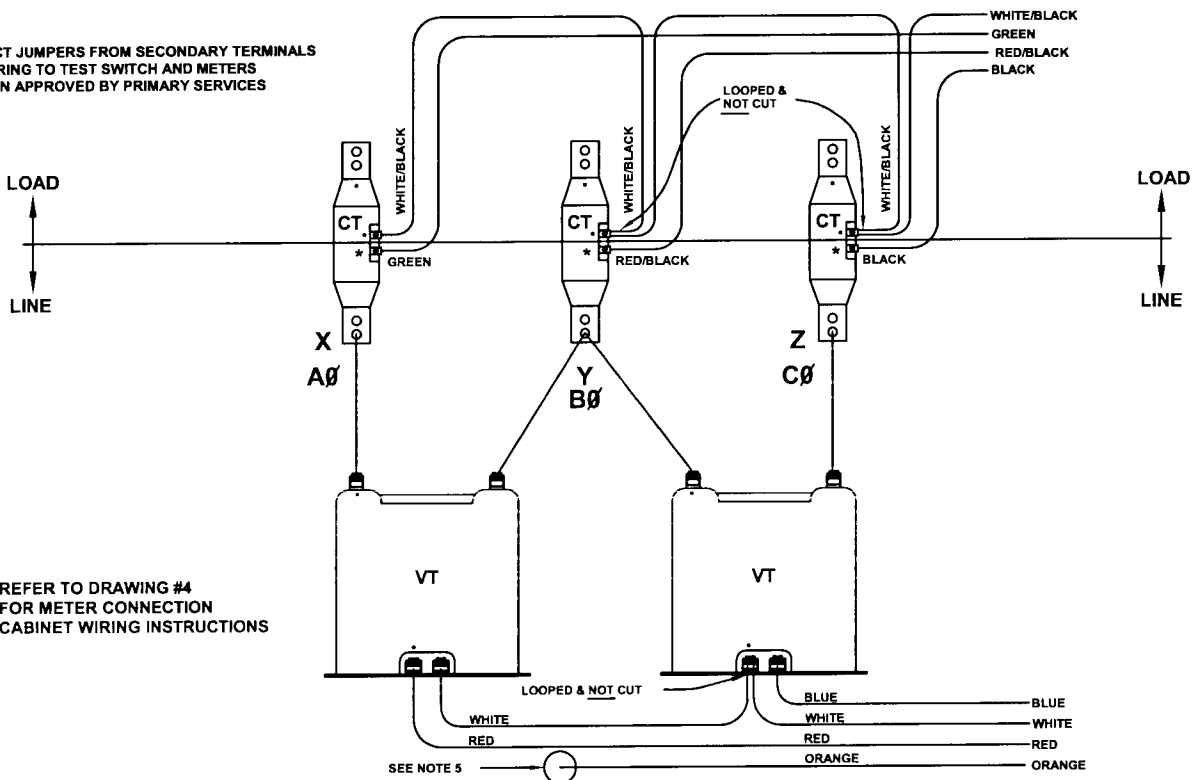
**WIRING INSTRUCTIONS
4.8KV METER UNIT
(3 CURRENT TRANSFORMER)
(FOR MAINTENANCE PURPOSES ONLY, NOT FOR NEW INSTALLATIONS)
METER CONNECTION CABINET (ZA-90)**



- NOTE:**
1. DECO METER WIRE TO BE TERMINATED WITH LOOP OR RING TYPE STAKE ON LUGS. FORK TYPE STAKE ON LUGS SHALL **NOT** BE PERMITTED
 2. THE STAKE ON LUGS SHALL BE INSTALLED BETWEEN THE TWO FLAT WASHERS ON THE TERMINAL POST. SEE INSET ILLUSTRATION #1



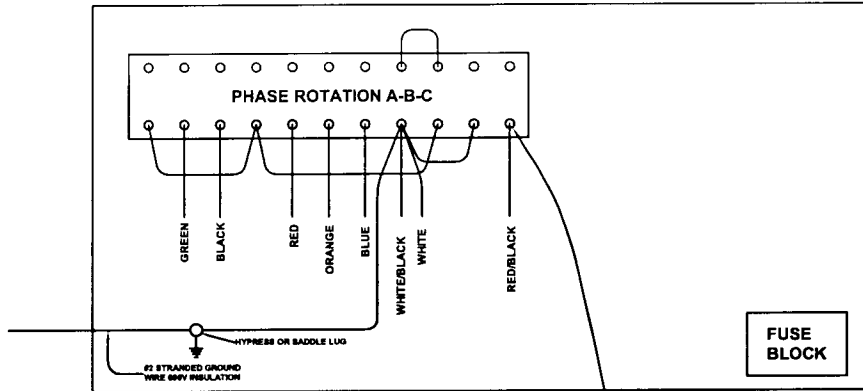
* REMOVE CT JUMPERS FROM SECONDARY TERMINALS AFTER WIRING TO TEST SWITCH AND METERS HAVE BEEN APPROVED BY PRIMARY SERVICES



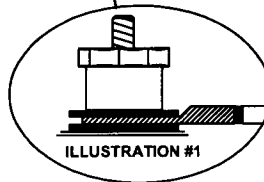
- NOTES:**
1. CT WIRES BLACK AND GREEN SHALL BE LONG ENOUGH TO REACH EITHER CT TERMINAL.
 2. VT WIRES RED AND BLUE SHALL BE LONG ENOUGH TO REACH EITHER VT TERMINAL.
 3. VT AND CT WIRES SHALL BE CONTINUOUS TO THE POINT OF CONNECTION. CUTTING OR SPLICING TO THAT POINT SHALL NOT BE PERMITTED.
 4. A #2 600 VOLT INSULATED GROUND CONDUCTOR (FURNISHED BY CUSTOMER) SHALL BE PULLED IN WITH THE 9 CONDUCTOR METER CABLE. ALTERNATIVES MUST BE APPROVED, PRIOR TO INSTALLATION, BY PRIMARY SERVICES.
 5. FOR FUTURE 3RD VT (13.2 KV CONVERSION ETC.)
 6. THE TOTAL LENGTH OF THE DECO 9 CONDUCTOR METER CABLE SHALL NOT EXCEED 150 FEET

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

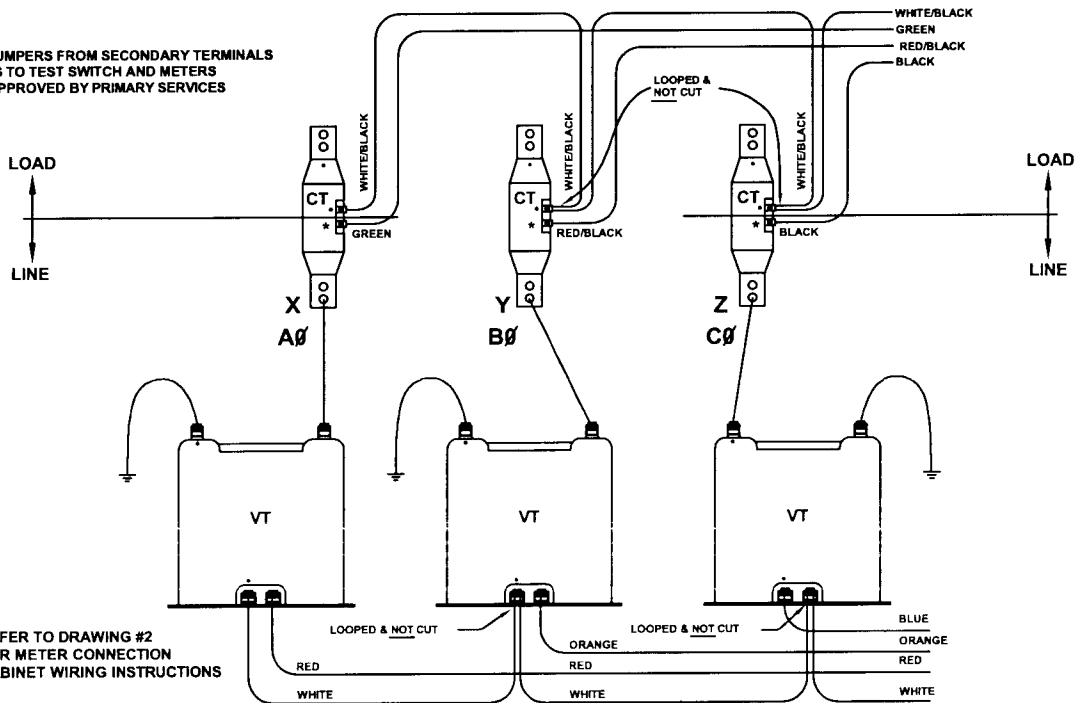
**WIRING INSTRUCTIONS
13.2KV, 8.3KV OR 4.16KV WYE SYSTEM
(FOR MAINTENANCE OF EXISTING INSTALLATIONS ONLY)
METER CONNECTION CABINET (ZA-90)**



- NOTE:**
1. DECO METER WIRE TO BE TERMINATED WITH LOOP OR RING TYPE STAKE ON LUGS. FORK TYPE STAKE ON LUGS SHALL NOT BE PERMITTED
 2. THE STAKE ON LUGS SHALL BE INSTALLED BETWEEN THE TWO FLAT WASHERS ON THE TERMINAL POST. SEE INSET ILLUSTRATION #1



* REMOVE CT JUMPERS FROM SECONDARY TERMINALS AFTER WIRING TO TEST SWITCH AND METERS HAVE BEEN APPROVED BY PRIMARY SERVICES

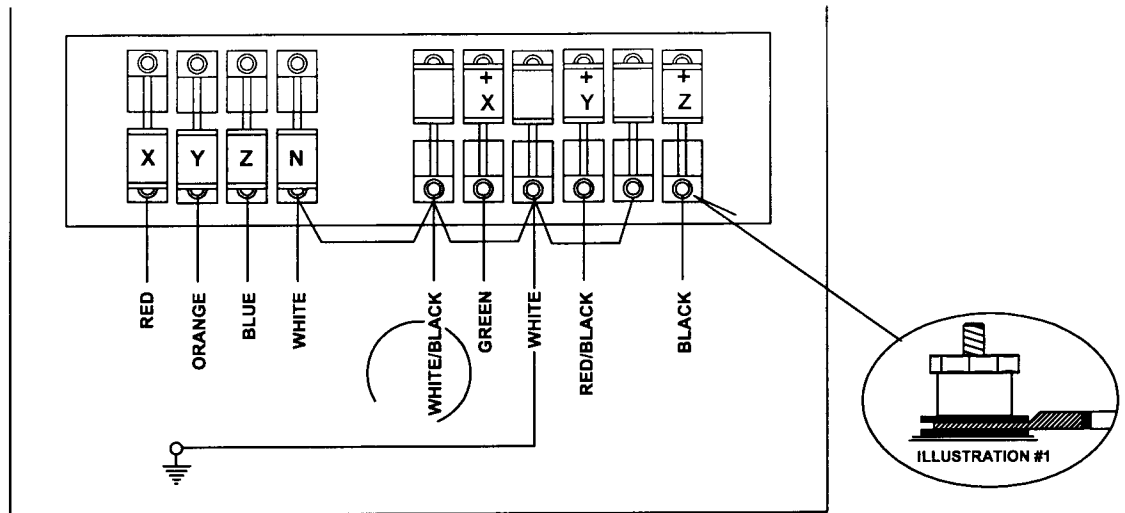


REFER TO DRAWING #2 FOR METER CONNECTION CABINET WIRING INSTRUCTIONS

1. CT WIRES BLACK AND GREEN SHALL BE LONG ENOUGH TO REACH EITHER CT TERMINAL.
2. VT WIRES RED AND BLUE SHALL BE LONG ENOUGH TO REACH EITHER VT TERMINAL.
3. VT AND CT WIRES SHALL BE CONTINUOUS TO THE POINT OF CONNECTION. CUTTING OR SPLICING TO THAT POINT SHALL NOT BE PERMITTED.
4. A #2 600 VOLT INSULATED GROUND CONDUCTOR (FURNISHED BY CUSTOMER) SHALL BE PULLED IN WITH THE 9 CONDUCTOR METER CABLE. ALTERNATIVES MUST BE APPROVED, PRIOR TO INSTALLATION, BY PRIMARY SERVICES.
5. THE TOTAL LENGTH OF THE DECO 9 CONDUCTOR METER CABLE SHALL NOT EXCEED 150 FEET.

