



Milwaukee Water Works

Safe, Abundant Drinking Water.

City of Milwaukee Department of Public Works Milwaukee Water Works

Specifications for

Florist Avenue Pumping Station

NW-47: Florist Pumping Station Upgrades



2/20/12
ALL SPECIFICATIONS
UNLESS OTHERWISE
NOTED.

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GENERAL REQUIREMENTS

- PART 1** DEPARTMENT OF PUBLIC WORKS - GENERAL SPECIFICATIONS
(The Department of Public Works General Specifications applies to all contracts.)
http://www.mpw.net/services/bids_home
- PART 2** SPECIFIC OFFICIAL NOTICE AND GENERAL OFFICIAL NOTICE
The Specific Official Notice as it appears in The Daily Reporter and General Official Notice are a part of these contract documents.
- PART 3** SPECIFICATIONS

NW-47: FLORIST PUMPING STATION UPGRADES

TABLE OF CONTENTS

<u>SECTION</u>	<u>SUBJECT</u>	<u>PAGE NUMBERS</u>
-----	Official Notices	(i)–(ii)
JR	Job Requirements.....	1 – 4
01010	Summary of Work.....	1 – 5
01039	Coordination And Meetings.....	1 – 4
01500	Jobsite Security, Utilities And Facilities.....	1 – 6
	Attachment "A"	1 – 1
	Attachment "B"	1 – 1
01600	Materials And Equipment	1 – 2
01640	Equipment Manufacturers' Services.....	1 – 4
	Attachment "C"	1 – 1
	Attachment "D"	1 – 1
01700	Contract Closeout.....	1 – 5
01810	Equipment Testing & Facility Startup	1 – 6
	Attachment "E"	1 – 1
	Attachment "F"	1 – 1
	Attachment "G"	1 – 2
02050	Demolition And Abandonment.....	1 – 3
02200	Earthwork.....	1 – 13
	Attachment "H"	1 – 1
02930	Seeding.....	1 – 4
03301	Concrete	1 – 9
03600	Grout	1 – 2
09900	Painting	1 – 3
15100	Piping, Valves & Fittings.....	1 – 12
15101	Flow Tubes, Transmitters & Accessories	1 – 2
15500	Centrifugal Pumping Unit.....	1 – 3

15600	Horizontal Centrifugal Pump.....	1 – 5
15700	Electric Motor	1 – 7
16010	Basic Electrical Requirements	1 – 8
16111	Conduit.....	1 – 5
16118	Underground Ductbanks	1 – 3
16121	Medium-Voltage Cable (Above 600 Volts)	1 – 8
16123	Building Wire And Cable (Below 600 Volts)	1 – 6
16130	Boxes.....	1 – 4
16170	Grounding And Bonding	1 – 4
16190	Supporting Devices.....	1 – 2
16195	Electrical Identification.....	1 – 4
16461	Dry Type Transformers (Less Than 600V)	1 – 2
16465	Three-Phase Pad-Mounted Transformers (Above 600 Volts)	1 – 7
16470	Panelboards	1 – 2
16800	Low Voltage Variable Frequency Drive.....	1 – 3

- EXHIBIT “A” FABCO Bid Allowance Technical Information (Secured Document)
- EXHIBIT “B” WE Energies Bid Allowance Technical Information (Secured Document)
- EXHIBIT “C” Technical Specifications (Secured Document)

DRAWINGS Project and Reference Drawings (Secured Document)

NOTE: A Milwaukee Water Works Confidentiality Agreement (available online) shall be signed and submitted by each person prior to viewing any secured documents for this project.

JOB REQUIREMENTS
NW-47: FLORIST PUMPING STATION UPGRADES

JR-1 **FORM OF BID:** Contractor shall submit a lump sum bid (including all bid allowances) for furnishing the complete job in accordance with plans and specifications.

JR-2 **JOB LOCATION:** The Florist Pumping Station is located at 8525 West Florist Avenue, Milwaukee, Wisconsin, 53225.

JR-3 **GENERAL DESCRIPTION OF WORK:** The work to be performed under the provisions of this contract and as set forth in these documents consists of the supply and installation of all materials, labor, supervision and rentals for all work involved and described below.

FLORIST PUMPING STATION UPGRADES:

Supply and installation of all material and labor required for improvements to the Florist Pumping Station to accommodate the installation of electrical switchgear, engine generator, transformers, retrofit of existing switchgear, associated electrical improvements and pump replacements. Work shall include site, mechanical, electrical and structural work as shown on the drawings.

JR-4 **CONTRACT DRAWINGS:** The contract drawings upon which the proposal is to be based are listed hereunder:

<u>Drawing No.</u>	<u>Title</u>
NW-47-01	LOCATION MAP – DRAWING INDEX
NW-47-02	ELECTRICAL SYMBOLS AND ABBREVIATIONS
NW-47-03	PARTIAL ONE-LINE DIAGRAM
NW-47-03A	PARTIAL ONE-LINE DIAGRAM
NW-47-04	ELECTRICAL SITE PLAN
NW-47-05	CONDUIT TRENCH AND DUCTBANK PLAN
NW-47-06	SITE GROUNDING PLAN
NW-47-06A	SITE LIGHTING AND SECURITY PLAN
NW-47-07	SITE DEMOLITION PLAN
NW-47-07A	SITE EROSION CONTROL PLAN
NW-47-07B	EROSION CONTROL DETAILS
NW-47-08	MAIN LEVEL ELECTRICAL DEMOLITION PLAN
NW-47-09	PUMP FLOOR ELECTRICAL DEMOLITION PLAN
NW-47-10	CONDUIT ROUTING DETAILS
NW-47-11	CONDUIT ROUTING DETAILS
NW-47-12	MAIN LEVEL ELECTRICAL PLAN
NW-47-13	PUMP FLOOR ELECTRICAL PLAN
NW-47-14	ELECTRICAL DETAILS
NW-47-15	ELECTRICAL DETAILS
NW-47-16	ELECTRICAL DETAILS
NW-47-17	ELECTRICAL DETAILS
NW-47-18	ELECTRICAL DETAILS
NW-47-19	SECURITY DETAILS

NW-47-20	5KV SWITCHGEAR RETROFIT
NW-47-21	5KV SWITCHGEAR RETROFIT
NW-47-22	5KV SWITCHGEAR RETROFIT
NW-47-23	5KV SWITCHGEAR RETROFIT
NW-47-24	5KV SWITCHGEAR RETROFIT
NW-47-25	5KV SWITCHGEAR RETROFIT
NW-47-26	5KV SWITCHGEAR RETROFIT
NW-47-27	5KV SWITCHGEAR RETROFIT
NW-47-28	INSTRUMENTATION AND CONTROL
NW-47-29	INSTRUMENTATION AND CONTROL
NW-47-30	ELECTRICAL SCHEDULES
NW-47-30A	ELECTRICAL SCHEDULES
NW-47-31	MECHANICAL DEMOLITION PLAN
NW-47-32	MECHANICAL INSTALLATION PLAN
NW-47-33	MECHANICAL SECTIONS AND DETAILS

JR-4.1 REFERENCE DRAWINGS: The following reference drawings are the original construction drawings. These are included here for **general information only**. The drawings are assumed to be accurate; however, **the CONTRACTOR is responsible for field verification of any and all dimensions essential to the work.**

<u>Reference Drawing No.</u>	<u>Title</u>
NW-9-3	TANK FILL & PUMP SUCTION PIPES PROFILES
NW-10-2	SOUTH & EAST ELEVATIONS
NW-10-3	NORTH & WEST ELEVATIONS
NW-10-7	ROOF PLAN & DETAILS
NW-10-8	BUILDING SECTIONS
NW-10-9	BUILDING SECTION & DETAILS
NW-10-13	STRUCTURAL PLANS OF SWITCHGEAR FLOOR
NW-10-14	CONCRETE SECTIONS
NW-10-15	CONCRETE SECTIONS
NW-10-16	CONCRETE SECTIONS
NW-10-17	CONCRETE SECTIONS
NW-10-18	ROOF BEAM REINFORCEMENT
NW-10-19	MISC. BEAM REINFORCEMENT
NW-13-2	COMPREHENSIVE ONE-LINE DIAGRAM
NW-13-14	YARD WIRING & DETAILS
NW-13-15	SUBSTATION STRUCTURE AND GROUNDING
NW-26-1	FUNCTIONAL ONE-LINE DIAGRAM
NW-28-1	SUBSTATION STRUCTURE AND GROUNDING
NW-30-1	COMPREHENSIVE ONE-LINE DIAGRAM
NW-42-01	SITE PLAN
NW-42-12	GRADING PLAN

JR-5 PRE-BID MEETING: A **MANDATORY** Pre-Bid Meeting is scheduled for Monday, March 19, 2012 at 10:00AM in the Linnwood Water Purification Plant Conference Room; 3000 North Lincoln Memorial Drive, Milwaukee, WI 53211. The City of Milwaukee will **ONLY** receive bids from prospective bidders who are in attendance at the **MANDATORY** Pre-Bid Meeting.

The official envelope for submitting a bid and bid bond form will be available at the **MANDATORY** Pre-Bid Meeting. All attendees are required to e-mail anthony.aquila@milwaukee.gov, anthony.j.supinski@milwaukee.gov AND joshua.iwen@milwaukee.gov at least 24 hours in advance of the **MANDATORY** Pre-Bid Meeting to be placed on the visitor list for access to the Linnwood Water Purification Plant.

JR-6 PRE-CONSTRUCTION MEETING: Within **ten (10) business days** after Notice to Proceed is issued, a pre-construction meeting will be held at the job site. Construction details of the project will be discussed in the meeting.

JR-7 JOB SCHEDULE: Within **ten (10) business days** after Notice to Proceed is issued, the contractor shall submit a construction schedule for approval. The schedule shall be made in sufficient detail to indicate dates of each significant operation. The schedule shall be such that the entire job will be completed within the specified completion time. **Contractor shall submit the construction schedule in hard copy and electronic format using Microsoft Project 2010. However, if an electronic copy cannot be provided in this format, a copy shall be transmitted electronically in a .PDF format and a hard copy of any updated schedules must be provided at all progress meetings.**

JR-8 COMPLETION DATE: All work on this project shall be completed according to the following schedule:

No Work Shall Begin Before :	<u>“NOTICE TO PROCEED”</u>
Project Substantial Completion:	Monday, January 14th, 2013
Project Final Completion:	Monday, March 4th, 2013

JR-9 CHARGE FOR INSPECTION: The Contractor will be charged \$350.00 per day per inspector for each and every day inspection is required on this Contract after the date allowed for completion or after such extension of time as may have been granted. This charge is further defined in Section 2.5.11 of the Department of Public Works (DPW) General Specifications.