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

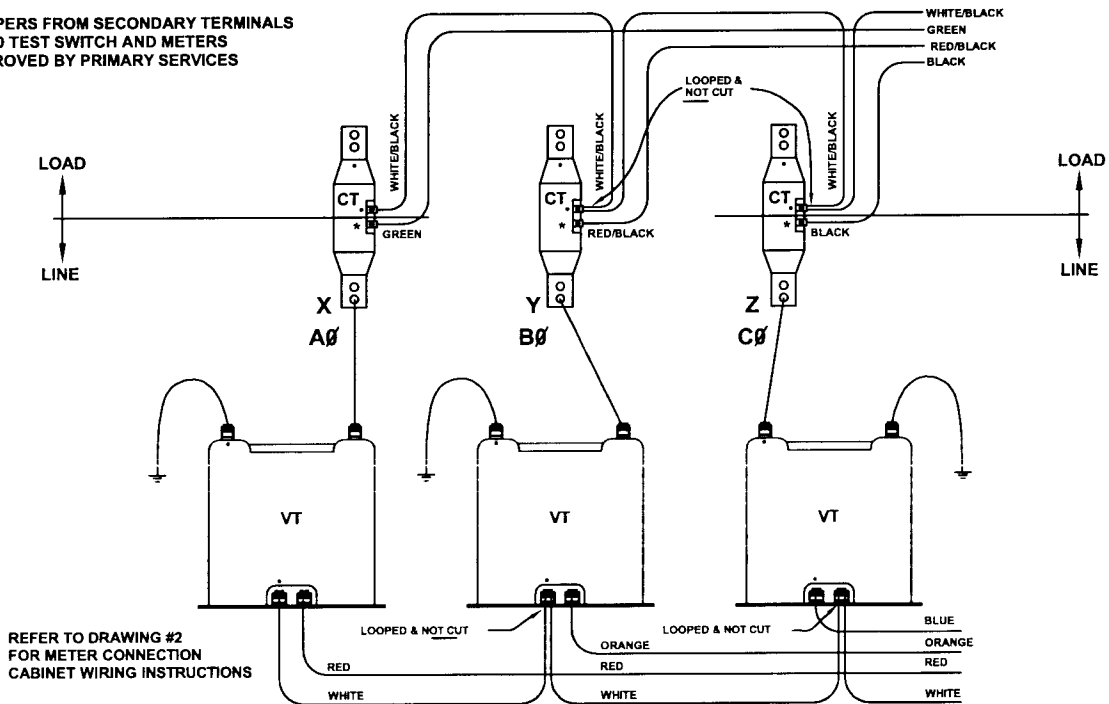
WIRING INSTRUCTIONS
13.2KV, 8.3KV OR 4.16KV WYE SYSTEM
METER CONNECTION BOX - TYPE ZS3-20 (4-Wire)



NOTE:

1. DECO METER WIRE TO BE TERMINATED WITH LOOP OR RING TYPE STAKE ON LUGS. FORK TYPE STAKE ON LUGS SHALL NOT BE PERMITTED
2. THE STAKE ON LUGS SHALL BE INSTALLED BETWEEN THE TWO FLAT WASHERS ON THE TERMINAL POST. SEE INSET ILLUSTRATION #1

* REMOVE CT JUMPERS FROM SECONDARY TERMINALS AFTER WIRING TO TEST SWITCH AND METERS HAVE BEEN APPROVED BY PRIMARY SERVICES

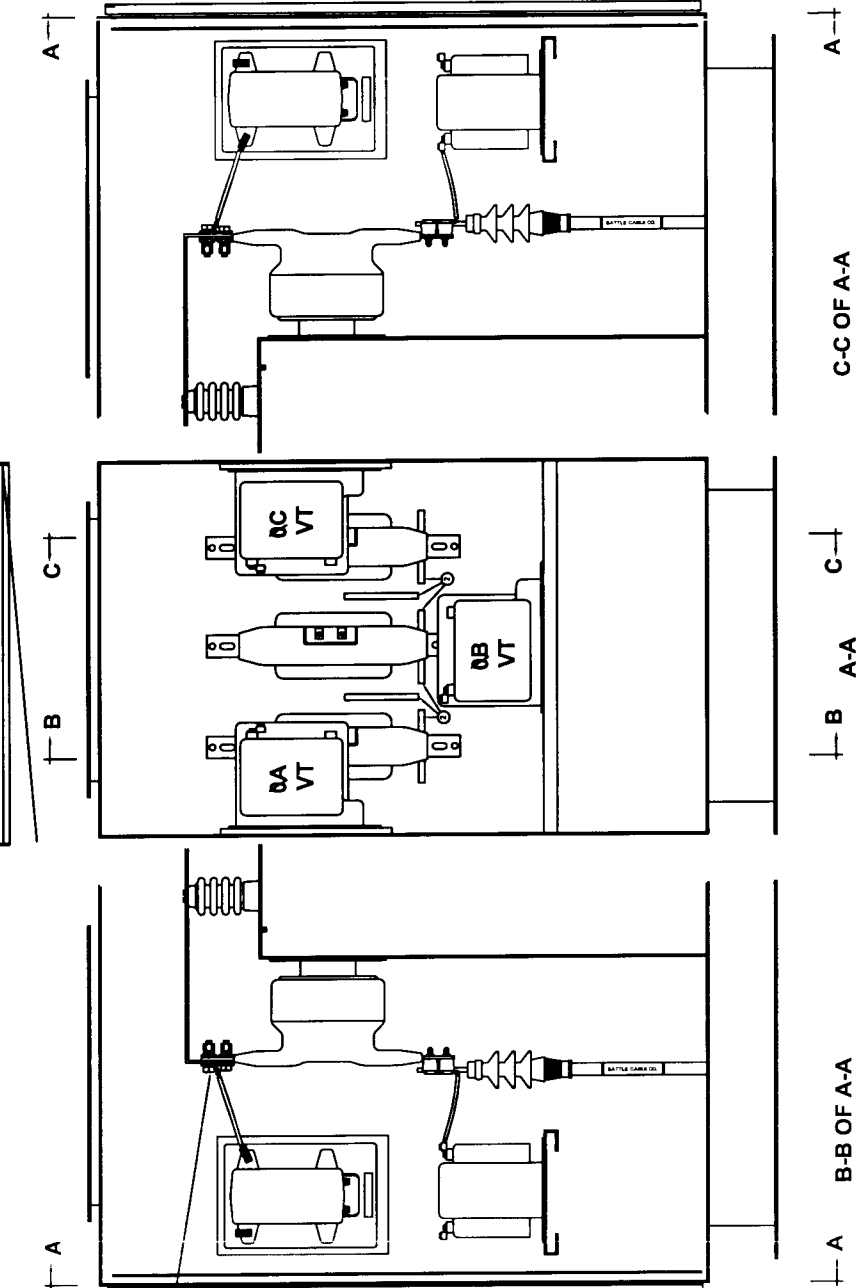
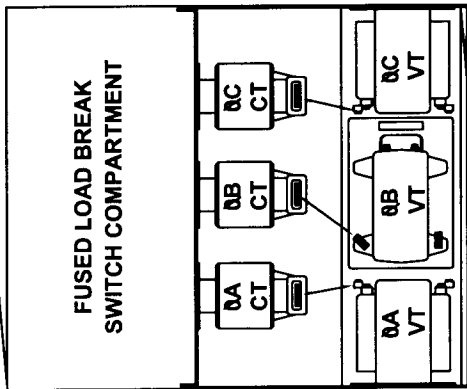
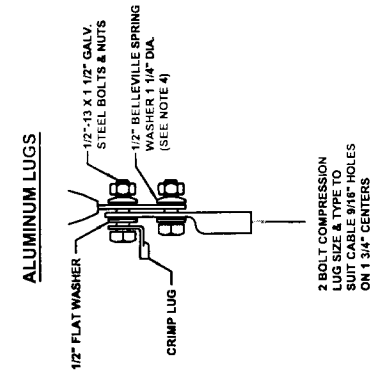


REFER TO DRAWING #2 FOR METER CONNECTION CABINET WIRING INSTRUCTIONS

1. CT WIRES BLACK AND GREEN SHALL BE LONG ENOUGH TO REACH EITHER CT TERMINAL.
2. VT WIRES RED AND BLUE SHALL BE LONG ENOUGH TO REACH EITHER VT TERMINAL.
3. VT AND CT WIRES SHALL BE CONTINUOUS TO THE POINT OF CONNECTION. CUTTING OR SPLICING TO THAT POINT SHALL NOT BE PERMITTED.
4. A #2 CU 600 VOLT INSULATED GROUND CONDUCTOR (FURNISHED BY CUSTOMER) SHALL BE PULLED IN WITH THE 9 CONDUCTOR METER CABLE. ALTERNATIVES MUST BE APPROVED, PRIOR TO INSTALLATION, BY PRIMARY SERVICES.
5. THE TOTAL LENGTH OF THE DECO 9 CONDUCTOR METER CABLE SHALL NOT EXCEED 150 FEET.

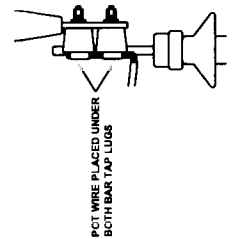
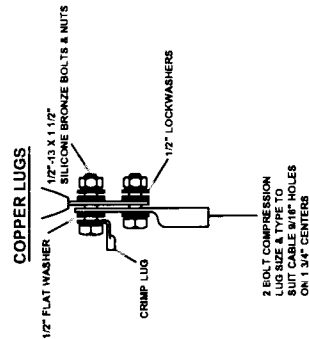
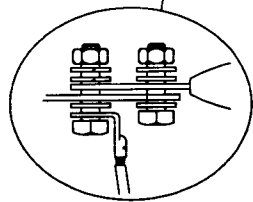
THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

INSTALLATION INSTRUCTIONS
13.2KV OR 8.3KV OUTDOOR
COMBINATION METERING AND SWITCH UNIT



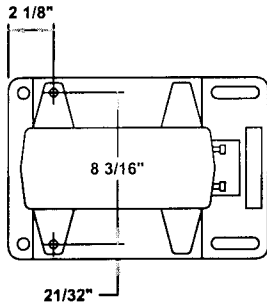
NOTES:

1. SEE PAGE 11-4-28 FOR WIRING INSTRUCTIONS.
2. STRIP 15 FOOT OF JACKET OFF METER CABLE. WIRES MAY BE CUT, BUT SEE NOTE 1, PAGE 11-4-12.
3. FOR ALUMINUM LUGS, CLEAN ALL CONTACT SURFACES WITH A WIRE BRUSH, THEN COAT WITH NO-OX-ID. TIGHTEN NUTS UNTIL BELLEVILLE SPRING WASHER FLATTENS.
4. USE 3/8"-16 X 1" PLATED BOLTS, LOCKWASHERS, AND FLAT WASHERS TO MOUNT CT'S AND PT'S.



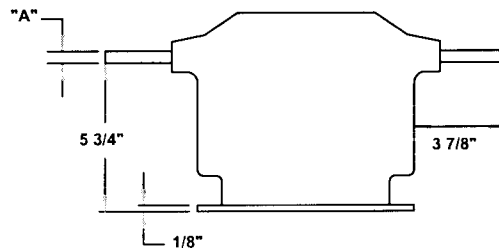
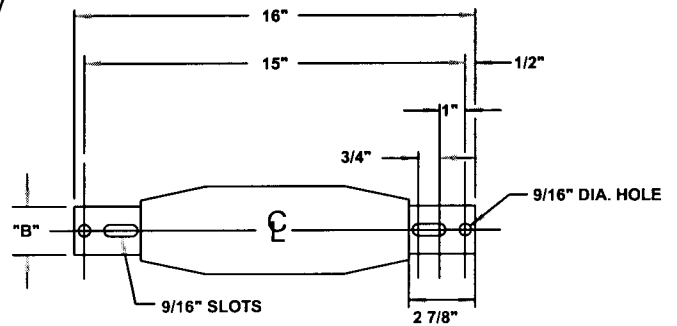
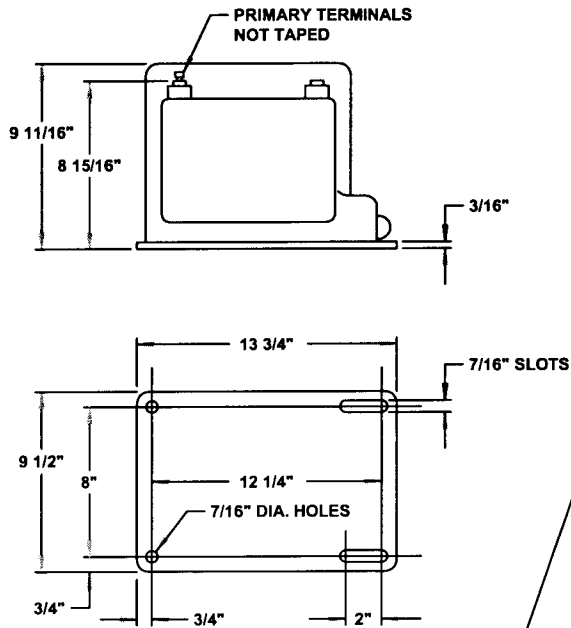
THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

OUTLINE OF 8.7KV METERING TRANSFORMERS
5 TO 800 AMPERES - 4.8KV



ALTERNATE LOCATION:
POTENTIAL TRANSFORMERS MAY BE LOCATED
IN SWITCHGEAR SUPERSTRUCTURE. DOOR TO
BE HINGED, BOLTED AND PADLOCKED.