JR-10 PROGRESS PAYMENTS: Within **ten (10) business days** after the Notice to Proceed is issued, the contractor shall submit to the City for approval a schedule showing the breakdown of the contract with quantities and prices as a basis for checking and computing progress estimates. The values shown in the approved breakdown shall be used for pay purposes only and shall not be used as a basis for additions to or deductions from contract work.

When the contractor proceeds properly and with diligence to perform and complete the work on this contract, the Commissioner of Public Works may, from time to time as the work progresses, grant to the contractor an estimate of the amount already earned. In making such progress estimates, there shall be retained 5.0% of each progress estimate until final completion and

acceptance of the work; except that after 50% of the work has been completed and the Commissioner finds that satisfactory progress is being made and all conditions complied with, he may authorize any of the remaining progress payments to be paid in full to the contractor with no amount retained.

In accordance with Charter Ordinance 7.26 as amended 6-1-72, payment for materials delivered to the work or storage site may be authorized by the Commissioner of Public Works providing the following terms and conditions are met:

- A. The work is progressing properly and such materials as specified are properly stored and suitable for permanent incorporation in the work. Field Engineer shall verify that material is as specified and properly stored.
- B. Materials designated for pay in the next progress estimate after delivery shall be limited to fabricated or manufactured components which are assembled in final form ready for placement in the work.
- C. The following forms shall be submitted with requests for payment:
 - 1. Progress Estimate and Request for Payment for Fabricated Materials or Components Properly Stored.
 - 2. Certification of the Contractor or his duly authorized representative.
- D. The contractor shall be responsible for the safeguarding of any such materials against loss or damage whatsoever, and in the case of any loss or damage, the contractor shall replace such lost or damaged materials at no cost to the City. The Commissioner shall reserve the right to deduct from ensuing progress estimates the value of any lost or damaged materials until the contractor restores such loss or damage.
- E. The Commissioner may limit processing progress estimates to those cases where the amount earned in any pay period for work and materials is \$5,000 or more.
- F. Any materials for which payment has been made shall not be removed from the work or storage site without the specific written approval of the Commissioner of Public Works.

END OF SECTION

SECTION 01010
SUMMARY OF WORK

PART 1 - SCOPE OF THE CONTRACT

1.01 CONTRACT DESCRIPTION

- A. This contract includes the furnishing of all equipment, labor, supervision, materials and appurtenances for and in connection with improvements to existing facilities and construction of new facilities at the Florist Pumping Station.

1.02 ELECTRICAL IMPROVEMENTS

- A. The work covered by this part of the specification shall consist of, but not be limited to, the furnishing of all material, labor, equipment, and supervision for the following:
1. Metal-Enclosed Switchgear
 2. Pad mounted transformers
 3. Fully enclosed, via walk-in structure, diesel standby emergency generator with integral sub base fuel tank and utility / generator paralleling switchgear
 4. Generator load bank
 5. Outdoor rated uninterruptable power supply
 6. 480V distribution equipment
 7. 208V distribution equipment
 8. Existing switchgear upgrades
 9. Miscellaneous electrical and automation upgrades

1.03 MECHANICAL IMPROVEMENTS

- A. The work covered by this part of the specification shall consist of, but not be limited to, the furnishing of all material, labor, equipment, and supervision for the following:
1. Pump/Motor #2
 - a) New split case, double suction, side-suction, side-discharge, centrifugal water pump, electric motor and variable frequency drive (VFD)
 - b) Suction and discharge piping replacement, new butterfly valves and ball valve, pipe supports, concrete pump foundation, couplings, monitoring devices, electrical connections, instrumentation, and miscellaneous work
 - c) Start-up assistance and certification of pump operations
 2. Pump/Motor #3 (Relocated Pump/Motor #2)
 - a) Relocate existing split case, double suction, side-suction, side-discharge, centrifugal water pump and electric motor
 - b) Suction and discharge piping replacement, new butterfly valves and ball valve, pipe supports, concrete pump foundation, couplings, monitoring devices, electrical connections, instrumentation, and miscellaneous work

c) Start-up assistance and certification of pump operations

3. 36" Butterfly valve with electric operator on facility's discharge header

1.04 CONSTRUCTION SEQUENCE

A. Construction sequence, subject to change, is as follows:

1. Install new outdoor switchgear and associated electric services.
2. Remove existing outdoor substation.
3. Install new uninterruptible power supply and generator.
4. Install new 480V emergency electric service.
5. Remove existing 480V distribution equipment.
6. Install new 480V distribution equipment.
7. Remove existing 208V distribution equipment.
8. Install new 208V distribution equipment.
9. Upgrade existing switchgear.
10. Remove Pump/Motor #3 and all associated Line #3 suction/discharge piping, valves, instrumentation, fittings, supports and bases.
11. Remove and save Pump/Motor #2 for relocation to Line #3. Remove all associated Line #2 suction/discharge piping, valves, instrumentation, fittings, supports and bases.
12. Relocate existing Pump/Motor #2 to Line #3. Place on new equipment pad and install all new associated piping, valves, instrumentation, fittings, supports and bases.
13. Install new Pump/Motor #2. Place on new equipment pad and install all new associated piping, valves, instrumentation, fittings, supports and bases.
14. Remove existing 36" check valve #19D from discharge header and isolate from system. New Pump/Motor #2 must be in place prior to any work on #19D.
15. Install new 36" butterfly valve with electrical actuator as valve #19D.

1.05 PCB / ASBESTOS / LEAD PAINT:

- A. The CONTRACTOR is responsible for the proper disposal of the two outdoor substation transformers and the indoor 480V distribution transformer which are assumed to contain polychlorinated biphenyl (PCB). A removal plan shall be submitted to and approved by the CITY.
- B. The CONTRACTOR shall test a sample of the ceiling tiles at the Florist Pumping Station for asbestos and submit the testing results to the CITY.
- C. It has not been documented that any of the pump #2 or #3 assemblies are coated with lead based paint. The CONTRACTOR is responsible for and shall take any and all precautions necessary for the safe removal of the pump parts and other items containing lead based paint. The removal plan shall be submitted to and approved by the CITY.

1.06 QUALIFICATIONS

- A. The new pumping unit, motor, valves, operators and instrumentation as specified shall be standard equipment manufactured by a company with no less than ten (10) years experience in the manufacturing of such equipment. Upon request by the Project Engineer, the manufacturer shall provide proof of such experience by providing installation lists, brochures, catalogue cuts, reference lists etc.

1.07 SPECIFICATIONS AND STANDARDS

- A. All materials, general design, design loads, allowable stresses, joint design, shop fabrication and field construction shall conform to the requirements of the following latest standard specifications of any technical society, organization, or association, or to codes of local or state authorities:
 - 1. NEC, National Electric Code.
 - 2. NEMA, Standards of National Electrical Manufacturers Association.
 - 3. IEEE, Institute of Electrical and Electronic Engineers.
 - 4. ASTM, American Society for Testing and Material.
 - 5. United States Environmental Protection Agency (EPA)
 - 6. American Water Works Association (AWWA)
 - 7. AFBMA, Anti-Friction Bearing Manufacturers Association.
 - 8. ANSI, American National Standards Institute.
 - 9. SSPC, Steel Structures Painting Council.
 - 10. ASTM, American Society for Testing and Material.
 - 11. The Wisconsin Administrative Code.
 - 12. U.S. Department of Labor Occupational Safety and Health Act (OSHA).
 - 13. National Electric Motor Association
- B. The contractor shall be familiar with the requirements of the above agencies. Any conflict in the contract drawings, these specifications, the contractor's design or construction methods shall result in this contractor performing in a manner which conforms to the applicable requirements.

1.08 SHOP DRAWINGS AND SUBMITTALS

- A. Within three (3) weeks after Notice to Proceed is issued, the Contractor shall submit to the CITY for approval a minimum three (3) copies of all shop, fabrication, assembly, other drawings and engineering data required by the specifications; all drawings of equipment and devices offered by the Contractor; all drawings showing essential details of any change in design or construction proposed by the Contractor; and all necessary wiring and piping layouts. Drawings of equipment and devices shall show sufficient detail to adequately depict the construction and operation of each item.
- B. Each shop drawing shall bear City of Milwaukee, the name and location of the structure, job number, the name of the Contractor, the date of the drawing, the date of each correction or revision, and the specification numbers and plan sheet numbers applicable thereto.
- C. Each submittal shall cover items from only one section of the specification unless the item consists of components from several sources. Contractor shall submit a complete initial submittal including all components. When an item consists of components from several sources, Contractor's initial submittal shall be complete including all components.
- D. Each submittal shall indicate the intended use of the item in the Work. When catalog pages or cut sheets are submitted, applicable items shall be clearly identified and inapplicable data crossed out. The current revision, issue number, and date shall be indicated on all drawings and other descriptive data.
- E. Three (3) revised copies of each drawing shall be submitted each time a drawing is returned to the contractor for revision. Upon final approval of a drawing, eight (8) copies shall be submitted to the CITY for record and distribution to authorized persons.
- F. After reviewed by the CITY, all such drawings shall become a part of the contract documents and the work or equipment shown thereby shall be furnished and installed as shown unless otherwise required by the CITY. No work shall be performed or equipment manufactured until drawings have been approved. The review of drawings submitted by the Contractor will be for, and will cover only general conformity to the plans and specifications and will not constitute a blanket approval of all dimensions, quantities, or details of the material or equipment shown by such drawings, nor shall such approval relieve the Contractor of responsibility for errors contained therein.
- G. At the completion of work and prior to final payment, the Contractor shall provide the CITY with six (6) sets of "as-built" drawings for the completed job showing all new equipment and piping. All concealed piping, conduit or similar items shall be located by dimensions and elevations. The Contractor will be responsible for the accuracy of these drawings. Two (2) copies of the above "as-built" drawings shall be submitted in an electronic format compatible with the latest edition of MICROSTATION® (currently V8).

1.09 WARRANTY AND GUARANTEE

- A. The contractor shall furnish a written two (2) years warranty from the date of official acceptance against defective materials or workmanship before the final payment is made.
- B. During the period of two (2) years from and after the date of the final acceptance by the CITY of the work embraced by this contract, the Contractor shall make all needed repairs arising out of defective workmanship or materials, or both, which in the judgment of the Commissioner of Public Works, shall become necessary during such period.
- C. Whenever defective equipment or materials are replaced, the equipment or materials shall be guaranteed for one (1) year from the date that the replacement is performing satisfactorily.
- D. If within ten (10) business days after mailing of a notice in writing to the Contractor, or his agent, the said Contractor shall neglect to make, or undertake with due diligence to make, the aforesaid repairs, the CITY is hereby authorized to make such repair at the Contractor's expense; providing, however, that in case of an emergency where, in the judgment of the Commissioner, delay would cause serious loss or damage, repairs may be made without notice being sent to the Contractor, and the Contractor shall pay the cost thereof.
- E. The Contractor shall also furnish written guarantees as required by each Section. Length of time and requirements of guarantees, if applicable, are specified in each Section. Each guarantee shall commence on the date of official acceptance. Final payment will not be paid until the City receives all guarantees.
- F. Refer to Division 15 and Division 16 specifications for additional equipment warranty requirements.