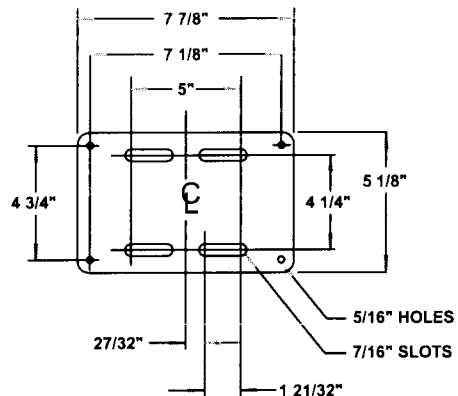
JVM-4 POTENTIAL TRANSFORMERS (UNFUSED)
40/1 RATIO (2 REQUIRED)



JKM-4 CURRENT TRANSFORMERS
(2 REQUIRED)

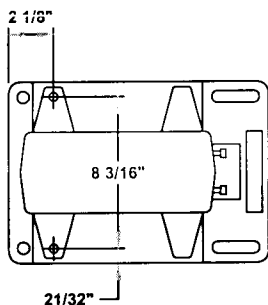
IMPORTANT
NOTE AMPERE RATING

AMPERE RATING	"A"	"B"
5-150	3/16"	1 1/2"
200-400	1/4"	2"
500-800	3/8"	2"

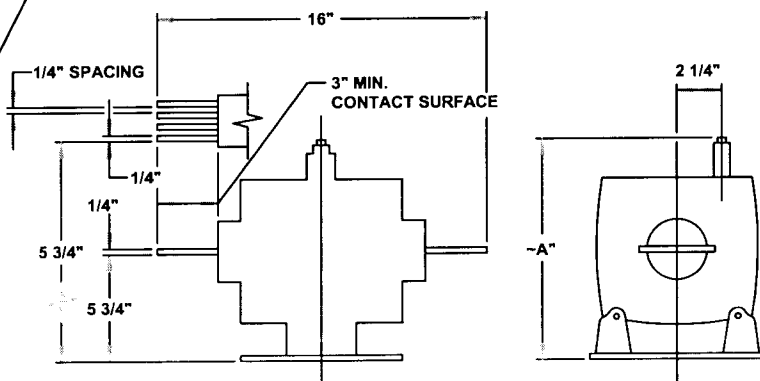
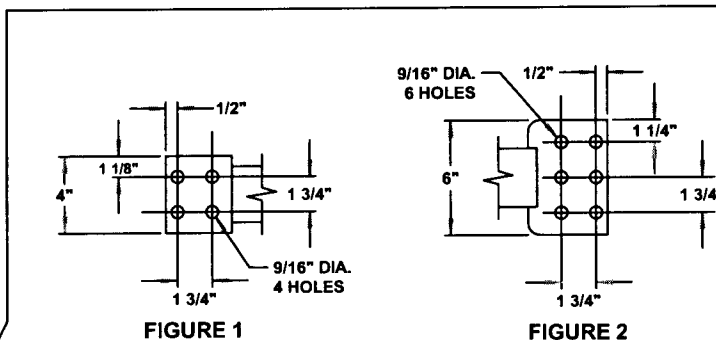
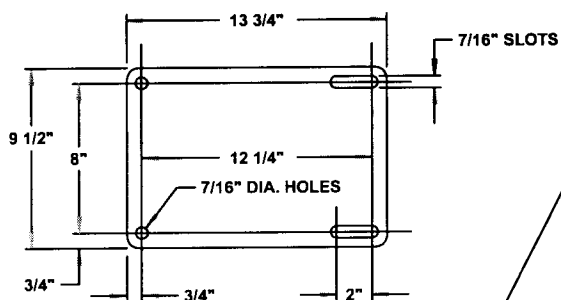
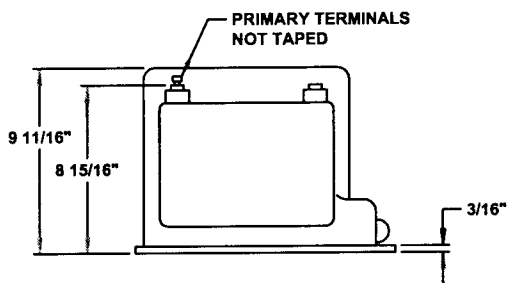


THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY
OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

OUTLINE OF 8.7KV METERING TRANSFORMERS
1200 TO 4000 AMPERES - 4.8KV



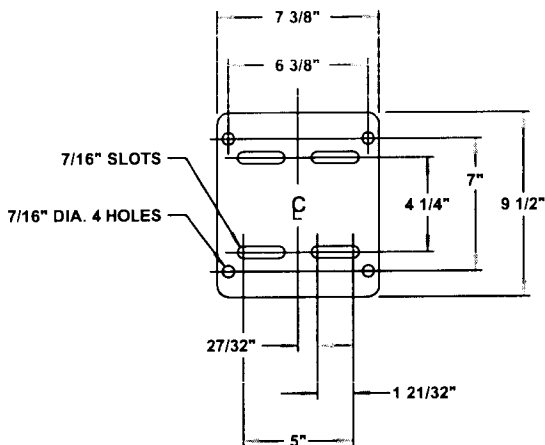
JVM-4 POTENTIAL TRANSFORMERS (UNFUSED)
40/1 RATIO (2 REQUIRED)



JCM-4 CURRENT TRANSFORMERS
(2 REQUIRED)

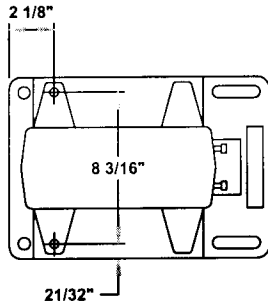
IMPORTANT
NOTE AMPERE RATING

AMPERE RATING	-A"	FIG.	NUMBER OF PADS
1200-1500	11 11/16"	1	1
2000-2500	12 3/16"	1	2
3000	12 7/16"	2	3
4000	12 11/16"	2	4

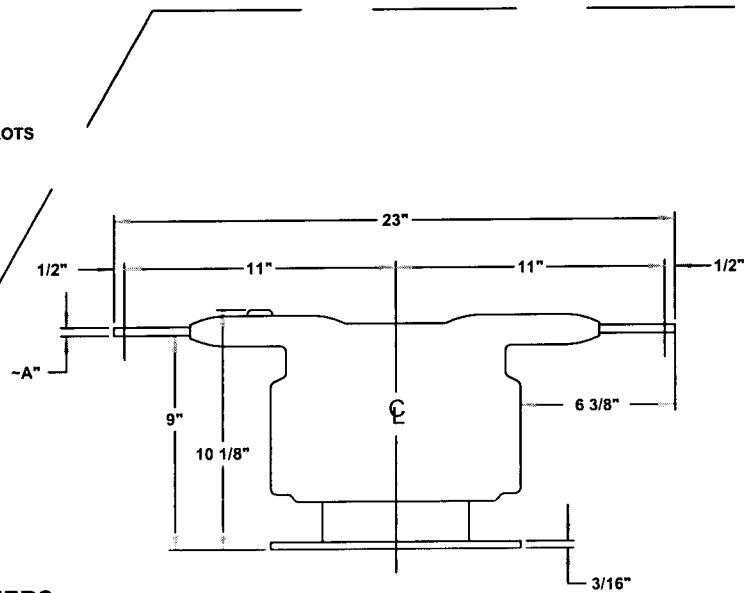
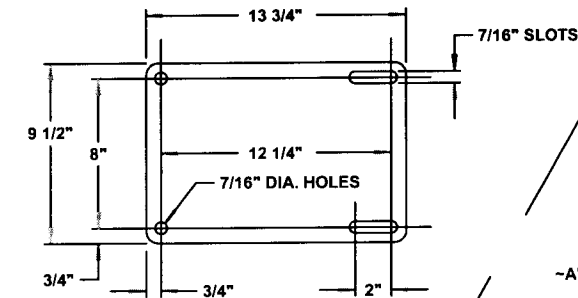
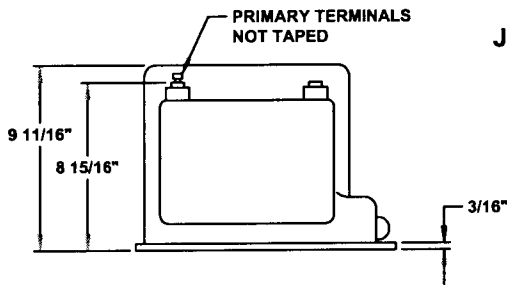


THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY
OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

OUTLINE OF 15KV METERING TRANSFORMERS
10 TO 800 AMPERES - 13.2KV



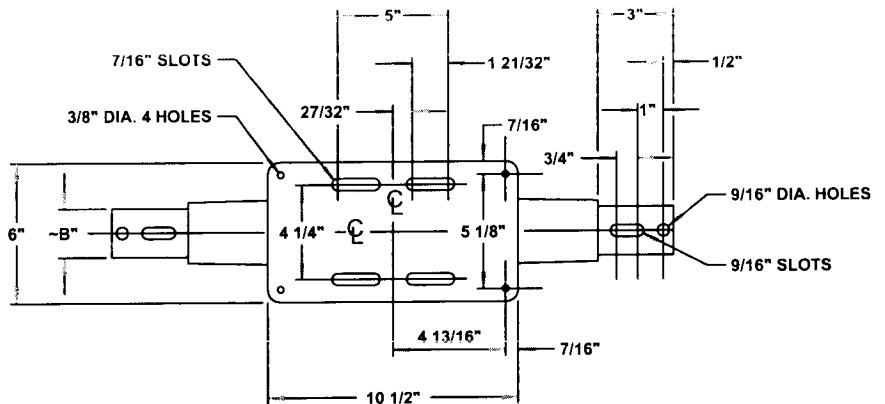
JVM-5 POTENTIAL TRANSFORMERS (UNFUSED)
70/1 RATIO (3 REQUIRED)



JKM-5 CURRENT TRANSFORMERS
(3 REQUIRED)

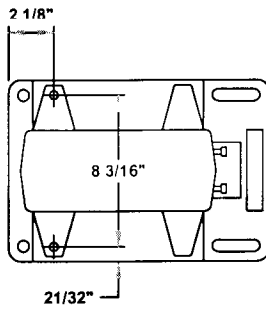
IMPORTANT
NOTE AMPERE RATING

AMPERE RATING	-A"	-B"
10-150	3/16"	1 1/2"
200-400	1/4"	2"
600-800	3/8"	2"



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**OUTLINE OF 15KV METERING TRANSFORMERS
1200 TO 4000 AMPERES - 13.2KV**



**JVM-5 POTENTIAL TRANSFORMERS (UNFUSED)
70/1 RATIO (3 REQUIRED)**

ALTERNATE LOCATION:
POTENTIAL TRANSFORMERS MAY BE LOCATED
IN SWITCHGEAR SUPERSTRUCTURE. DOOR TO
BE HINGED, BOLTED AND PADLOCKED.

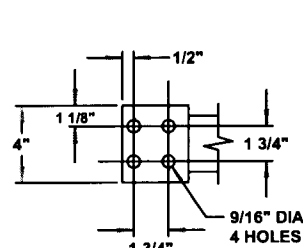
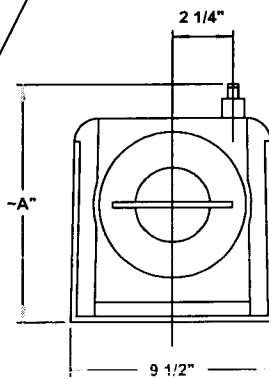
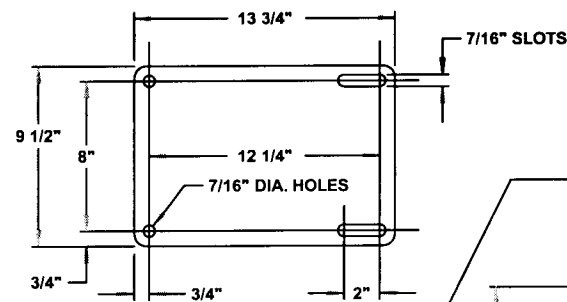
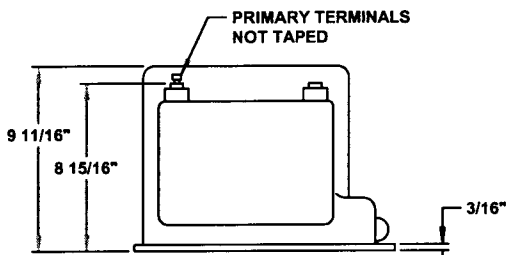


FIGURE 1

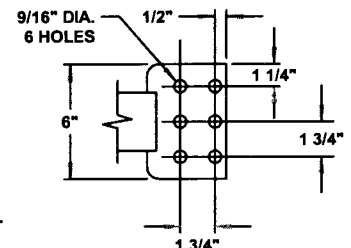
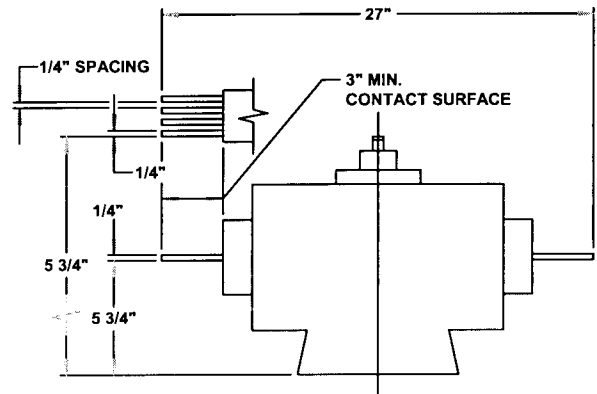


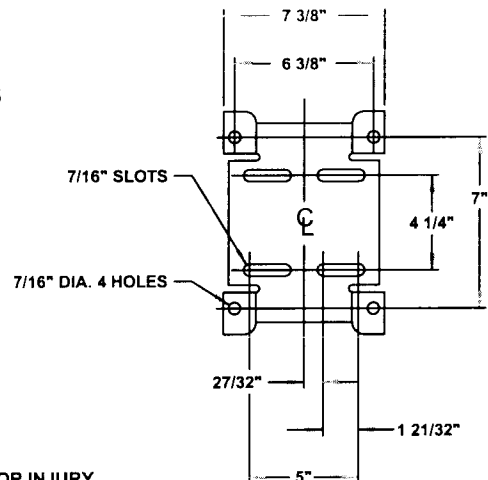
FIGURE 2



**JCM-5 CURRENT TRANSFORMERS
(3 REQUIRED)**

**IMPORTANT
NOTE AMPERE RATING**

AMPERE RATING	-A"	FIG.	NUMBER OF PADS
1200-1500	11 11/16"	1	1
2000-2500	12 3/16"	1	2
3000	12 7/16"	2	3
4000	12 11/16"	2	4



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OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

SINGLE CONDUCTOR PRIMARY SERVICE CABLE

All service cable must be approved by Primary Services prior to purchase. The following types of single conductor cable are acceptable for use as primary service cable on the Detroit Edison system.

All single conductor cable must be 15kV. Cable must be cooper and minimum #2. Corrosion resistant covering may be required.

- A. Cross-Linked Polyethylene Concentric Cable as per Detroit Edison Specification 527, revision L or later.
- B. Ethylene Propylene Rubber, Detroit Edison Specification 520, revision E or later.