1.10 EROSION CONTROL IMPLEMENTATION PLAN

- A. Section 02200 Earthwork, contains requirements for completing and submitting an Erosion Control Implementation Plan for review and approval by the City.

END OF SECTION

SECTION 01039
COORDINATION AND MEETINGS

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Coordination
- B. Alterations
- C. Cutting and patching
- D. Pre-construction conference
- E. Progress meetings
- F. Pre-installation conferences

1.02 COORDINATION

- A. Coordinate scheduling, submittals and work on the various Sections of the Specifications to assure efficient and orderly sequence of installation of interdependent construction elements.
- B. Verify that the CITY requirement 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 as equipment.
- C. Coordinate space requirements and installation of mechanical and electrical work. Follow routing shown for pipes and conduit, as closely as practicable; place runs parallel with lines of structures. Utilize spaces efficiently to maximize accessibility for other installations, maintenance and repairs.
- D. Coordinate completion and clean up of work of separate Sections in preparation for Substantial Completion.
- E. Coordinate correction of defective work and work not in accordance with Contract Documents in order to minimize disruption of the City of Milwaukee's activities.

1.03 ALTERATIONS

- A. Materials: As specified in product Sections, match existing products and work for patching and extending work.
- B. Close openings in exterior surfaces to protect existing work from weather and extremes of temperature, humidity and precipitation.
- C. Remove, cut and patch work in a manner to minimize damage to and provide a means of restoring products and finishes to original condition.
- D. Refinish visible existing surfaces to original condition.
- E. Where new work abuts or aligns with existing, perform a smooth and even transition. Patched work shall match existing adjacent work in texture and appearance.

- F. When finished surfaces are cut so that a smooth transition with new work is not possible, terminate existing surface along a straight line at a natural line of division and make recommendation to the CITY.
- G. Patch or replace portions of existing surfaces which are damaged, lifted, discolored or showing other imperfections.
- H. Finish surfaces as specified in individual product Sections.

1.04 CUTTING AND PATCHING

- A. Employ skilled and experienced installer to perform cutting and patching.
- B. Submit written request in advance of cutting or altering elements which affects:
 - 1. Structural integrity of element.
 - 2. Integrity of weather-exposed or moisture resistant element.
 - 3. Efficiency, maintenance or safety of element.
 - 4. Visual qualities of sight-exposed elements.
 - 5. Work of City of Milwaukee or separate contractor.
- C. Execute cutting, fitting and patching to complete work, and to:
 - 1. Fit the several parts together, to integrate with other work.
 - 2. Uncover work to install or correct ill-timed work.
 - 3. Remove and replace defective and non-conforming work.
 - 4. Remove samples of installed work for testing.
 - 5. Provide openings in elements of work for penetrations of mechanical and electrical work.
 - 6. Execute work by methods that will avoid damage to other work, and provide proper surfaces to receive patching and finishing.
 - 7. Cut rigid materials using masonry saw or core drill.
 - 8. Restore work with new products in accordance with requirements of Contract Documents.
 - 9. Fit work tight to pipes, sleeves, ducts, conduit and other penetrations through surfaces.
 - 10. Maintain integrity of wall, ceiling or floor construction; completely seal voids.
 - 11. Refinish surfaces to match adjacent finishes. For continuous surfaces, refinish to nearest intersection; for an assembly, refinish entire unit.
 - 12. Identify any hazardous substance or condition exposed during the work to the CITY.

1.05 PRECONSTRUCTION CONFERENCE

- A. City of Milwaukee will schedule a pre-construction conference after Notice of Award.
- B. Attendance Required: CITY and Prime Contractor.
- C. Sample Agenda (subject to change):
 - 1. Submission of executed bonds and insurance certificates (unless previously submitted to DPW).
 - 2. Submission of list of all Subcontractors, Schedule of Values and project progress schedule.
 - 3. Designation of personnel representing the parties in Contract.
 - 4. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders and Contract closeout procedures.
 - 5. Scheduling and reports.
 - 6. Use of premises by City of Milwaukee and Contractor.
 - 7. Construction facilities and controls provided by City of Milwaukee, if any.
 - 8. Temporary utilities and controls provided by City of Milwaukee, if any.
 - 9. Security procedures.
 - 10. Procedures for testing.
 - 11. Procedures for start-up of equipment.
 - 12. Requirements for maintaining record documents.
 - 13. Inspection and acceptance of equipment put into service during construction period.
 - 14. Conflicts.

1.06 PROGRESS MEETINGS

- A. The CITY will Schedule and administer meetings throughout progress of the work as required.
- B. The CITY will make arrangements for meetings, prepare agenda with copies for participants, preside at meetings, records minutes and distribute copies within three days to the CITY, participants and those affected by decisions made.
- C. Attendance Required: Contractor's general superintendent, major Subcontractors and suppliers, CITY, as appropriate to agenda topics for each meeting.

- D. Sample Agenda (subject to change):
1. Review minutes of previous meetings.
 2. Review of work
 3. Field observations, problems and decisions.
 4. Field observations of problems to impede planned progress.
 5. Review of submittals schedule and status of submittals.
 6. Review of off-site fabrication and delivery schedules.
 7. Maintenance of progress schedule.
 8. Corrective measures to regain projected schedules.
 9. Planned progress during succeeding work period.
 10. Coordination of projected progress.
 11. Maintenance of quality and work standards.
 12. Other business relating to work.

1.07 PRE-INSTALLATION CONFERENCES

- A. When determined by the CITY, convene a pre-installation conference at work site prior to commencing work.
- B. Require attendance of parties directly affecting, or affected by, work of the specific Section.
- C. Notify all parties four (4) days in advance of meeting date.
- D. Prepare agenda; preside at conferences, record minutes and distribute copies within two (2) days after conference to participants, with one copy to the CITY.
- E. Review conditions of installation, preparation and installation procedures and coordination with related work.

END OF SECTION

SECTION 01500
JOB SITE SECURITY, UTILITIES AND FACILITIES

PART 1 - SCOPE

1.01 INDEX

- A. PART 1 - Scope
- B. PART 2 - Security and Safety
- C. PART 3 – City of Milwaukee Permits
- D. PART 4 - Occupancy during Construction
- E. PART 5 - Electrical Power and Telephone Service
- F. PART 6 – Heat and Ventilation
- F. PART 7 - Water
- G. PART 8 - Toilet Facilities
- H. PART 9 - Deliveries

1.02 GENERAL CONDITIONS

- A. All operations shall be carried on with a minimum of damage and disturbance. All damages shall be repaired to the original condition to the satisfaction of the Water Engineering representative.
- B. All removals become the property of the Contractor and shall be disposed of off-site, unless otherwise specified.

1.03 TEMPORARY VENTILATION

- A. Ventilate enclosed areas to assist cure of materials, dissipate humidity and/or prevent accumulation of dust, fumes, vapors or gases.

1.04 BARRIERS

- A. Provide barriers to prevent unauthorized entry to construction areas and protect existing facilities and adjacent properties from damage caused by construction operations and demolition.
- B. Protect non-owned vehicular traffic, stored materials, site and structures from damage.
- C. Utilize road plates to protect underground utilities and structures, and to minimize disturbances caused by construction traffic.

1.05 PROGRESS CLEANING

- A. Waste materials, debris and rubbish shall be removed daily after work. Maintain site in a clean and orderly condition.
- B. Clean and repair damage caused by removals or installations.
- C. Restore existing facilities used during construction to original condition.

PART 2 – SECURITY AND SAFETY

2.01 GENERAL

- A. The Milwaukee Water Works consists of a number of facilities to treat and deliver drinking water to the City and surrounding suburban communities. To ensure the safety and security of drinking water, the Milwaukee Water Works has instituted protocols for visitors and contractors to control entry to these facilities. It is essential that contractors strictly comply with the security policy outlined in the Specification Section.
- B. For this project, the Contractor shall continuously coordinate building and site security measures, including accessing the site, with the designated Water Engineering representative or the Water Security Manager, Mr. Michael Schaefer, who can be reached at **Telephone # (414) 286-3465 or Facsimile # (414) 286-2672.**

2.02 SCOPE

- A. Any and all City agencies and contractors engaged for work at Milwaukee Water Works facilities shall be required to attend a "Pre-Construction Security Briefing" before any contracted work can be initiated. At this meeting, the contractor and sub-contractors shall have a detailed briefing with discussions regarding the following items:
 - 1. Milwaukee Water Works site security policies and procedures
 - 2. Contractor & Sub-Contractor Obligations
 - 3. Permit System

2.03 POLICIES

- A. During the "Security Briefing" portion of the "Pre-Construction Meeting", Milwaukee Water Works Security staff shall provide the Prime Contractor with site policies to be reviewed by the Prime and Sub Contractors. These documents may include:
 - 1. Lock-out / Tag-out Policy
 - 2. Confined Space Entry Procedures
 - 3. Evacuation Procedure for Propane, Lox, & Ammonia Releases
 - 4. Personal Protective Equipment Guidelines
 - 5. No Smoking Policy
 - 6. Prohibited Materials
- B. Additionally, the contractor will be provided:
 - 1. Contact Phone Numbers for MWW Staff.
 - 2. On-Site Parking Location and designated construction entrance.
 - 3. Site security policy and procedures.

- C. The Prime Contractor shall be required to review these documents and is responsible for conveying the contents of these submittals to their employees, sub-contractors and any other parties working directly or indirectly for them. These policies apply equally to all contractors. Failure to comply with established policies and procedures may result in access privileges being withdrawn.
- D. MWW Staff shall provide a “walk-through” session with the contractor to review area layout and site plans as part of this orientation process and to establish the specific work areas necessary for the contractors to perform their scope of work. Topics covered in this session include: site overview with hazards, Material Safety Data Sheets (MSDS), fire extinguisher placement and the storm water protection policy.