Note:

1. If copper tape shielded cable is used an additional #2/0, grounded conductor will be pulled into the same conduit as the power cable. The conductor shall be #2/0 copper with 600v insulation (a smaller conductor may be adequate in some cases - consult Primary Services).
2. All cables must meet Local Code requirements.

**RECOMMENDED JOINTS AND TERMINATIONS
FOR 15 kV CROSS-LINKED POLYETHYLENE AND
POLYETHYLENE CONCENTRIC SINGLE CONDUCTOR
PRIMARY CABLES**

(See Page 11-5-1 for Acceptable Cables)

Termination's Indoor Only*

PLM Type FSDT
RAYCHEM CAT. HVT-150
3M Type Quickterm, 5600 Series & 7600 Series

Termination's Indoor or Outdoor

3M Type 5600 Quickterm with Skirts & 7600 Series
RAYCHEM CAT. HVT-150-S
G& W Type PAT 1700 or LCT
Elastimold Style 15 THG, 16 THG or 35 MTG
PLM Type FSDW

Splices

3M Catalog No. 5400 or 5500
RAYCHEM CAT. 1520
G& W Style 225 or 370
Elastimold Style 250S or 650S
PLM Catalog No. SA to SE-15
RTE Type 2603890A
Plymouth Plyjoint

All terminal connectors must be long barrel compression lugs with two holes NEMA (1-3/4" spaced, or bendable spike lugs).

Specify insulation thickness and cable diameter when ordering termination's and splices. For any additional information, contact the Primary Services.

Load Break Elbows and Bushings for Deadfront Transformers

FOR SPECIAL APPLICATIONS ONLY:

Elastimold Style 167LR/1601A3R
RTE Type 2609459 A_ _/2604797B01M

**An indoor installation is one that is in a structure that is conditioned for human comfort. This does not include outdoor meter units, switchgear or transformers. Installations coming within this definition will normally have proper humidity assuring that indoor terminations will be installed in dry locations.*

FUSED LOADBREAK INTERRUPTER SWITCHES, ACCEPTABLE TO DETROIT
EDISON COMPANY FOR PRIMARY SERVICE EQUIPMENT

Manufacturers	Manufacturers Closing Amps (RMS Asymmetrical)
<u>Federal Pacific</u> Auto-Jet Switch Catalog No. AJS-4306	40,000A
<u>S & C Electric Company</u> Mini-Rupter Alduti-Ruptor	40,000A 61,000A
<u>Powercon Corporation</u> Type PIF	40,000A
<u>Square D Company</u> Type HVL	40,000A
<u>Cutler-Hammer Company</u> Type MVS	40,000A

All manufacturers must use one of these approved loadbreak switches in their switchgear.

LOADBREAK SWITCHGEAR REQUIREMENTS
FOR DETROIT EDISON PRIMARY CUSTOMERS

This document contains the requirements and recommendations for loadbreak switchgear and meter compartments intended for installation as service equipment on the Detroit Edison system. It includes construction requirements as well as drawings showing several acceptable arrangements for one and two line installations. Detroit Edison must first approve any variance from these requirements and/or recommendations.

Loadbreak switches, which have been approved, are listed on Page 11-5-3 of the Electrical Service Installation Guide.

Loadbreak switchgear built for use by Primary customers on the Detroit Edison system must be 15 kV class and meet ANSI and NEMA standards in addition to the following requirements:

Switchgear Nameplate

The switchgear nameplate must be prominently displayed and include the following information:

- 1. Manufacturer**
- 2. Voltage Class**
- 3. Continuous Current Rating**
- 4. Load Interrupting Rating**
- 5. Momentary Withstand Amperage**
- 6. BIL Rating**
- 7. 60-Cycle Withstand**

Switch

1. The loadbreak switch(s) shall be three-phase, gang operated, single throw, motor or manual operation. It shall be quick-closing and quick-opening and be independent of the operating handle or motor drive once the blades have started independent movement. Manual switches shall not be awkward, difficult to reach, or difficult to close or open. There must be a positive means of deactivating and securing any automatic transfer scheme.

2. Switch elements shall be mounted on a metal, grounded frame that grounds the leakage path parallel to the open switch to provide positive protection in the open position.
3. Switches using a chain link drive shall have a barrier installed to prevent a broken chain from contacting energized equipment.
4. Refrain from using inverted switches, consult Primary Services.

Fusing

Type and style of fuse must be approved by Primary Services. The manufacturer must provide spare fuses. Fuses must be hinged.

Clearances

The following table specific voltage clearances to be maintained throughout the switchgear including bus-work, cable terminations, metering equipment and any other high voltage equipment.

AIR CLEARANCE IN "INCHES"

	<u>Phase-to-Phase</u>	<u>Phase-to-Ground</u>
4800V	5	4
13.2 kV	6	6
24 kV	7.5	7.5

Four (4) inches phase-to-phase and phase-to-ground is acceptable for extruded bus insulation systems on 4800V and 13.2 kV.

Note that 4800V clearances are provided for existing equipment only, as all new switchgear must be built to 15kV class specifications. Voltage clearances from energized parts including terminations to baffle materials such as micarta and glass polyester, shall be a minimum of 1-1/2 inches at 4800V or 13.2 kV and 2-1/2 inches at 24 kV.

Heating Element

Switchgear intended for outdoor use or for use in areas of high humidity must have strip heaters installed in each cubicle. Strip heater wiring must have high-temperature insulation and be trained away from proximity to the heater element. For longevity a 220v heater strip operated at 120v is recommended.

Locking Devices

Detroit Edison uses padlocks, with a 3/8" shackle for equipment security and protective tagging. The following items must have provisions for the installation of padlocks with a 3/8-inch shackle.

- 1. Switch handles for manually operated switches and spring-charging handles.**
- 2. Door incoming line cubicles and feeder positions.**
- 3. Doors of Detroit Edison revenue metering cubicles.**
- 4. Doors of cubicles that contain control potential transformer secondary switches, motor-control secondary switches, or any other component-isolating points that may require protective tagging by Detroit Edison.**

Metering Cubicle

The metering cubicle shall be easily accessible by a hinged, lockable door and remain under control of Detroit Edison. Also an inner door screen barrier, hinged with "Danger High Voltage" sign. No customer-owned components (e.g.: line potential transformers, surge arresters) will be located in the metering cubicle. High-voltage clearances and clearance to baffles will be consistent with that of the entire switchgear (See page 11-5-5).

Available meter specification drawing for metal clad switchgear (provided by Primary Services) Dwg.# 5PC394-41, Metering Equipment Compartment. No customer-owned equipment or components (ex. line potential transformers, surge arresters) will be located in the metering cubicle. High voltage clearances and clearances to baffles will be consistent with that of the entire switchgear (see page 11-5-5). The potential transformer shelf will be horizontal and of adequate width to accommodate three (3) transformers in an upright position while maintaining specified clearances as well as clearance to, over and around baffles. See sample drawing on Page 11-5-27 for minimum spacing of metering cubicles with or without baffles. Shelf must be a minimum of 18 inches above the floor.

Positioning of potential and current transformers must allow visual inspection of primary and secondary connections and serial numbers of same while equipment is energized. The 15kV potential transformer cable will be provided by Detroit Edison as well as the multi-conductor cable for the potential and current transformer secondaries. Contractor will provide Detroit Edison with length required to reach Edison meter connection cabinet from the meter cubicle.

Meter cubicle shall have welded condulets for training of secondaries to the outgoing conduit. The conduit from the meter cubicle to the meter connection cabinet will be 1 ½" rigid steel and contain the potential transformer and current transformer secondary cable and a separate, #2 copper ground conductor with 600V insulation. Fused metering potential transformers, may be required when metering is on the utility side of the main switch and the customer is served from all-underground power lines, industrial substation, services 24kV and above or the available fault currents exceed 7,000A at 13.2kV or 10,000A at 4.8kV, consult Primary Services.

Switchgear for Two-Line Operation

Adjoining switchgear positions that contain both incoming lines must be gas-proofed as outline in the Gas-Proofing section of this publication (Page 11-5-9). See example drawings for suggested bushing locations.

Switchgear fed from more than one Detroit Edison line must have an interlock system to prevent the customer from electrically paralleling any two Detroit Edison lines. A key interlock system for manual switchgear or an electrical interlock system for automatic switchgear can accomplish this. An extra key or key-operated electrical "Interlock bypass" switch must be provided to permit paralleling by Detroit Edison personnel under controlled conditions. The key will remain under sole control of Primary Services. Reference Detroit Edison control scheme Spec drawings (Section 11-5-8).

Automatic Loadbreak Switchgear

Switchgear built for automatic operation shall conform to conditions previously mentioned for two-line operation as well as meeting the following requirements:

- 1. Must have an automatic-manual switch.*
- 2. May have a key-operated "Interlock-bypass" switch.*
- 3. Must have an approved throw over scheme (drawings provided to Primary Services).*
- 4. Potential transformers, which are located on the line side of the main switch, must have secondaries equipped with a gang operated open knife-blade switch (blades de-energized when open) appropriately located for ease of protective tagging. Line potential transformers are to be fused. Fuses must be easily accessible by a hinged door.*

5. *There must be a means of mechanically and electrically disabling the switch operator (motor, spring or spring charging mechanism) and a means of padlocking the switch operator to prevent closing when protective tagging is required.*
6. *A three-phase voltmeter shall be mounted on the front side of the switchgear for each line to prove to the operator that each line is energized.*

Detroit Edison Specification Drawings

The following Detroit Edison specification drawings are available:

- 5PC894-38 - Two Line Automatic Throw Over Scheme
- 5PC894-39 - Parallel/Radial Operation Control Scheme
- PC894-40 - Partial Schematic – Normal/Alternate A.T.O. Scheme
- 5PC894-41 - Metering Equipment Compartment
- PC894-42 - Interruptible Service Control Scheme
- 5PC894-43 - Two Line A.T.O./Line Select A.T.O. Scheme

Contact Primary Services for copies of the above drawings.

Gas Proof Bushings

Adjacent compartments, containing separate incoming services, and tie compartments must be gas proofed to prevent the transfer of ionized gasses during certain fault conditions. This may be accomplished in either of the following ways:

A. Preferred Arrangement

The preferred arrangement employs the use of a gas proof bushing and mounting flange assembly, 15 kV class with a 95 kV BIL rating as shown on Page 11-5-10. This bushing should always be mounted in a steel wall between incoming line compartments or in the horizontal wall (steel shelf) between the upper and lower sections of the tie switch compartment. It is recommended that bushing specifications be submitted to Primary Services for approval prior to the switchgear being built. Construction of the wall between adjoining compartments should also limit the transfer of gas to the adjoining compartment.

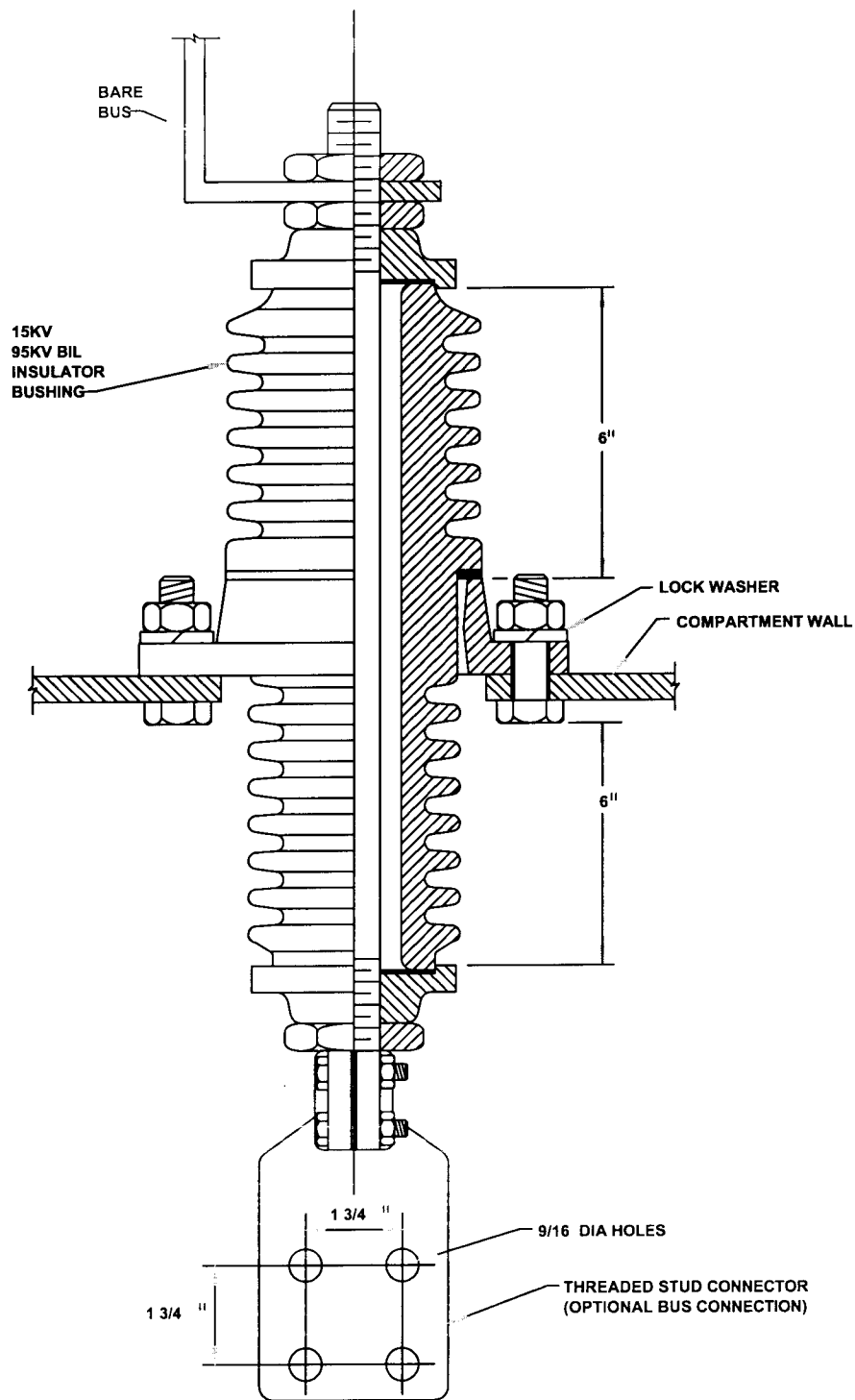
B. Alternative Arrangement

The alternative arrangement employs the use of an oval or rectangular, 15 kV 95 kV BIL rated insulator (see Page 11-5-11) having a minimum leakage distance of 1.0 inch per kV line to ground voltage (8 inches for 15 kV class switchgear) inserted between the bus bar and the sheet metal or insulating board compartment wall. The air space between the bus bar and insulator should be less than 1/8-inch on all sides of the bus and be sealed with duct seal, RTV, or in some other appropriate manner. The bus bar must have appropriate non-tracking insulation extending six (6) inches on either side of the wall or shelf. Insulated boards must have ¼-inch minimum thickness to contain forces developed in certain types of faults. Again, construction of walls between adjoining compartments should limit the transfer of gas between them.