2.04 CONTRACTOR RESPONSIBILITIES

- A. Contractors shall provide the following documents **no less than seven (7) business days prior** to the start of contracted work:
 1. Scope of work to be performed
 2. Name of primary contractor’s onsite representative
 3. Names of all companies sub-contracted to do work on the project
 4. Completed “Contract Firm Registration Form” (see attachment ‘A’) for prime contract firm and every sub-contract firm
 5. A “Contractor Employee Registration Form” completed for the contractors and every employee who needs to be granted site access (see attachment ‘B’)
 6. List of items to be stored on-site
 7. Material Safety data Sheets for all Chemicals to be used/stored on-site
- B. Note: It is the responsibility of the Prime Contractor to facilitate gathering and submittal of the “Contractor Employee Registration Form” for all sub-contractors working on the project. A sub-contractor is defined as an individual or firm hired by the primary contractor to perform a specific task as part of the overall project. This would not include an organization making deliveries of supplies or equipment to the job site; procedures for these firms are covered under Part 8, "DELIVERIES".
- C. **In the event it is necessary for the Prime Contractor to add additional employees to the list of approved personnel, a minimum of 72 hours, or 3 business days, must be allowed for processing of the request. Site access will be denied to the additional personnel until processing is complete.**
- D. Contract Firms are obligated to notify MWW in a timely manner of any site-authorized staff that leaves the employ of the Contractor.
- E. At no time should anyone but the Prime Contractor be contacting Milwaukee Water Works employees with issues or access requests. If a request for site access does not come from the Prime Contractor, the request will not be processed.
- F. During the time period that the Contractor is on-site, they must agree to:

1. Notify the Plant Manager immediately of any significant chemical spills or leaks.
2. Maintain Normal Non-Toxic Breathable Air Quality, through Adequate Ventilation, at their work site.
3. Perform no equipment isolations or tie-ins without the signed approval of Site Management.
4. Restrict movement to the specific work areas within the site to perform Contractors Scope of Work.

2.05 CONTRACTOR SPECIAL WORK PERMITS

- A. Contractors must notify Engineering / Site Management staff of any welding, torching or potentially hazardous or operational impact request prior to commencing such operations. Special Permits shall be issued to the contractor, and these must also be displayed at the work site.
- B. Failure to comply with the terms of the Special Work Permits, or provisions that provide for MWW Employee Safety shall be cause for revocation of such Permits, and the contractor may be forced to discontinue activities at the site.

2.06 CONTRACTOR IDENTIFICATION AND DAILY REGISTRATION

- A. Every day, all contractors shall be required to show a valid picture ID card, to sign-in at the start of work, and sign out at the end of work. A MWW employee or designated security representative shall be on site to ensure compliance. Any identification tags or lanyards issued by MWW are to be worn while on site and returned to site management upon completion of contracted work. A fee of \$50.00 will be charged for any identification tags or lanyards issued by MWW that are not returned.

2.07 CONTRACTOR GATE ACCESS & PARKING

- A. Contractors must comply with the terms of entry for the site and park only in the areas designated for parking by the MWW site representative.
- B. Parking Note:
 1. Parking privileges may be rescinded at any time as Site Operational Requirements dictate.

PART 3 - CITY OF MILWAUKEE PERMITS

3.01 GENERAL

- A. The Contractor shall obtain the necessary permits for this Project.

PART 4 - OCCUPANCY DURING CONSTRUCTION

4.01 GENERAL

- A. The Water Works facility shall be in continuous operation during this contract. Contractor and Sub-Contractors are to take any and all necessary precautions to ensure there is no interference with daily operations or security. MWW personnel shall be continuously occupying the facility. All hours of contractor's operations shall be coordinated with the MWW site or Water Engineering representative.

4.02 CONTRACTOR FIELD OFFICE / JOB TRAILER

- A. The Prime Contractor is responsible for providing their own field office via a construction job trailer.
- B. The Prime Contractor is responsible for furnishing an engineering field office for the MWW project representative. The lockable engineering field office shall be located in the same trailer with the Prime Contractor. The office shall have access to copier, fax and dedicated computer work station with a high-speed internet connection.

PART 5 - ELECTRICAL POWER AND TELEPHONE SERVICE

5.01 GENERAL

- A. On-site electrical service is available for Contractor use during project duration within the Florist Pumping Station. The Contractor is required to request a dedicated service for job trailers from the electric utility.
- B. Contractor shall provide and maintain all necessary power cords and electrical lighting, and shall make all necessary connections in accordance with OSHA regulations.
- C. Contractor shall provide, maintain and pay for his own wireless telephone and internet service.

PART 6 – HEAT AND VENTILATION

6.01 GENERAL

- A. Contractor shall provide and maintain all necessary heat and ventilation equipment required for the contract. Contractor shall perform all air treatment procedures and make all necessary connections in accordance with OSHA regulations.

PART 7 - WATER

7.01 GENERAL

- A. Water is available for the Contractor at the site and may be obtained from the fixture(s) so designated by MWW staff or Water Engineering Representative.
- B. Contractor and Sub-Contractors must provide their own hoses, back flow preventer and any other connection appurtenances required for the contract.

PART 8 - TOILET FACILITIES

8.01 GENERAL

- A. On-site toilet facilities are available for Contractor use during project duration. The specific location of these facilities will be transmitted to the Contractor at the pre-construction meeting. However, if project requirements render the use of on-site facilities impractical, then Contractor shall furnish portable facilities. If portable facilities are required, Contractor shall maintain these toilet facilities in a sanitary condition throughout the duration of the project and shall remove them from site at the end of the project. The placement and location of the temporary portable toilets shall be coordinated with the Plant Manager and Water Engineering Representative.

PART 9 - DELIVERIES

9.01 GENERAL

- A. Contractor shall coordinate the delivery of all equipment, material, dumpsters, portable toilets (and their maintenance) and other required items required for the contract work with the MWW staff. A minimum of 24 hours prior notice in advance of the desired delivery date shall be transmitted to the designated Water Engineering Representative.
- B. Contractor shall provide the following information in the notification:
 - 1. Trucking/Delivery Company
 - 2. Driver Name
 - 3. Truck License Plate Number
- C. The driver of the delivery vehicle is required to display picture identification as a pre-requisite for entry to the MWW facility for the delivery. Failure to comply with the above will result in denial of project site access, requiring the contractor to re-schedule delivery.

END OF SECTION

Milwaukee Water Works

Safe, Abundant Drinking Water.

FORM A

CONTRACT FIRM REGISTRATION FORM

CONTRACTOR: _____

PLANT/SITE: _____

CONTRACT/SERVICE ORDER No. _____

WATER ENGINEERING PROJECT No. _____

PRIMARY CONTACT PERSON: _____

OFFICE PHONE NUMBER: _____

CELL PHONE NUMBER: _____

REQUESTED WORK HOURS (00am – 00pm): _____

NUMBER OF EMPLOYEES TO BE WORKING ON-SITE: _____

**Signature certifies receipt of the materials outlined in
Contract Section 01500, Part 2 – Security and Safety, Section C, Policies.**

SIGNATURE: _____

PRIMARY CONTACT PERSON

DATE: _____

***Accompanying this form should be a complete listing of all
equipment to be stored on site for the duration of the project.***

Milwaukee Water Works

Safe, Abundant Drinking Water.

FORM B

CONTRACTOR EMPLOYEE REGISTRATION FORM

Contract Firm: _____

Plant/Site/Project: _____

Employee Name (Printed): _____

This certifies that I have received the building site security and safety policies.

EMPLOYEE
SIGNATURE: _____

Required

DATE: _____

ONSITE PARKING

- I will always be driving a Company vehicle.
- I will always be a passenger in a vehicle.
- I will be driving my personal vehicle. If checked here complete and sign the next section.

Contractor Personal Vehicle Liability Waiver

EMPLOYEE VEHICLE

MAKE & MODEL: _____ LICENSE PLATE: _____

I, hereby agree to hold harmless the City of Milwaukee for any and all damage, loss or injury, which may occur as a result of utilizing the contractor onsite parking area.

EMPLOYEE
SIGNATURE: _____

Required

DATE: _____

SECTION 01600
MATERIALS AND EQUIPMENT

PART 1 - GENERAL

1.01 PRODUCTS

- A. Products: Defined as new material, machinery, components, equipment, fixtures and systems forming the work; does not include machinery and equipment used for preparation, fabrication, conveying and erection of the work.
- B. All materials which will be in direct contact with potable drinking water shall be in compliance with NSF Standard 61 Drinking Water System Components – Health Effects.
- C. Do not use materials and equipment removed from existing premises, except as specifically permitted.
- D. Assure standardization and uniformity in all parts of the work by providing like items of equipment or certain materials as products of one manufacturer.
- E. Uniformity in equipment items is required in order to provide the CITY with interchangeability capabilities, simplified spare parts inventories and standardized maintenance programs and manufacturers services.

1.02 TRANSPORTATION AND HANDLING

- A. Transport and handle products in accordance with manufacturer's instructions.
- B. Promptly inspect shipments to assure 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.

1.03 CRANE

- A. An electric operated crane is available at the pump station for removal and installation of equipment and machinery under this contract. The crane has a capacity of 7.5 tons. Contractor shall be responsible for the safe operation of the crane during this contract. The contractor shall be responsible for all repairs for damage done to or by the crane caused by contractor's operation of the crane.

1.04 STORAGE AND PROTECTION

- A. Store and protect products in accordance with manufacturer's instructions, with seals and labels intact and legible. Store sensitive products in weather-tight, climate controlled enclosures.
- B. Provide off-site storage and protection when site does not permit on-site storage or protection.
- C. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation.

- D. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- E. Arrange storage of products to permit access for inspection. Periodically inspect to assure products are undamaged and are maintained under specified conditions.
- F. Spare parts and special tools shall be properly marked to identify the associated equipment by name, equipment and part number. Delivery of spare parts and special tools shall be made prior to the initial test run of the associated equipment.

END OF SECTION

SECTION 01640
EQUIPMENT MANUFACTURERS' SERVICES

PART 1 – GENERAL

1.01 DEFINITIONS

- A. Person-Day: One person for 8 hours within regular CONTRACTOR working hours.

1.02 SUBMITTALS

- A. Informational Submittals:

1. Training Schedule: Submit, not less than fourteen (14) days prior to start of equipment installation, and revise as necessary for acceptance.
2. Lesson Plan: Submit proposed lesson plan (as applicable), not less than fourteen (14 days) prior to scheduled training, and revise as necessary for acceptance.

1.03 QUALIFICATION OF MANUFACTURERS' REPRESENTATIVE(S)

- A. Authorized representative of the manufacturer, factory trained and experienced in the technical applications, installation, operation and maintenance of respective equipment, subsystem or system, with full authority by the equipment manufacturer to issue the certifications required of the manufacturer. Additional qualifications may be specified elsewhere.
- B. Representative is subject to acceptance by CITY. No substitute representatives will be allowed unless prior written approval by such has been given.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 FULFILLMENT OF SPECIFIED MINIMUM SERVICES

- A. Furnish manufacturers' services when required by an individual specification section, to meet the requirements of this Section.
- B. Where time is necessary in excess of that stated in the Specifications for manufacturers' services, or when a minimum time is not specified, the time required to perform the specified services shall be considered incidental.
- C. Schedule manufacturers' services to avoid conflict with other on-site testing or other manufacturers' on-site services.
- D. Determine, before scheduling services, that all conditions necessary to allow successful testing have been met.
- E. Only those days of service approved by CITY will be credited to fulfill the specified minimum services.
- F. When specified in individual specification sections, manufacturer's on-site services shall include:

1. Assistance during product (system, subsystem or component) installation to include observation, guidance, instruction of CONTRACTOR'S assembly, erection, installation or application procedures.
2. Inspection, checking and adjustment as required for product (system, subsystem or component) to function as warranted by manufacturer and necessary to furnish Manufacturer's Certificate of Proper Installation.
3. Providing, on a daily basis, copies of all manufacturers' representatives' field notes and data to CITY.
4. Revisiting the site, as required, to correct problems until installation and operation are acceptable to CITY.
5. Resolution of assembly or installation problems attributable to, or associated with, respective manufacturer's products and systems.
6. Assistance during functional and performance testing, facility startup and evaluation.
7. Training of CITY'S personnel in the operation and maintenance of respective product(s) as required.
8. Additional requirements may be specified elsewhere.

3.02 MANUFACTURERS' CERTIFICATE OF COMPLIANCE

- A. When specified in an individual Specification section, submit prior to shipment of product or material.
- B. CITY may permit use of certain materials or assemblies prior to sampling and testing if accompanied by accepted certification of compliance.
- C. Signed by product manufacturer certifying that product or material specified conforms to or exceeds specifications. Attach supporting reference data, affidavits and certifications as appropriate.
- D. May reflect recent or previous test results on material or product, if acceptable to CITY.

3.03 MANUFACTURERS' CERTIFICATE OF PROPER INSTALLATION

- A. When so specified, a Manufacturers' Certificate of Proper Installation form, Attachment "C" and "D", copies of which are attached to this section, shall be completed and signed by the equipment manufacturers' representative.
- B. Such form shall certify that the signing party is a duly authorized representative of the manufacturer, is empowered by the manufacturer to inspect, approve and operate their equipment and is authorized to make recommendations required to assure that the equipment is complete and operational.

3.04 TRAINING

A. General:

1. Furnish manufacturers' representatives for detailed classroom and hands-on training to CITY'S personnel on operation and maintenance of specified product (system, subsystem and component) and as may be required in applicable Specifications.
2. Furnish trained and articulate personnel to coordinate and expedite training, to be present during training coordination meetings with CITY and familiar with operation and maintenance manual information.
3. Manufacturers' representative shall be familiar with facility operation and maintenance requirements, as well as with specified equipment.
4. Furnish complete training materials, to include operation and maintenance data, to be retained by each trainee.

B. Training Schedule:

1. List specified equipment and systems that require training services and show:
 - a) Respective manufacturer.
 - b) Estimated dates for installation completion.
 - c) Estimated training dates.
2. Allow for multiple sessions when several shifts are involved.
3. Adjust schedule to ensure training of appropriate personnel as deemed necessary by CITY, and to allow full participation by manufacturers' representatives. Adjust schedule for interruptions in operability of equipment.

C. Lesson Plan: When manufacturer or vendor training of CITY personnel is specified, prepare for each required course, containing the following minimum information:

1. Title and objectives.
2. Recommended types of attendees (e.g., managers, engineers, operators, maintenance, etc.).
3. Course description and outline of course content.
4. Format (e.g., lecture, self-study, demonstration, hands-on).
5. Instruction materials and equipment requirements.
6. Resumes of instructors providing the training.

D. Pre-startup Training:

1. Coordinate training sessions with CITY's operating personnel and manufacturers' representatives.
2. Complete at least 14 days (if feasible) prior to beginning of facility startup.

- E. Post-startup Training: If required in Specifications, furnish and coordinate training of CITY's operating personnel by respective manufacturers' representatives.

3.05 SUPPLEMENTS

- A. The supplements listed below, following "END OF SECTION," are part of this Specification.
 - 1. Forms: Manufacturers' Certificate of Proper Installation for Pump
 - 2. Forms: Manufacturers' Certificate of Proper Installation for Motor

END OF SECTION

ATTACHMENT "C"

MANUFACTURERS' CERTIFICATE OF PROPER INSTALLATION FOR PUMP

LOCATION : PUMP SERIAL NO :
PUMP NO : SYSTEM :
PROJECT NO : SPEC. SECTION :

I hereby certify that the above-referenced equipment has been:

(Check Applicable)

- Installed in accordance with Manufacturer's recommendations.
- Inspected, checked, and adjusted.
- Serviced with proper initial lubricants.
- Electrical and mechanical connections meet quality and safety standards.
- All applicable safety equipment has been properly installed.
- Functional tests.
- System has been performance tested, and meets or exceeds specified performance requirements.

Note: Attach any performance test documentation from manufacturer.

Comments:

I, the undersigned Manufacturers' Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve and operate his equipment and (iii) authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20__

Manufacturer :

By Manufacturers' Authorized Representative :

(Authorized Signature)

SECTION 01700
CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes

1. Closeout Procedures
2. Final Cleaning
3. Adjusting
4. Project Record Documents
5. Operation and Maintenance Data
6. Guarantee
7. Spare Parts and Maintenance Materials

B. Related Sections

1. Section 01500 – Job Site Security, Utilities and Facilities

1.02 CLOSEOUT PROCEDURES

- A. Submit written certification that contract has been reviewed, Work has been inspected, and Work is complete in accordance with Contract and is ready for CITY inspection.
- B. Provide submittals to CITY that is required by governing or other authorities.
- C. Submit Final Application for Payment identifying total adjusted Contract price, previous payments, and sum remaining due.

1.03 FINAL CLEANING

- A. Execute final cleaning prior to final inspection.
- B. Clean equipment and fixtures to a sanitary condition.
- C. Clean site, sweep paved areas, rake clean landscaped surfaces.
- D. Remove waste and surplus materials, rubbish, and construction facilities from the work site.

1.04 ADJUSTING

- A. Adjusting operating products and equipment to ensure smooth and unhindered operation.

1.05 PROJECT RECORD DOCUMENTS

- A. Maintain onsite, one set of the following record documents; record actual revisions to the work:
 - 1. Contract Drawings
 - 2. Specifications
 - 3. Addenda
 - 4. Change Orders
 - 5. Reviewed shop drawings, Product data, and samples.
- B. Store Record Documents separate from documents used for construction.
- C. Record information concurrent with construction progress. Electrical boxes and conduit location determined in the field and not specifically shown on the drawings shall be recorded and documented.
- 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 alternate utilized.
 - 3. Changes made by Addenda or Change Orders.
- E. Record Documents and Shop Drawings: Legibly mark each item to record actual construction including:
 - 1. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
 - 2. Field changes of dimensions and details.
 - 3. Details not on original Contract Drawings.
- F. Delete Consultant, City of Milwaukee title block and Engineer's seal from all documents.
- G. Submit **five (5)** sets of documents with **one (1)** reproducible "Mylar" to CITY prior to final Application for Payment.
 - 1. Accompany submittal with transmittal letter containing the following:
 - a) Date
 - b) Project title and number
 - c) Contractor's name and address
 - d) Title and number of each record document
 - e) Certification that each document as submitted is complete and accurate.
 - f) Signature of Contractor, or his authorized representative.

1.06 OPERATION AND MAINTENANCE DATA

- A. Submit **six (6)** sets prior to final inspection, bound in 8 ½ x 11 -inch text pages, three D side ring binder capacity expansion binders with durable plastic covers.
- B. Prepare binder covers with printed title "OPERATION MAINTENANCE INSTRUCTIONS", title of project, and subject of binder when multiple binders are required.
- C. Internally subdivide the binder contents with permanent dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.
- D. Contents: Prepare a Table of Contents for each volume, with each Product or system description identified, typed on 30-pound white paper.
 1. Part 1: Directory, listing names, addresses, telephone numbers and emails of CITY, Contractor, Subcontractors, and major equipment suppliers.
 2. Part 2: Operation and maintenance instructions arranged by system and subdivided by specification section. For each category, identify name, addresses, telephone numbers and emails of Subcontractors and suppliers.

Identify the following:

 - a) Significant design criteria.
 - b) List of equipment.
 - c) Parts list for each component.
 - d) Operating instructions.
 - e) Maintenance instructions for equipment and systems.
 - f) Maintenance instructions for special finishes, including recommended cleaning methods and materials and special precautions identifying detrimental agents.
 3. Part 3: Project documents and certificates, including the following:
 - a) Shop drawings and product data.
 - b) Air and water balance reports.
 - c) Certificates.
 - d) Photocopies or warranties and bonds, if required.
- E. Special Requirements for Operation and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied for all equipment requiring maintenance or other attention. The Contractor shall provide operation and maintenance manuals for each type of equipment supplied.
 1. Operation and Maintenance Manuals shall include the following:
 - a) All sets of manuals shall be originals. Copies will not be acceptable.

- b) Equipment function, normal operating characteristics, and limiting conditions.
 - c) Assembly, installation, alignment, adjustment, and checking instructions.
 - d) Operation instructions for start up, routine and normal operation, regulation and control, shutdown, and emergency conditions.
 - e) Lubrication and maintenance instructions, including lubrication cross references to a minimum of three locally available suppliers.
 - f) Guide to "troubleshooting".
 - g) Parts list and predicted life of parts subject to wear.
 - h) Outline, cross-section, and detailed assembly drawings; engineering data; wiring diagrams.
 - i) Test data and performance curves, where applicable.
2. The operation and maintenance manuals shall be in addition to any instructions or parts packed with or attached to the equipment when delivered, or instructions that may be required by the Contractor.
 3. Manuals and other data shall be printed on heavy, first quality paper, in an 8 ½ x 11-inch size with standard 3-hole punching. Drawings and diagrams shall be reduced to 8 ½ x 11-inches, or 11 x 17 inches. Where reduction is not practicable, larger drawings shall be folded separately and placed in an envelope that is bound into the manuals. Each envelope shall bear suitable identification on the outside.
 4. Material shall be assembled and bound in the same order as it appears in the Specifications, and each volume shall have a table of contents and suitable index tabs.
 5. All submittals shall be marked with Contract identification, and inapplicable information shall be erased or deleted.
 6. Shipment of equipment will not be considered complete until required data and manuals have been received.
- F. Copies will be returned after final inspection, with CITY'S comments. Revise content of documents as required prior to final submittal.
 - G. Submit final volumes within **ten (10)** days after receipt of CITY'S comments.
- 1.07 SPARE PARTS AND MAINTENANCE MATERIALS
- A. Provide products, spare parts and equipment, maintenance and extra materials in quantities as noted in applicable Specification Sections.
 - B. Deliver to Project site and place in location as directed, obtain receipt prior to final payment.
- 1.08 GUARANTEE
- A. Provide duplicate notarized copies.