Insulators

Porcelain or cycloaliphatic insulators are required in cubicles containing DECo meter instrument transformers & incoming power cable, and are recommended throughout the switchgear line-up. Glass polyester products are not acceptable.

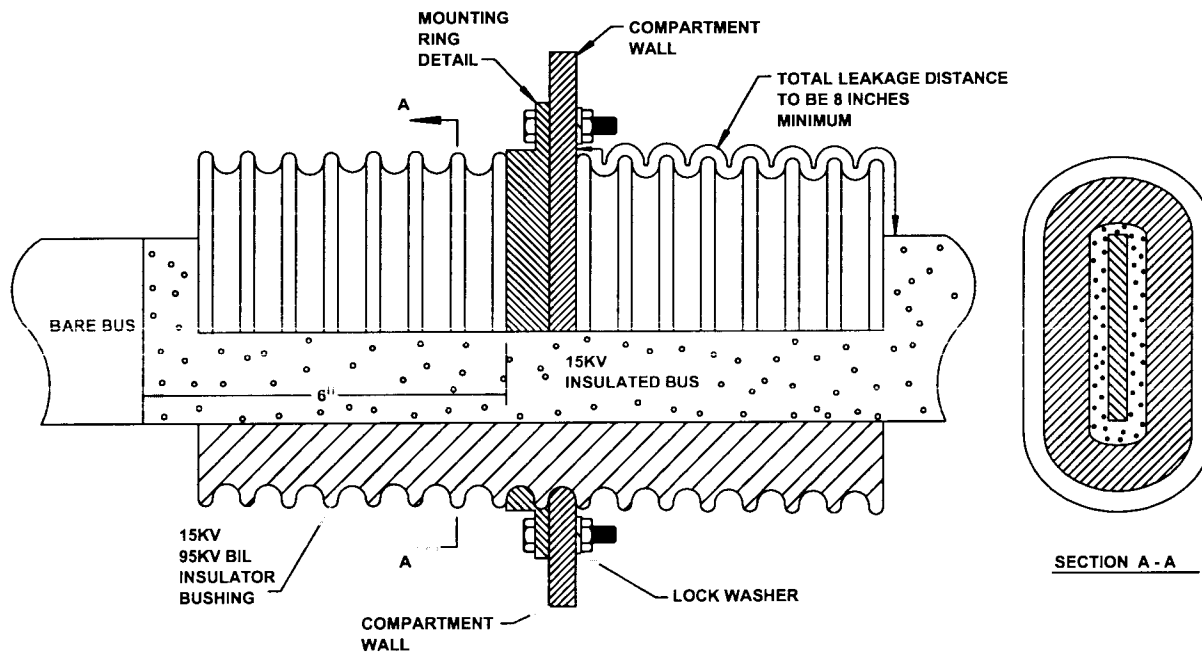
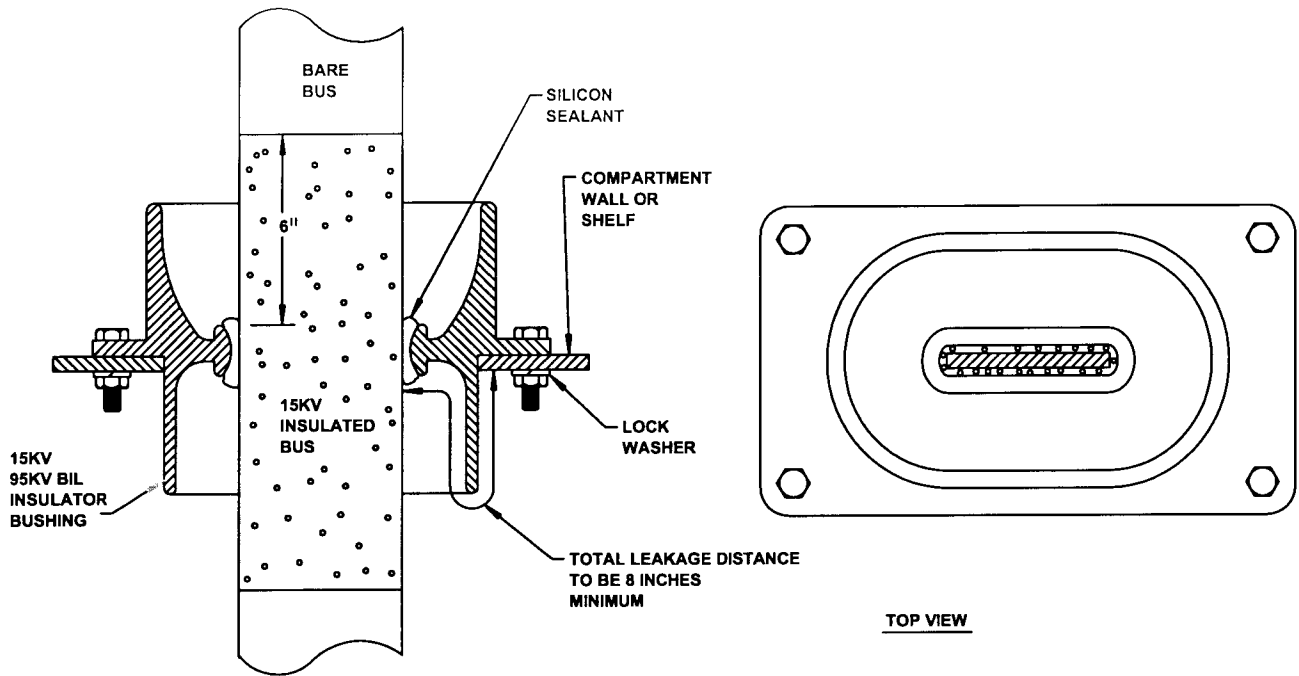
PREFERRED ARRANGEMENT FOR GAS PROOFING
TYPICAL CONFIGURATION
FIGURE #1



**GAS - PROOF
FEED THROUGH BUSHING**

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

ALTERNATE ARRANGEMENT FOR GAS PROOFING
TYPICAL CONFIGURATIONS
FIGURE #2



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OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

General Construction

Doors

1. Doors of fused positions must be mechanically or key-interlocked with that corresponding switch handle so the door cannot be opened unless the switch is open. Conversely, the interlock must prevent the switch from being closed when the door is open.
2. If tie position is fused, that position must have an upper and lower metal door or one outer metal door and two hinged inner doors constructed of minimum ¼ inch Plexiglas or sturdy screen with a sign reading, **“WARNING! OPEN BLADES MAY BE ENERGIZED.”** Inner doors may have a simple latching mechanism.
3. Door and door hardware (hinge, 3-point latch, door handle) shall be attached to switchgear by a minimum 3/8 inch bolts with nuts and lock washers or welded.
4. Doors must have a 3-point, heavy duty, high strength latch and sturdy handle.
5. Two hinges are required for doors under 36 inches high. Three hinges are required for doors from 36 through 72 inches high. Four hinges are required for doors over 72 inches high. Hinge pins must be stainless steel and 5/16-inch diameter minimum.
6. Switch compartments must have a window built with safety glass or equivalent for easy viewing of switch status by a person of normal height.
7. Outdoor switchgear shall be equipped with door stops.
8. “Access to exposed live parts in excess of 600v shall require two separate conscious acts. The first shall be the opening of a door or barrier, which is located or otherwise, secured against unauthorized entry. The second act shall be either the opening of a door or the removal of a barrier.” (*Reference National Electrical Safety Code*).

Miscellaneous

1. All components are to be mounted in a suitable and adequate housing of minimum 11-gauge steel or UL equivalent. Outdoor enclosures should be suitably rain-proof, dust-proof, and provided with a heater and ventilation adequate to prevent water condensation. Provide air filter material behind vents to filter air contaminants, snow, etc., from entering switchgear. Louvers shall be screened to prevent insertion of foreign objects into switchgear. Indoor enclosures should be rain proof if located in an area susceptible to water damage.
2. All installations shall be tamper-proof commensurate with the degree of access by unqualified personnel. Warning signs indicating “**DANGER! HIGH VOLTAGE – KEEP OUT!**” and the voltage level shall be provided on the outside of doors, panels or barriers that can be removed to expose energized equipment. Reference NEMA Standards No. 260-1996.
3. Inadequate components such as cable bus, 5kV materials, etc., will not be acceptable.
4. Compartments containing components such as current and potential transformers, surge arresters, or any components that may require periodic inspection, maintenance or testing should be easily accessible by a hinged, lockable door. There should be no hazard associated with reaching over energized equipment.
5. Arresters should be electrically located as near as possible to the components that are installed to protect, yet located where a violent failure of the arrester will not damage other components such as transformer windings, cable terminations or current and potential transformers. Baffles may be required to accomplish this and must provide for easy inspection of the arresters while energized in case of suspected failures.
6. Bus work and components must be supported by 15kV, 95kV BIL rated porcelain or cycloaliphatic insulators.
7. On multiple service installations, the incoming service cable cubicle must be constructed so that workers can work on the cable terminations without the hazard of leaning over an energized switch, bus or other equipment. Provisions (e.g., horizontal support shelf) must also be made to prevent tools or other equipment from dropping into energized equipment while working on terminations.
8. Outdoor switchgear will be enclosed by a buried ground ring consisting of at least six, 8’x 5/8” driven copper-clad ground rods connected by 4/0, bare, stranded copper cable. Ground rods connect to the ring via Cadweld or Anderson connectors, type 6C-103-02 or equivalent. A minimum of two 4/0 bare, copper risers will be connected to the switchgear by two-hole compression lugs or double bar taps.

- 9 Suitable operating instructions must be provided with switchgear.
- 10 The ground mat resistance will be five (5) ohms or less. The switchgear shall have a means to ground the cable termination neutrals/ grounds in near proximity of the cable terminations (utilize double split bolt connection). The ground bus shall be copper and continuous throughout the switchgear including the meter cubicle.
- 11 The customer is responsible for switchgear signage. Signage must follow ANSI standards. Primary Services will notify the customer of any special signage required prior to energizing the switchgear.
- 12 All current circuit secondary terminations should utilize ring lug connectors.
- 13 An easy means to test and ground the bus on the incoming line position needs to be provided.

General Switchgear Arrangement Drawings

The following are sample drawings of switchgear arrangements:

In preparing these drawings, it is assumed that the switch to be used is identified on the list of acceptable equipment (page 11-5-3 of the electrical Service Installation Guide). The various two-line configurations in this package are designed to provide for the safety of personnel during testing and/or cable replacement while allowing the customer to maintain near normal operations. Rear cable access is preferred.

Single Line Service

Page 11-5-17 identifies the typical configuration for a single line customer. It may utilize one of the available combination meter/switch units or, as pictured, utilize freestanding switchgear. The advantage of the freestanding equipment is the ease of expansion should a second switch and transformer is required.

Two-Source One-Load Carrying Line

Page 11-5-18 and its alternatives identify suggested configurations wherein the customer has full redundant service available, but is normally served by one load carrying line.

Page 11-5-18 identifies suggested configurations designed for rear or top entry. It may be used for either manual or motor operated loadbreak switches.

Page 11-5-19 is an acceptable alternative; however, it minimizes the potential for future expansion.

Page 11-5-20 is an alternative where the equipment will be located against a wall and rear entry is not available. It should be noted that currently S& C makes the only loadbreak approved for inverted mounting (normal upright blades acceptable). In this layout a horizontal barrier shelf, located between the fuse and switch, the full depth of the fuse compartment and an interior screen door is required in L. B. compartment.

Page 11-5-21 is another option for front access equipment. Again, the barrier shelf is required between each fuse and switch position along with a gas barrier and interior screen.

Two-Source Two-Load Carrying Lines

Page 11-5-22 and its alternatives can be used for two-line facilities. If bottom entry is not available a transition compartment may be required. This configuration requires a shelf in the tie compartment with a gas proof bushing and would present difficulty if future expansion were anticipated.