- B. Execute and assemble documents and Subcontractors, suppliers, and manufacturers.
- C. Provide Table of Contents and assemble in three D side ring binder with durable plastic cover.
- D. Submit prior to final Application for Payment.

END OF SECTION

SECTION 01810
EQUIPMENT TESTING AND FACILITY STARTUP

PART 1 - GENERAL

1.01 DEFINITIONS

- A. Facility: Entire Project or an agreed-upon portion including its unit processes.
- B. Functional Test: Test or tests in presence of CITY to demonstrate that installed equipment meets manufacturers' installation, calibration and adjustment requirements and other requirements as specified.
- C. Performance Test: Test or tests performed after any required functional test in presence of CITY to demonstrate and confirm individual equipment meets performance requirements specified in individual sections.
- D. Facility Performance Demonstration:
 - 1. A demonstration conducted by CONTRACTOR, with assistance of CITY, to demonstrate and document the performance of the entire operating facility, both manually and automatically (if required), based on criteria developed in conjunction with CITY and as accepted by CITY.
 - 2. Such demonstration is for the purposes of (i) verifying to CITY entire facility performs as a whole, and (ii) documenting performance characteristics of completed facility for CITY's records. Neither the demonstration nor the evaluation is intended in any way to make performance of a unit process or entire facility the responsibility of CONTRACTOR, unless such performance is otherwise specified.

1.02 SUBMITTALS

- A. Informational Submittals:
 - 1. Facility Startup and Performance Demonstration Plan.
 - 2. Functional and performance test results.
 - 3. Completed Unit Process Startup Form for each unit process.
 - 4. Completed Facility Performance Demonstration/Certification Form.
 - 5. Completed Contractor Startup Field Checklist Pump/Motor Assembly and Control System.

1.03 FACILITY STARTUP AND PERFORMANCE DEMONSTRATION PLAN

- A. Develop a written plan, in conjunction with CITY's operations personnel; to include the following:
 - 1. Step-by-step instructions for startup of each unit process and the complete facility.

2. Unit Process Startup Form (Attachment “E”), to minimally include the following:
 - a) Description of the unit process, including equipment numbers/nomenclature of each item of equipment and all included devices.
 - b) Detailed procedure for startup of the unit process, including valves to be opened/closed, order of equipment startup, etc.
 - c) Startup requirements for each unit process, including water, power, chemicals, etc.
 - d) Space for evaluation comments.
3. Facility Performance Demonstration/Certification Form (Attachment “F”), to minimally include the following:
 - a) Description of unit processes included in the facility startup.
 - b) Sequence of unit process startup to achieve facility startup.
 - c) Description of computerized operations, if any, included in the facility.
 - d) CONTRACTOR certification facility is capable of performing its intended function(s), including fully automatic operation.
 - e) Signature spaces for CONTRACTOR and CITY.
4. Contractors Startup Field Checklist Pump/Motor Assembly and Control System (Attachment “G”), to minimally include the following:
 - a) Proper certificates have been completed and turned over to the CITY.
 - b) All components are properly installed in proper working order and the distribution system is ready to accept flow.
 - c) CONTRACTOR certification facility is capable of performing its intended function(s), including fully automatic operation.
 - d) Signature spaces for CONTRACTOR and CITY.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.01 GENERAL

- A. Facility Startup Meetings: Schedule to discuss test schedule, test methods, materials, chemicals and liquids required, facilities operations interface, and CITY involvement.

- B. Contractor's Testing and Startup Representative:
 - 1. Designate and furnish one or more personnel to coordinate and expedite testing and facility startup.
 - 2. Representative(s) shall be present during startup meetings and shall be available at all times during testing and startup.
- C. Provide temporary valves, gauges, piping, test equipment and other materials and equipment required for testing and startup.
- D. Provide Subcontractor and equipment manufacturers' staff adequate to prevent delays. Schedule ongoing work so as not to interfere with or delay testing and startup.
- E. CITY will:
 - 1. Provide water, power, chemicals, and other items as required for startup, unless otherwise indicated.
 - 2. Operate process units and facility with support of CONTRACTOR.

3.02 EQUIPMENT TESTING

- A. Preparation:
 - 1. Complete installation before testing.
 - 2. Furnish qualified manufacturers' representatives, when required by individual Specification sections.
 - 3. Obtain and submit from equipment manufacturer's representative Manufacturer's Certificate of Proper Installation Form, in accordance with Section 01640, EQUIPMENT MANUFACTURERS' SERVICES, when required by individual Specification sections.
 - 4. Equipment Test Report Form: Provide written test report for each item of equipment to be tested, to include the minimum information:
 - a) CITY/Project Name.
 - b) Equipment or item tested.
 - c) Date and time of test.
 - d) Type of test performed (Functional or Performance).
 - e) Test method.
 - f) Test conditions.
 - g) Test results.
 - h) Signature spaces for CONTRACTOR and CITY as witness.

5. Cleaning and Checking: Prior to beginning functional testing:
 - a) Calibrate testing equipment in accordance with manufacturer's instructions.
 - b) Inspect and clean equipment, devices, connected piping, and structures to ensure they are free of foreign material.
 - c) Lubricate equipment in accordance with manufacturer's instructions.
 - d) Turn rotating equipment by hand when possible to confirm that equipment is not bound.
 - e) Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
 - f) Check power supply to electric-powered equipment for correct voltage.
 - g) Adjust clearances and torque.
 - h) Test piping for leaks.
 6. Ready-to-test determination will be by CITY based at least on the following:
 - a) Acceptable Operation and Maintenance Data.
 - b) Notification by CONTRACTOR of equipment readiness for testing.
 - c) Receipt of Manufacturer's Certificate of Proper Installation, if so specified.
 - d) Adequate completion of work adjacent to, or interfacing with, equipment to be tested.
 - e) Availability and acceptability of manufacturer's representative, when specified, to assist in testing of respective equipment.
 - f) Satisfactory fulfillment of other specified manufacturer's responsibilities.
 - g) Equipment and electrical tagging complete.
 - h) Delivery of all spare parts and special tools.
- B. Functional Testing:
1. Conduct as specified in individual Specification sections.
 2. Notify CITY in writing at least 10 days prior to scheduled date of testing.
 3. Prepare Equipment Test Report summarizing test method and results.
 4. When, in CITY's opinion, equipment meets functional requirements specified, such equipment will be accepted for purposes of advancing to performance testing phase, if so required by individual Specification sections. Such acceptance will be evidenced by CITY's signature as witness on Equipment Test Report.

C. Performance Testing:

1. Conduct as specified in individual Specification sections.
2. Notify CITY in writing at least 10 days prior to scheduled date of test.
3. Performance testing shall not commence until equipment has been accepted by CITY as having satisfied functional test requirements specified.
4. Type of fluid, gas, or solid for testing shall be as specified.
5. Unless otherwise indicated, furnish labor, materials, and supplies for conducting the test and taking samples and performance measurements.
6. Prepare Equipment Test Report summarizing test method and results.
7. When, in CITY's opinion, equipment meets performance requirements specified, such equipment will be accepted as conforming to Contract requirements. Such acceptance will be evidenced by CITY's signature on Equipment Test Report.

3.03 STARTUP OF UNIT PROCESSES

- A. Prior to unit process startup, equipment within unit process shall be accepted by CITY as having met functional and performance testing requirements specified.
- B. Make adjustments, repairs, and corrections necessary to complete unit process startup.
- C. Startup shall be considered complete when, in opinion of CITY, unit process has operated in manner intended for 5 continuous days (120 hours) without significant interruption. This period is in addition to functional or performance test periods specified elsewhere.
- D. Significant Interruption: May include any of the following events:
 1. Failure of CONTRACTOR to provide and maintain qualified onsite startup personnel as scheduled.
 2. Failure to meet specified functional operation for more than 2 consecutive hours.
 3. Failure of any critical equipment or unit process that is not satisfactorily corrected within 5 hours after failure.
 4. Failure of any noncritical equipment or unit process that is not satisfactorily corrected within 8 hours after failure.
 5. As determined by CITY.
- E. A significant interruption will require startup then in progress to be stopped. After corrections are made, startup test period to start from beginning again.

3.04 FACILITY PERFORMANCE DEMONSTRATION

- A. When, in the opinion of CITY, startup of all unit processes has been achieved, sequence each unit process to the point that facility is operational.
- B. Demonstrate proper operation of required interfaces within and between individual unit processes.

3.05 SUPPLEMENTS

- A. Supplements listed below, following “END OF SECTION,” are a part of this Specification:
 - 1. Unit Process Startup Form.
 - 2. Facility Performance Demonstration/Certification Form.
 - 3. Contractor Startup Field Checklist Pump/Motor Assembly and Control System Form.

END OF SECTION

ATTACHMENT "E"

UNIT PROCESS STARTUP FORM

CITY:

PROJECT:

Unit Process Description: (Include description and equipment number of all equipment and devices):

Startup Procedure (Describe procedure for sequential startup and evaluation, including valves to be opened/closed, order of equipment startup, etc.):

Startup Requirements (Water, power, chemicals, etc.):

Evaluation Comments:

ATTACHMENT "F"

FACILITY PERFORMANCE DEMONSTRATION/CERTIFICATION FORM

CITY:

PROJECT:

Unit Processes Description (List unit processes involved in facility startup):

Unit Processes Startup Sequence (Describe sequence for startup, including computerized operations, if any):

CONTRACTOR Certification that Facility is capable of performing its intended function(s), including fully automatic operation:

CONTRACTOR:

(Authorized Signature)

Date: _____,

20____

CITY:

(Authorized Signature)

Date: _____,

20____

ATTACHMENT "G"

**CONTRACTOR STARTUP FIELD CHECKLIST PUMP/MOTOR ASSEMBLY
AND CONTROL SYSTEM FORM**

LOCATION :

MOTOR SERIAL NO :

MOTOR NO :

PUMP SERIAL NO :

PUMP NO :

SYSTEM :

PROJECT NO :

SPEC. SECTION(s) :

Contractor shall certify that the above-referenced equipment and system, at a minimum, has satisfied the requirements outlined below:

(Check Applicable – If not Applicable indicate reason why item does not apply)

- Manufacturers' Certificate of Proper Installation for Pump "Attachment C" has been completed.
- Manufacturers' Certificate of Proper Installation for Motor "Attachment D" has been completed.
- ALL valves are installed in accordance with manufacturers' recommendations.
- ALL valve limits have been set and verified per specification.
- Verify with field engineer that "A" valve is open, the "C" valve is in the appropriate position and the system is ready to accept flow.
- Establish contact with field operator responsible for remote starting of pump.
- Establish contact with electrical contractor's controls engineer (required to be present for startup).
- Demonstrate to field engineer that control sequence/program meets specification requirements. Verify system: Normal Open Cycle, Normal Close Cycle, Emergency Close Cycle, Manual Valve Operation Functions and Emergency ESTOP functions without starting pump.
- Verify Pressure Switch connections (if applicable)
- Verify Prime System if functioning (if applicable)
- Verify Flow Switch connections (if applicable)
- Present field engineer with copy of alignment report
- Verify Pump and Motor coupling clearance is in accordance with manufacturers' recommendations.