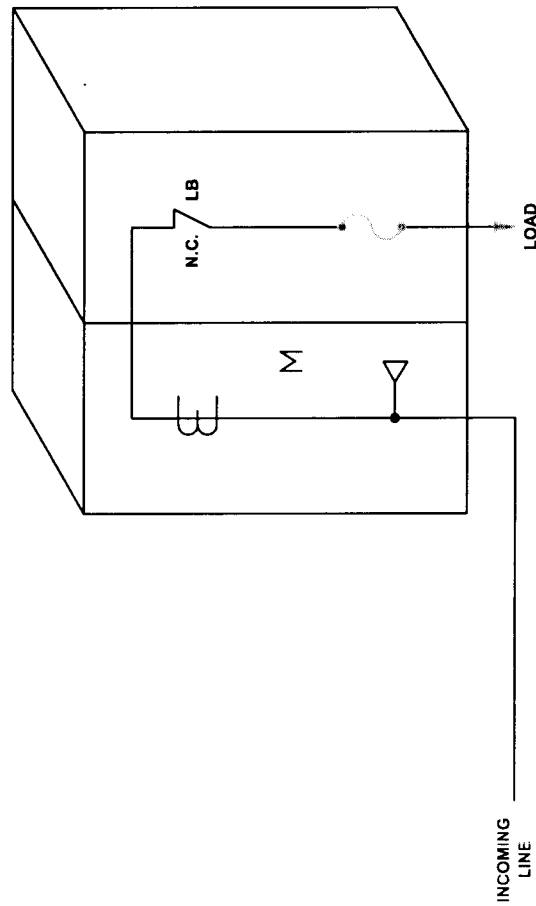
Page 11-5-23 configuration provides the greatest degree of flexibility where rear access is available.

Page 11-5-24 is the alternative that eliminates the tap between the switch and fuse on each main and the fuse in the tie compartment; however, it requires main fuses, which are capable of carrying the total load.

Double-Ended Substation

Page 11-5-26's configuration would be typical of a package substation for indoor installations. It is usually outfitted with dry-type transformers with automatic throw-over. Frequently, not only are the secondary mains and tie interlocked, but also the loadbreak would be interlocked with its respective secondary main.

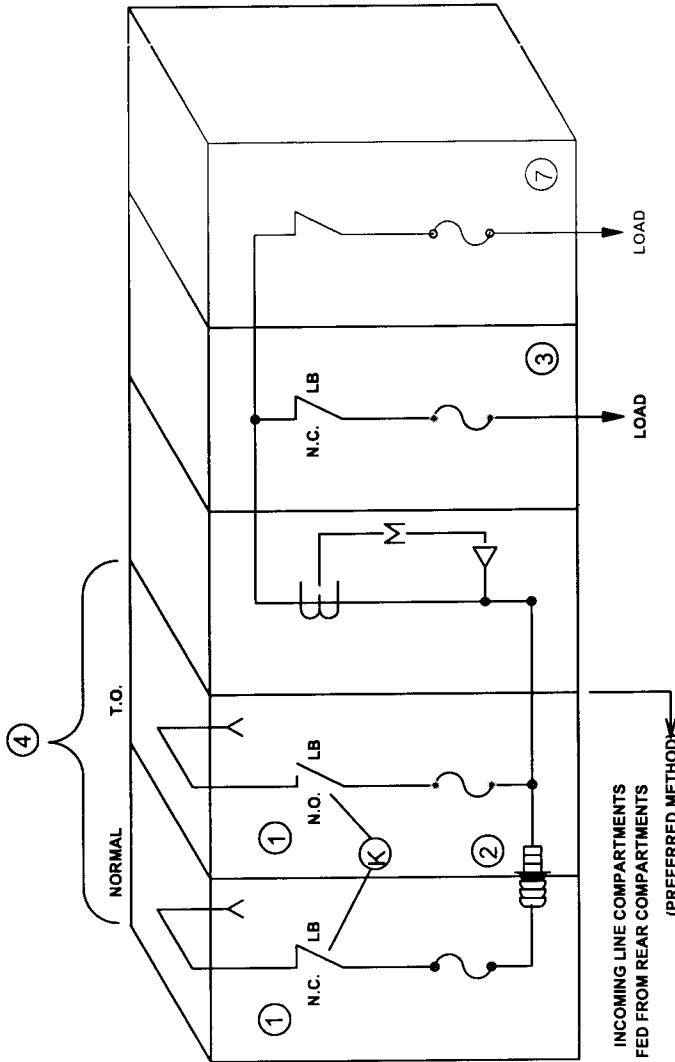
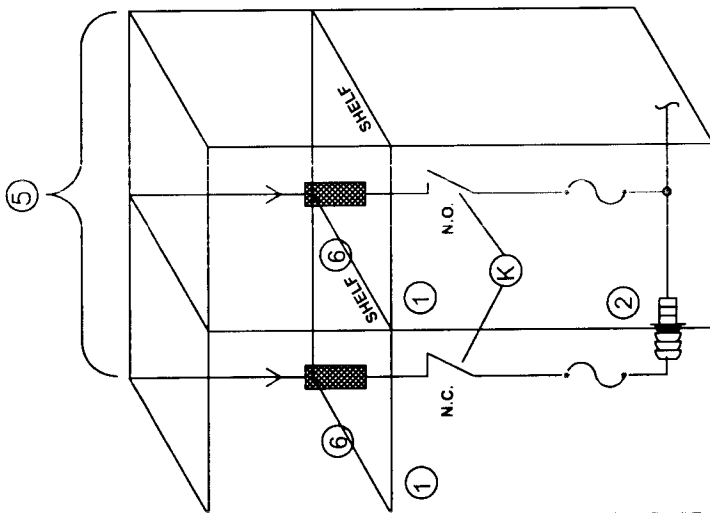
ONE LOAD CARRYING LINE
ONE SOURCE



SYMMETRICALLY OPPOSITE PERMISSIBLE

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY
OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

ONE LOAD CARRYING LINE
TWO SOURCES

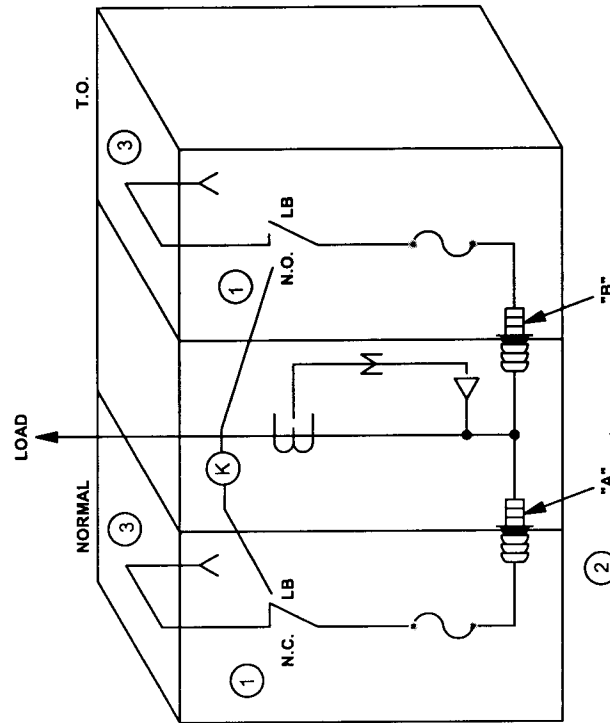


NOTES:

- ① — INTERIOR SCREEN REQUIRED W/WARNING SIGN "DANGER-OPEN BLADES MAY BE ENERGIZED".
- ② — GAS BARRIER REQUIRED. 15KV 95KV BIL, ALL SWITCHGEAR APPLICATIONS.
- ③ — FEEDER LOADBREAK SWITCH OPTIONAL.
- ④ — SERVICE CABLES ENTER AT REAR OF COMPARTMENT, ACCESSIBLE VIA HINGED DOORS.
- ⑤ — SERVICE CABLES ENTER AT TOP OF COMPARTMENT, ACCESSIBLE VIA HINGED DOORS. PROTECTIVE SHELF REQUIRED.
- ⑥ — BUS NOT TO BE IN PHYSICAL CONTACT WITH SHELF MINIMUM 1 1/2" SPACING. INSULATE BUS IN VICINITY OF SHELF FOR 15 KV, 95KV BIL.
- ⑦ — ADDITIONAL BAYS AS REQUIRED.
- Ⓚ — KEY INTERLOCK

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

ONE LOAD CARRYING LINE (OPTION A)
TWO SOURCES

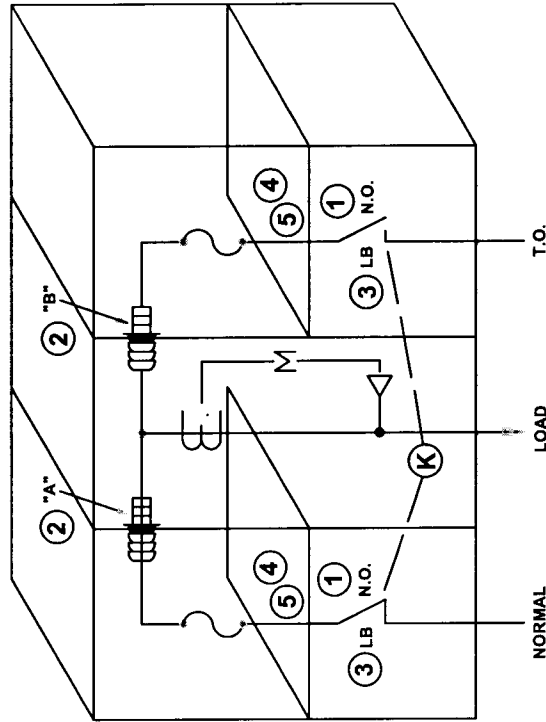


NOTES:

- ① — INTERIOR SCREEN REQUIRED W/WARNING SIGN "DANGER-OPEN BLADES MAY BE ENERGIZED".
- ② — GAS BARRIER REQUIRED AT "A" OR "B".
- ③ — SERVICE CABLES ENTER AT REAR OF COMPARTMENT ACCESSIBLE VIA HINGED DOOR. (SEE 11-7-22 FOR TOP FED ALTERNATIVE)
- (K) — KEY INTERLOCK

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

ONE LOAD CARRYING (OPTION B)
TWO SOURCES

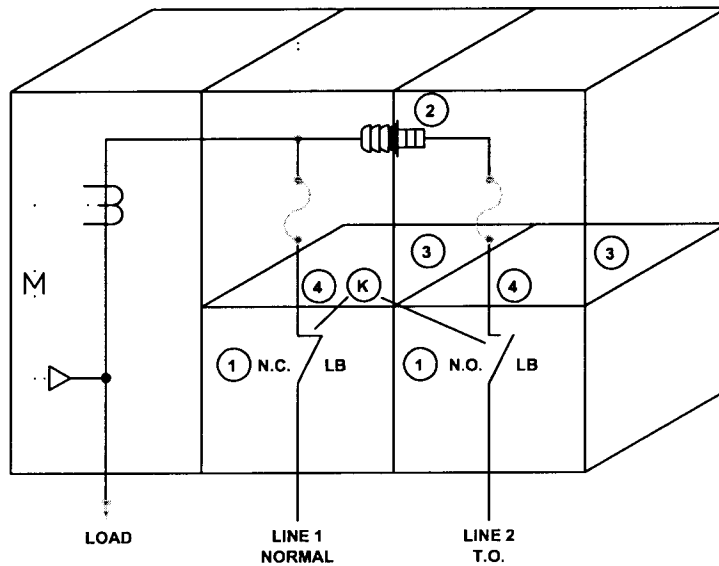


NOTES:

- ① · S & C LOADBREAK INTERRUPTERS ONLY.
- ② · GAS BARRIER REQUIRED
- ③ · SCREEN REQUIRED ACROSS DISCONNECT COMPARTMENT W/SIGN "DANGER-OPEN BLADES MAY BE ENERGIZED"
- ④ · HORIZONTAL SHELF
- ⑤ · BUS NOT TO BE IN PHYSICAL CONTACT WITH SHELF. MINIMUM 1 1/2" SPACING. INSULATE BUS IN VICINITY OF SHELF FOR 15KV, 95KV BIL.
- Ⓚ · KEY INTERLOCK

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

ONE LOAD CARRYING (OPTION C)
TWO SOURCES

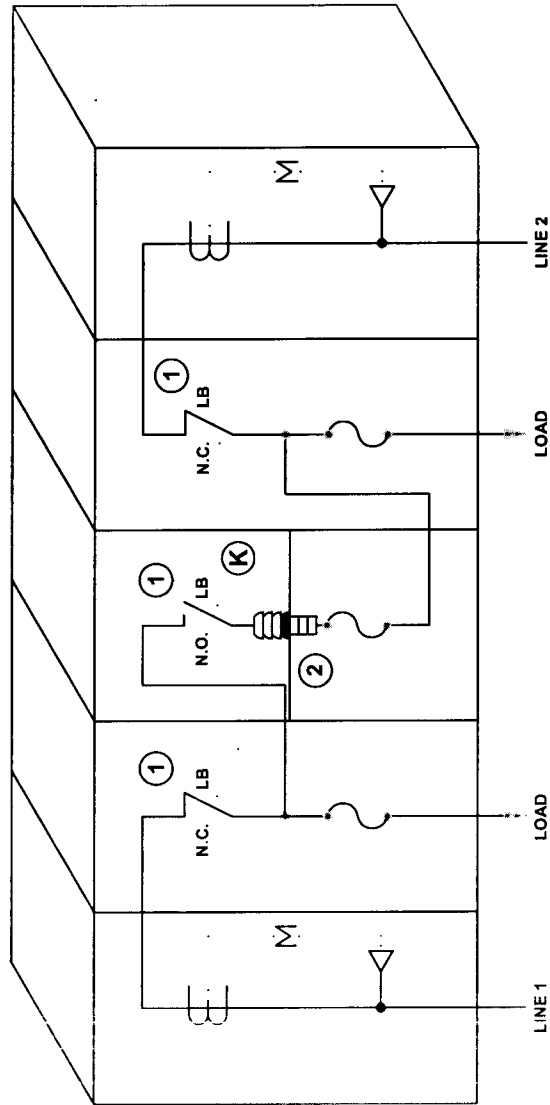


NOTES:

- SCREEN REQUIRED ACROSS DISCONNECT COMPARTMENT W/SIGN "DANGER-OPEN BLADES MAY BE ENERGIZED"
- GAS BARRIER REQUIRED
- HORIZONTAL SHELF
- BUS NOT TO BE IN PHYSICAL CONTACT WITH SHELF. MINIMUM 1 1/2" SPACING. INSULATE BUS IN VICINITY OF SHELF FOR 15KV, 95KV BIL.
- KEY INTERLOCK