NOTE: Attach any performance test documentation from manufacturer.

Comments:

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate his equipment and (iii) authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20__

Manufacturer:

By Manufacturers' Authorized Representative:

(Authorized Signature)

By CITY Representative:

(Authorized Signature)

SECTION 02050
DEMOLITION AND ABANDONMENT

PART 1 - GENERAL

1.01 SCOPE

- A. This section covers the demolition and abandonment of portions of structures, piping, equipment, and sitework as indicated on the drawings.

1.02 GENERAL

- A. The Contractor shall be responsible for all work under this section.
- B. All structures and facilities of the existing Florist Pump Station which are not to be removed must remain in continuous operation during the work. Demolition and salvage work shall create minimum interference with the City's operations and minimum inconvenience to the City.
- C. Any structural member which provides support, restraint, stabilization, etc., for any part of the pump station facilities shall remain in place, if possible, during demolition. If the member must be moved or demolished, adequate measures shall be taken to provide support, restraint, etc., for all affected parts of the pump station facility.
- D. Blasting will not be permitted.

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 DEMOLITION

A. General

1. All portions of structures, piping, equipment, and sitework indicated on the Drawings to be demolished shall be removed and shall become property of the Contractor, unless otherwise specified. All such items shall be promptly removed from the job site.
2. All piping and equipment remaining after demolition that will not be incorporated in the new Work shall be permanently capped in a manner acceptable to City.
3. All pavements, including curb & gutter, shown to be removed shall have a neat sawcut edge and shall be removed full depth, to include aggregate base.
4. The cutting and removal of pavement shall be performed by equipment and methods which will leave a vertical uniform face on the remaining pavement.
5. Any irregularities shall be eliminated by bush hammering or grinding to the satisfaction of the City Representative.

3.02 ABANDONMENT

A. General

1. Storm drains that are to be abandoned shall be bulkheaded with an 8-inch brick wall. Sewers, storm water drains, and structures 15 inches and larger that are to be abandoned and have not been removed shall be filled with sand unless otherwise indicated on the plans.
2. Service shall be maintained until the City, or an authorized City representative, shall order sewers, storm drains, and sewer structures that are no longer in use to be bulkheaded and abandoned.
3. The cost of abandoning sewers, storm water drains, and sewer structures is incidental to construction.

3.03 RESTORATION

A. General

1. All structures and surfaces damaged during the course of demolition work that are to remain in the completed work, shall be restored by the Contractor as follows:
 - a) All restoration work shall be done with new materials and appropriate methods as specified elsewhere in these Specifications for new work of similar nature; or, if not specified, best recommended practice of manufacturer, or appropriate trade association.
 - b) Damaged work shall be restored in such a way that there is a secure and intimate bond or fastening between new and old work. Restored surfaces shall be finished to such planes, shapes, and textures that no transition between new and old work is evident in finished surfaces.
2. All holes remaining in existing concrete structures which were created by demolition work shall be patched with concrete and/or non-shrink grout. The patch shall be structurally keyed to the existing concrete structure. Holes in existing buried and/or water holding structures shall be repaired with a patch which is also watertight.
3. All holes remaining in existing masonry structures which were created by demolition work shall be patched with non-shrink grout if smaller than 9 square inches and shall be repaired to match adjacent construction if larger than 9 square inches.
4. All exposed anchor bolts, reinforcement, and other metal items remaining in existing concrete structures shall be cut, and then patched with nonmetallic, non-shrink grout. The concrete around each item shall be chipped back a minimum of one inch, then water saturated for 24 hours prior to cutting the item. Immediately after cutting the item, coat it with an epoxy bonding agent and patch the hole.

3.04 SALVAGE MATERIALS

- A. During demolition procedures the Contractor shall allow the City to request the salvage of materials and shall return those materials to the possession of the City.
- B. Salvage items shall include, but not be limited to:
 - 1. Electric valve operators
 - 2. Other items requested by City

END OF SECTION

SECTION 02200
EARTHWORK

PART 1 - GENERAL

1.01 SCOPE

- A. This section covers earthwork and shall include the necessary clearing, grubbing, and preparation of the site; removal and disposal of all debris; excavation; handling, storage, transportation, and disposal of all excavated material; all necessary sheeting, shoring, and protection work; preparation of sub-grades; pumping and dewatering as necessary; protection of adjacent property; backfilling; construction of fills and embankments; surfacing and grading; and other appurtenant work

1.02 GENERAL

- A. With reference to the terms and conditions of the construction standards for excavations set forth in OSHA "Safety and Health Regulations for Construction", Chapter XVII of Title 29, CFR, Part 1926, Contractor shall employ a competent person and, when necessary based on the regulations, a registered professional engineer, to act upon all pertinent matters of the work of this section.

1.03 SUBMITTALS

- A. Drawings, specifications, and data covering the proposed materials shall be submitted in accordance with the requirements of Section 01010 and this section.
- B. Sheeting, shoring, and excavation support systems' submittals shall bear the seal and signature of a Professional Engineer licensed or registered in the State of Wisconsin.
- C. Filter Fabric Data
1. Complete descriptive and engineering data for the fabric shall be submitted in accordance with the Submittals section. Data submitted shall include:
 - a) 12-inch square sample of fabric
 - b) Manufacturer's descriptive product data
 - c) Installation instructions
- D. Erosion Control Implementation Plan

1.04 INSURANCE

- A. Professional Liability insurance shall be provided.
1. Professional liability insurance shall be required for sheeting, shoring, and excavation support systems design services, as specified herein, to be performed by a professional engineer with appropriate expertise in accordance with applicable laws and regulations, licensed or registered in the State of Wisconsin, where the shop drawings or other evidence of design bear the seal and signature of that professional engineer.

This insurance shall provide protection against claims arising out of performance of professional design services and caused by a negligent error, omission, or act for which the insured party is legally liable; such professional liability insurance shall provide coverage in the amount of \$3,000,000 which shall be maintained throughout the duration of the Project and for one year after Final Acceptance.

2. In the event that the professional design services are performed by an independent consultant or Subcontractor engaged by Contractor, this insurance shall be furnished and maintained by the independent consultant or Subcontractor. In the event that the professional design services are performed by a member of Contractor's organization, this insurance shall be furnished and maintained by Contractor.
3. A certificate of insurance for such professional liability insurance coverage, including the amount, duration, and name of the insured party, shall be delivered to City.

1.05 EROSION CONTROL IMPLEMENTATION PLAN (ECIP)

A. General

1. Within fifteen (15) days after Notice to Proceed is issued, and at least twenty (20) working days prior to the start of any construction activity, the Contractor shall submit to the City for review & approval a minimum of three copies of an Erosion Control Implementation Plan (ECIP). The Contractor shall allow two (2) weeks for the City to review the ECIP for meeting technical standards and for the City to notify the Contractor if the plan meets the standards.
2. Work shall not start until the ECIP meets technical standards. No construction activity may begin without an ECIP approved by the City.
3. The Contractor shall be required to have a copy of the ECIP on the job site for the entire duration of the Contract.
4. The ECIP shall include, but not be limited to:
 - a) A completed "Erosion Control Implementation Plan" application (See Attachment "H").
 - b) A plan showing all locations of erosion control devices and other Best Management Practices (BMP's).
 - c) A written description of all erosion control devices and BMP's to be used.
 - d) A written schedule of installing erosion control devices.
 - e) A written schedule of construction operations related to implementing erosion control devices and BMP's.
 - f) A written maintenance schedule for all erosion control devices and BMP's.

5. All costs associated with implementing the erosion control plan, such as furnishing, installing, maintaining, and removal of erosion control devices shall be included in the lump sum bid (Base Bid) for the project. There shall be no additional compensation for revising the ECIP or utilizing additional BMP's in order to comply with Chapter 290 of the City of Milwaukee Code of Ordinances. If the Contractor is found not in compliance with the ECIP, the Contractor will be subject to the penalties included in Chapter 290.

B. Erosion Control Site Plan Characteristics

1. The Contractor may utilize the Contract Drawings for this project or provide a separate site diagram. The following information shall be included on the ECIP:
 - a) The scale of the drawing (not less than 1" = 100')
 - b) A north arrow (towards the top or to the right of the plan)
 - c) The name of all project streets and streets abutting the project
 - d) Approximate location of all existing and proposed drainage structures
 - e) The direction of water runoff (flow arrows)
 - f) The proposed limits of construction
 - g) The approximate location of all erosion control devices
 - h) Areas where vegetation will be disturbed and re-established
 - i) For non right-of-way projects, locate watershed areas of overland and concentrated flow. Include area sizes in acres and representative soil type of disturbed areas.

C. Storm Water Inlet Protection

1. Any structure that is connected to the drainage system shall be protected from sediment entering the system.
2. All storm water inlets adjacent to and on the project site shall have type M inlet protection.
3. If the frame of any storm water inlet or manhole is removed, or openings are in the masonry where storm water may enter, the protection device should be changed to a type R.

D. Temporary storage piles.

1. Storage of erodible materials (e.g. gravel, soil, etc.) should not be closer than 25 feet of a roadway or drainage way.
2. If placed in the right-of-way, the stockpiles shall not be placed closer than 100 feet of an unprotected storm drain.
3. Covering or surrounding with straw bales, silt fence or other measures, shall control erosion from stockpiles existing less than ten (10) days.