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

TWO LOAD CARRYING LINES

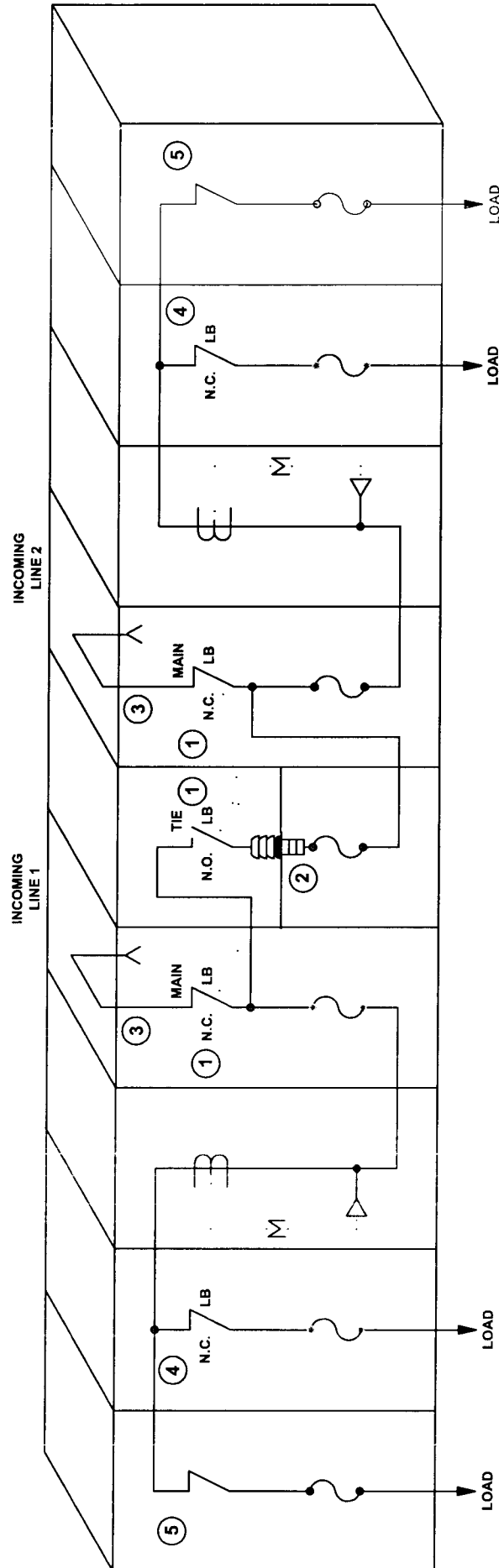


NOTES:

- ① SCREEN REQUIRED ACROSS DISCONNECT COMPARTMENT
W/SIGN "DANGER-OPEN BLADES MAY BE ENERGIZED"
- ② GAS BARRIER REQUIRED
KEY INTERLOCK

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

TWO LOAD CARRYING LINES (OPTION A)

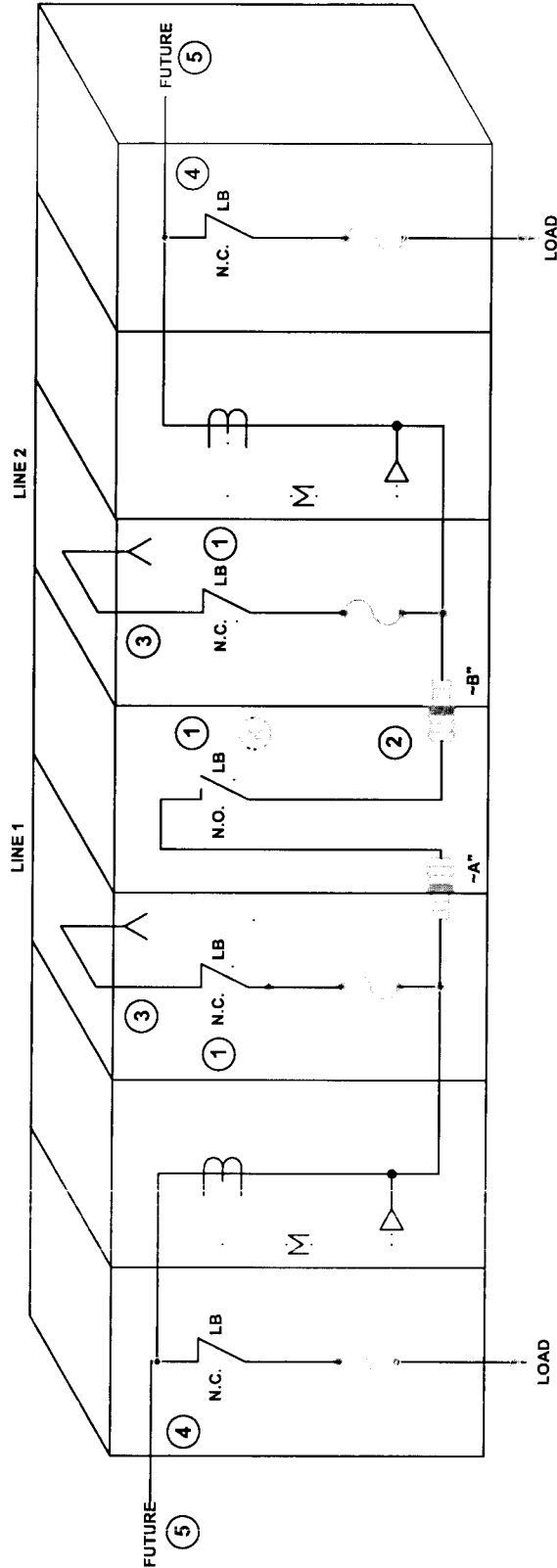


NOTES:

- ① INTERIOR SCREEN REQUIRED WITH WARNING SIGN "DANGER - OPEN BLADES MAY BE ENERGIZED".
- ② GAS BARRIER REQUIRED
- ③ SERVICE CABLE ENTRANCE AT REAR OF COMPARTMENT ACCESSIBLE VIA HINGED DOOR. (SEE 11-5-18 FOR TOP FED ALTERNATIVE).
- ④ FEEDER LOAD BREAK OPTIONAL.
- ⑤ ADDITIONAL FEEDER POSITIONS AS REQUIRED.
- K KEY INTERLOCK.

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

TWO LOAD CARRYING LINES (OPTION B)

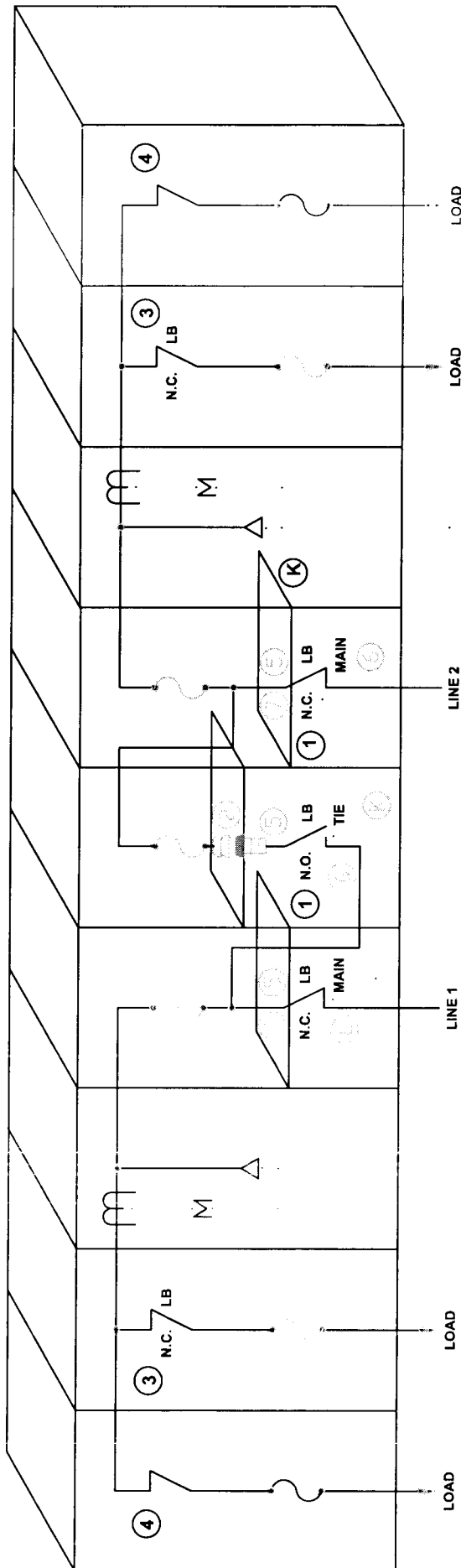


NOTES:

- ① INTERIOR SCREEN REQUIRED WITH WARNING SIGN "DANGER - OPEN BLADES MAY BE ENERGIZED".
- ② GAS BARRIER REQUIRED AT ~"A" OR ~"B".
- ③ SERVICE CABLE ENTRANCE AT REAR OF COMPARTMENT ACCESSIBLE VIA HINGED DOOR. (SEE 11-7-22 FOR TOP FED ALTERNATIVE).
- ④ FEEDER LOAD BREAK OPTIONAL.
- ⑤ ADDITIONAL FEEDER POSITIONS AS REQUIRED.
- (K) KEY INTERLOCK.

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

TWO LOAD CARRYING LINES (OPTION C)



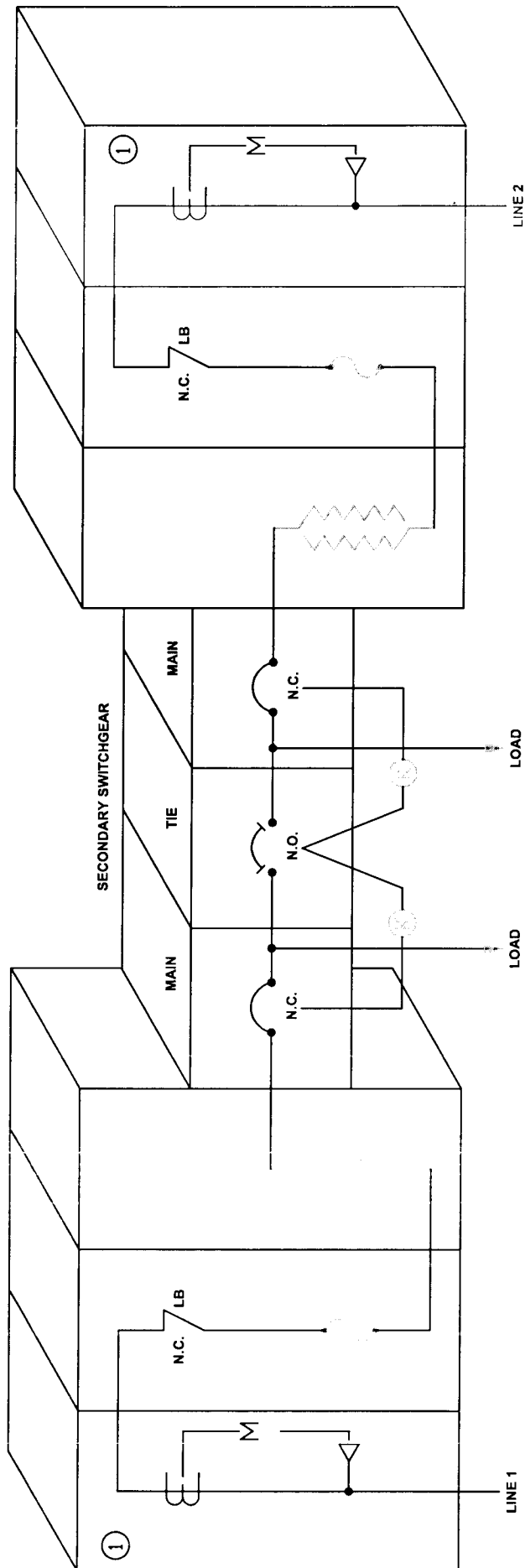
NOTE: CONSULT PRIMARY SERVICES BEFORE SPECIFYING INVERTED SWITCHES>

NOTES:

- ① SCREEN REQUIRED ACROSS DISCONNECT COMPARTMENTS W/ SIGN "DANGER-OPEN BLADES MAY BE ENERGIZED"
- ② GAS BARRIER REQUIRED.
- ③ FEEDER LOADBREAK OPTIONAL.
- ④ ADDITIONAL FEEDER LOADBREAKS AS REQUIRED.
- ⑤ HORIZONTAL SHELF REQUIRED.
- ⑥ S & C LOADBREAK INTERRUPTERS ONLY.
- ⑦ BUS NOT TO BE IN PHYSICAL CONTACT WITH SHELF. MINIMUM 1 1/2" SPACING. INSULATE BUS IN VICINITY OF SHELF FOR 15KV, 95KV BIL.
- (K) KEY INTERLOCK.

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

DOUBLED ENDED SUBSTATION

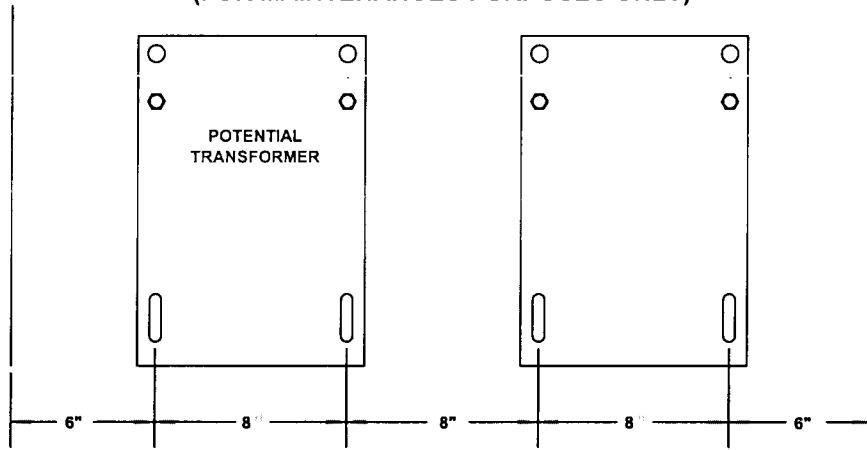


NOTES:

- ① — FOR TOP ENTRY, TRANSITION COMPARTMENT NECESSARY.
- KEY INTERLOCK

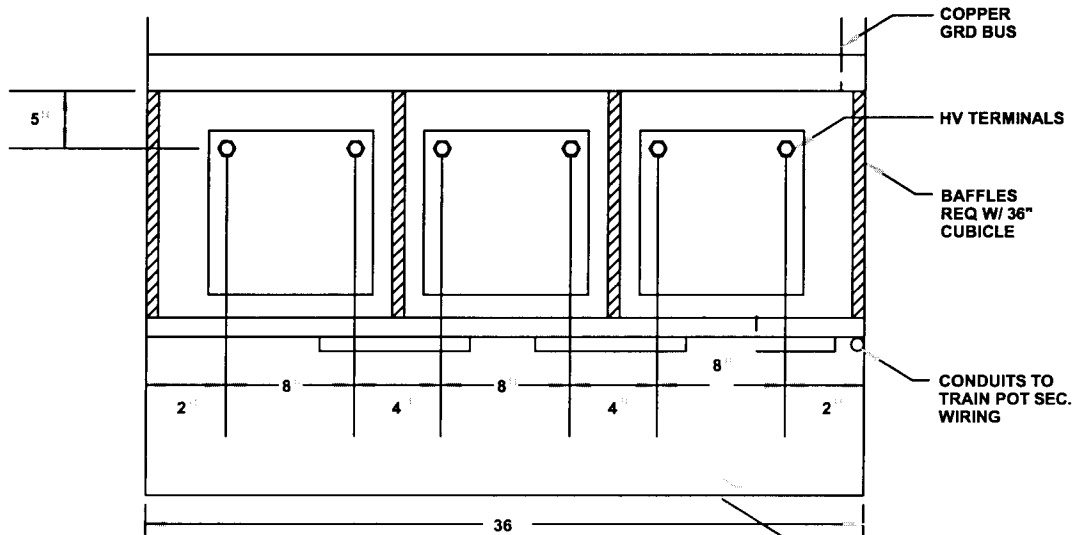
THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

**MINIMUM METERING CUBICLE CLEARANCES (36 INCH WIDE)
FOR POTENTIAL TRANSFORMERS
(FOR MAINTENANCES PURPOSES ONLY)**



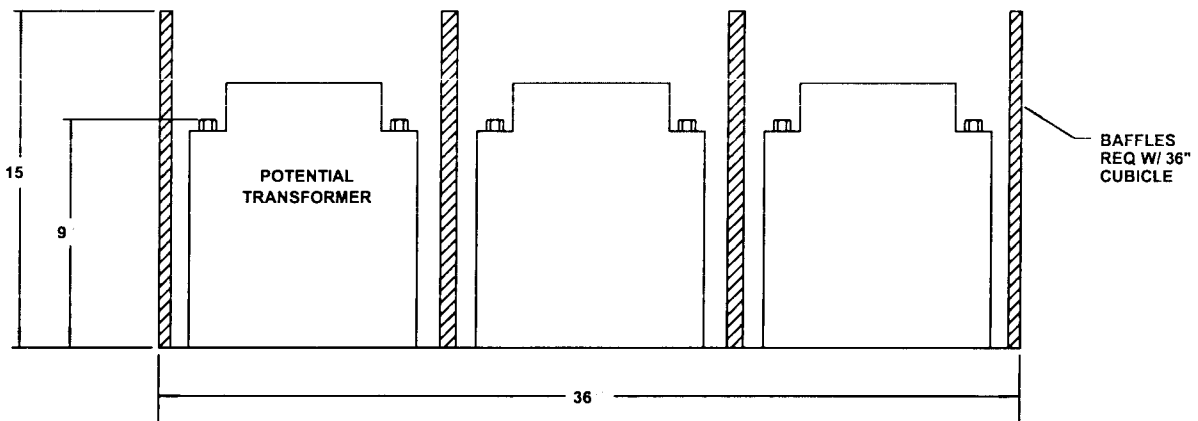
TOP VIEW

**4800 V SPACING
(BAFFLES NOT REQUIRED)**



TOP VIEW

13.2 KV

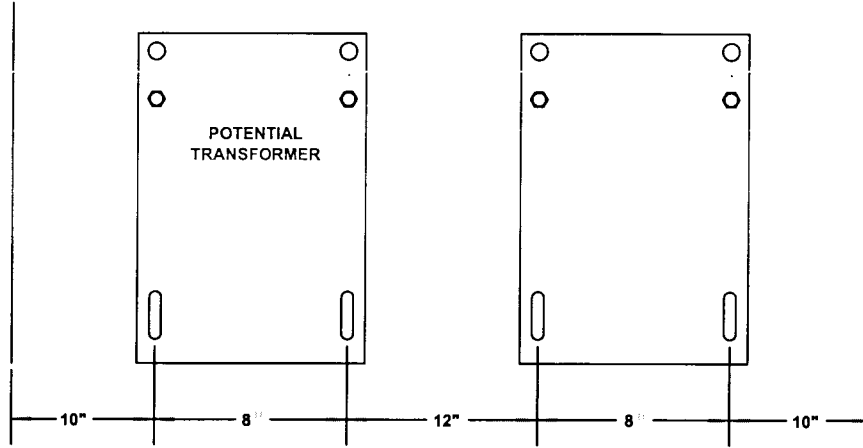


FRONT VIEW

13.2 KV MINIMUM SHELF SPACING

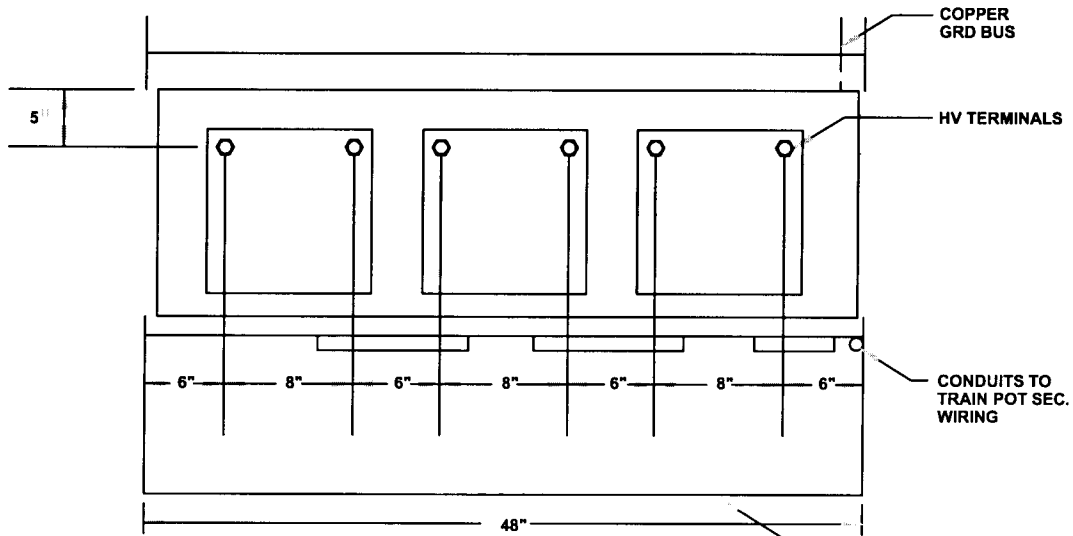
THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

MINIMUM METERING CUBICLE CLEARANCES (48 INCH WIDE)
FOR POTENTIAL TRANSFORMERS



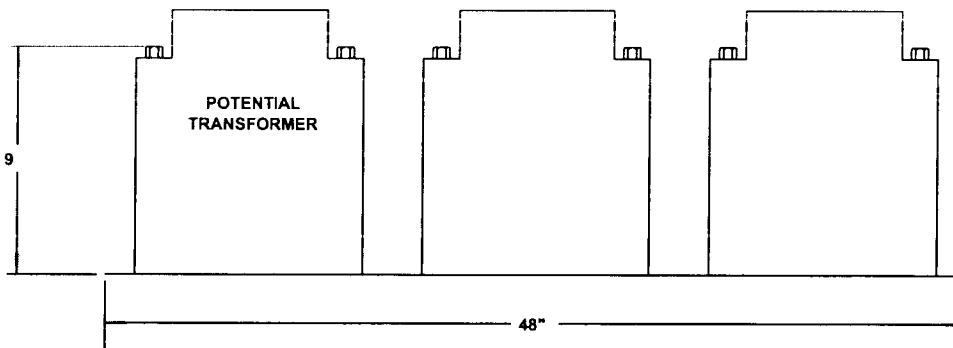
TOP VIEW

4800 V SPACING
(BAFFLES NOT REQUIRED)



TOP VIEW

13.2 KV

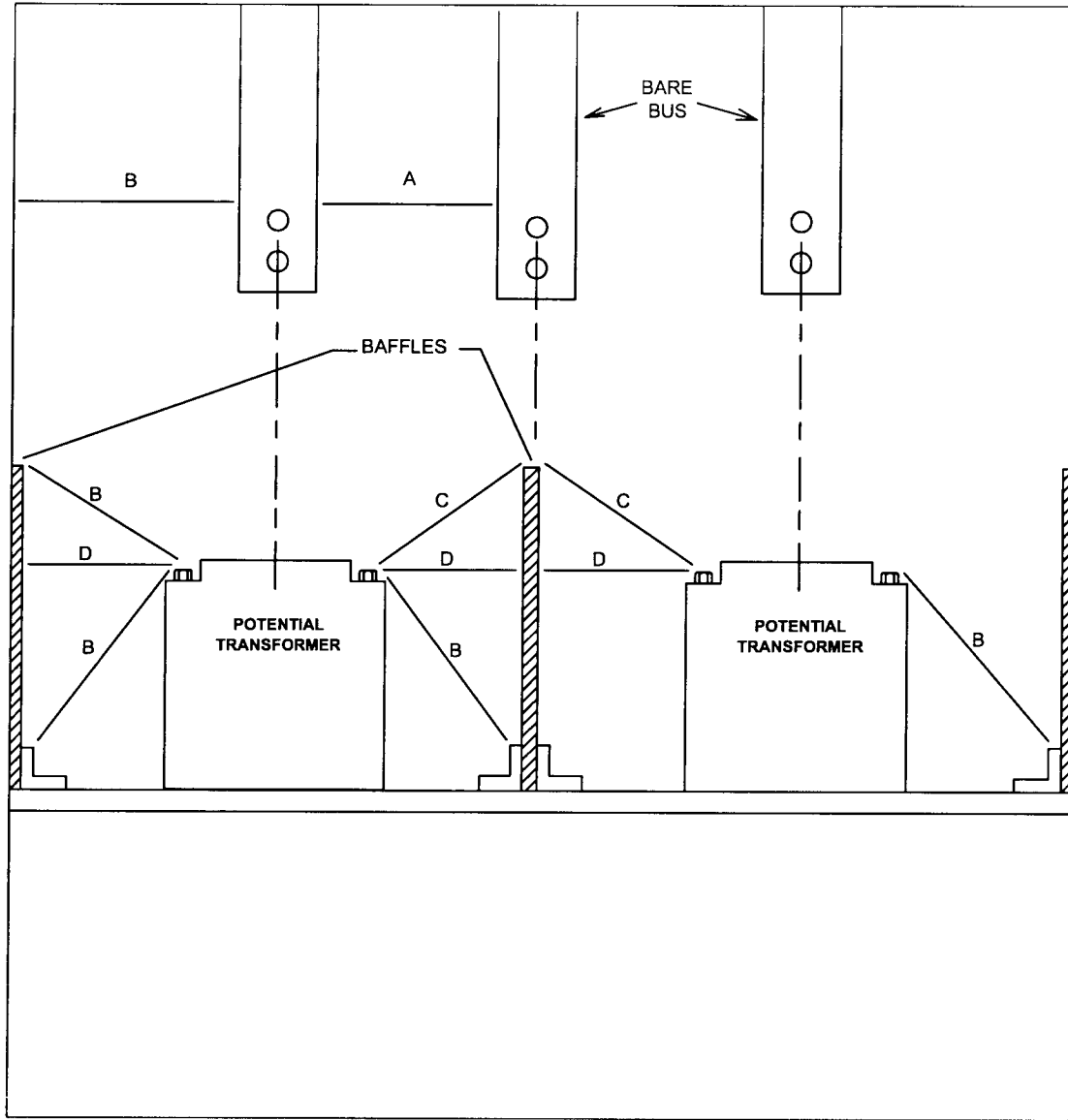


FRONT VIEW

13.2 KV SHELF SPACING
(BAFFLES NOT REQUIRED)

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY
OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.

MINIMUM AIR CLEARANCES



VOLTAGE CLASS KV	A PHASE-PHASE	B PHASE-GROUND W/O BAFFLE	C PHASE-PHASE WITH BAFFLE	D ENERGIZED PART TO BAFFLE
5	5	4	6	1.5
15	6	6	9	1.5
24	7.5	7.5	12	2.5

DIMENSIONS IN INCHES

THE DETROIT EDISON COMPANY ASSUMES NO RESPONSIBILITY FOR INJURY OR DAMAGE ARISING FROM THE USE OF THIS SPECIFICATION DIAGRAM.