4. Stockpiles existing longer than ten (10) days shall be seeded and mulched.

E. Tracking

1. The project and surrounding roadways shall be kept free from materials that may enter the drainage system.
2. Tracking pads at ingress and egress points may be used to help control tracking of sediment onto roadway surfaces. The pads shall be constructed with a minimum 3-inch size stone, a minimum of 8-feet wide and a minimum of 50-feet long.
3. Tracked roadways shall be cleaned immediately by means other than flushing with water.
4. The project roadways shall be cleaned on a daily basis. Cleaning shall be done by means other than flushing with water.

F. Locating Sediment Controls

1. Current Wisconsin Department of Natural Resource publications shall be consulted to determine the location of sediment controls (e.g. silt fence, straw bales, stone tracking pads, etc.) that minimize the amount of sediment from leaving the site.
 - a) Storm Water Management Technical Standards
 - b) The "*Wisconsin Construction Site Best Management Practices Handbook*"

G. Dewatering

1. Water containing particles of 100 microns or greater shall be treated by use of temporary sediment basins or other devices designed to remove particles of 100 microns or greater.

H. Vegetation

1. The construction activity shall be staged as to limit the amount of time vegetation is stripped and re-established.
2. Contractor shall utilize road plates to protect areas of greenspace and vegetation from ruts or depressions caused by construction traffic.
3. Refer to Section 02200 Earthwork and Section 02930 Seeding, as well as any applicable construction plan sheets, for further instruction on vegetation disturbance, protection, and restoration.

I. Maintenance

1. A schedule for maintaining all erosion control devices is necessary to maximize the effort of limiting sediment from entering the drainage system.
2. All devices shall be inspected and maintained after a rainfall event that totals 0.50 inches.
3. All devices shall be inspected and maintained at least once a week.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Filter Fabric

1. Filter Fabric shall be provided in rolls wrapped with covering for protection from mud, dirt, dust and debris.
 - a) Filter Fabric Type FF shall be provided for installation at locations indicated on the drawings. Filter fabric Type FF shall be a woven polypropylene fabric and shall have the indicated properties:

Grab Tensile Strength, lb.	ASTM D-4632	200 min.
Puncture Strength, lb.	ASTM D- 4833	105 min.
Apparent Breaking Elongation,	ASTM D-4632	24 min.
Machine Direction, %		
Apparent Breaking Elongation,	ASTM D-4632	10 min.
Cross Direction, %		
Apparent Opening Size, μm	ASTM D-4754	600 max.
Permittivity, s-1	ASTM D-4491	1.9 min.

B. Polyethylene film

1. Polyethylene film beneath concrete slabs or slab base course material shall be Product Standard PS17, 6 mil minimum thickness.

C. General Fill and Embankment Materials

1. To the maximum extent available, excess suitable material obtained from structure and trench excavation shall be used for the construction of general fills and embankments. Additional material shall be provided from Contractor's offsite source. No borrow pits shall be opened on site unless such pits are specifically indicated on the drawings.
2. All material placed in fills and embankments shall be free from rocks or stones larger than the required size in their greatest dimension, brush, stumps, logs, roots, debris, and other organic or deleterious materials. The maximum size of stone in fills and embankment shall be 4 inches. No rocks or stones shall be placed in the upper 18 inches of any fill or embankment. Rocks or stones within the allowable size limit may be incorporated in the remainder of fills and embankments, provided they are distributed so that they do not interfere with proper compaction.

D. Select Granular Fill

1. Granular fill material shall be crushed rock or gravel suitable for use as a free draining sub-base beneath slabs and foundations. Granular fill shall be free from dust, clay, and trash; hard, durable, non-friable; and shall be graded 3/4 inch to No. 4 as defined in ASTM C33 for No. 67 coarse aggregate and indicated below. Granular fill shall meet the quality requirements for ASTM C33 coarse aggregate. Only crushed rock with angular particles shall be used when the perimeter of the granular fill is not confined or otherwise subject to raveling, such as on a slope.

<u>Size</u>	<u>Percent Passing</u>
1 inch	100
3/4 inch	90 - 100
3/8 inch	20 – 55
No. 4	0 - 10
No. 8	0 – 5

E. Dense Graded Base

1. Dense graded base (3/4-inch) shall be placed as a subbase for asphaltic concrete pavement and beneath concrete curb & gutter. Dense graded base (3/4-inch) shall meet the following Wisconsin Department of Transportation Gradation requirements:

<u>Size</u>	<u>Percent Passing</u>
1 inch	100
3/4 inch	95 - 100
3/8 inch	50 - 90
No. 4	35 - 70
No. 10	15 - 55
No. 40	10 – 35
No. 200	5.0 – 15.0 *

* 8.0 – 15.0 if base is _ 50 percent crushed gravel.

2.02 MATERIAL TESTING

A. Preliminary Review of Materials

1. As stipulated in the Quality Control section, all tests required for preliminary review of materials shall be made by an acceptable independent testing laboratory at the expense of Contractor. Two initial gradation tests shall be made for each type of general fill, designated fill, backfill, or other material, and one additional gradation test shall be made for each additional 500 tons of each material delivered to the jobsite. In addition, one set of initial Atterberg Limits tests shall be made for each fill material containing more than 20 percent by weight passing the No. 200 sieve and for materials specified by Atterberg Limits. One additional Atterberg Limits test shall be made for each additional 500 tons of each material delivered to the job site.

B. Field Testing Expense

1. All moisture-density (Proctor) tests and relative density tests on the materials, and all in-place field density tests, shall be made by an independent testing laboratory approved by the City at the expense of Contractor. Contractor shall provide access to the materials and work area and shall assist the laboratory as needed in obtaining representative samples.

C. Required Field Tests

1. For planning purposes the following guidelines shall be used for frequency of field tests. Additional tests shall be performed as necessary for job conditions and number of failed tests. Test results shall be submitted as indicated in the Submittals section.
 - a) Two moisture-density (standard Proctor) tests in accordance with ASTM D698 or two relative density tests in accordance with ASTM D4253 and D4254 for each type of general fill, designated fill, backfill, or other material proposed.
 - b) For area fills and embankments, an in-place field density and moisture test for each 1000 cubic yards of material placed.
 - c) One in-place field density and moisture test for every 100 to 200 cubic yards of structure backfill or select fill.
 - d) One in-place density and moisture test whenever there is a suspicion of a change in the quality of moisture control or effectiveness of compaction.
 - e) At least one test for every full shift of compaction operations on mass earthwork.
 - f) Additional gradation, proctor, and relative density tests whenever the source or quality of materials changes.

PART 3 - EXECUTION

3.01 SITE PREPARATION

- A. All sites to be occupied by permanent construction or embankments shall be cleared of all logs, trees, roots, brush, tree trimmings, and other objectionable materials and debris. All stumps shall be grubbed. Subgrades for fills and embankments and sites to be occupied by permanent construction shall be cleaned and stripped of all surface vegetation, sod, and organic topsoil. All waste materials shall be removed from the site and disposed of by and at the expense of Contractor.

3.02 EXCAVATION

A. General

1. Excavations shall provide adequate working space and clearances for the work to be performed therein and for installation and removal of concrete forms. In no case shall excavation faces be undercut for extended footings.
2. Sub-grade surfaces shall be clean and free of loose material of any kind when concrete is placed thereon. Do not place base on foundations that are soft, spongy, or covered by ice or snow. Water and rework or re-compact dry foundations as necessary to ensure proper compaction, or as the City directs.
3. Except where exterior surfaces are specified to be damp-proofed, monolithic concrete manholes and other concrete structures or parts thereof that do not have footings that extend beyond the outside face of exterior walls may be placed directly against excavation faces without the use of outer forms, provided that such faces are stable and also provided that a layer of polyethylene film is placed between the earth and the concrete.
4. Excavations for manholes and similar structures constructed of masonry units shall have such horizontal dimensions that not less than 6 inches clearance is provided for outside plastering.

B. Classification of Excavated Materials

1. No classification of excavated materials will be made for payment purposes. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the work, regardless of the type, character, composition, or condition thereof.

C. Preservation of Trees

1. No trees shall be removed outside excavated or filled areas, unless their removal is authorized by City. Trees left standing shall be adequately protected from permanent damage by construction operations.

D. Unauthorized Excavation

1. Except where otherwise authorized, indicated, or specified, all materials excavated below the bottom of concrete walls, footings, slabs on grade, and foundations shall be replaced with concrete at the expense of Contractor. It shall be placed at the same time and monolithic with the concrete foundation.

E. Blasting

1. Blasting or other use of explosives for excavation will not be permitted.

F. Dewatering

1. Dewatering equipment shall be provided to remove and dispose of all surface water and groundwater entering excavations, trenches, or other parts of the work. Each excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.
2. All excavations for concrete structures or trenches which extend down to or below groundwater shall be dewatered by lowering and keeping the groundwater level to the minimum depth of 24 inches beneath such excavations. The specified dewatering depth shall be maintained below the prevailing bottom of excavation at all times.
3. Surface water shall be diverted or otherwise prevented from entering excavations or trenches to the greatest extent possible without causing damage to adjacent property.
4. Contractor shall be responsible for the condition of any pipe or conduit used for drainage purposes, and all such pipe or conduit shall be left clean and free of sediment.

G. Sheet piling and Shoring

1. Except where banks are cut back on a stable slope, excavations for structures and trenches shall be supported as necessary to prevent caving or sliding.
2. Steel sheet piling or other excavation support systems shall be furnished and installed as necessary to limit the extent of excavations for the deeper structures and necessary backfill under adjacent shallower structures, and to protect adjacent structures and facilities from damage due to excavation and subsequent construction. Contractor shall assume complete responsibility for, and install adequate protection systems for prevention of damage to existing facilities.
3. Excavation support systems and sheet piling and shoring shall be all removed after completion of work.

4. The design of the excavation support system shall be such as to permit complete removal while maintaining safety and stability in the excavation at all times.
5. Sheeting, shoring and excavation support systems shall be designed by a professional engineer retained by the Contractor and registered in the state where the project is located.

H. Stabilization

1. Sub-grades for concrete structures shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud and muck; and shall be sufficiently stable to remain firm and intact under the feet of the workers.
2. Sub-grades for concrete structures which are otherwise solid, but which become mucky on top due to construction operations, shall be reinforced with crushed rock or gravel as specified for granular fills. The stabilizing material shall be placed in such a manner that no voids remain in the granular fill. All excess granular fill with unfilled void space shall be removed. The finished elevation of stabilized sub-grades shall not be above sub-grade elevations indicated on the drawings.

I. Roadway Excavation

1. Excavation for the roadways, drives, and parking areas shall conform to the lines, grades, cross sections, and dimensions indicated on the drawings and shall include the excavation of all unsuitable material from the subgrade. After shaping to line, grade, and cross section, the subgrade shall be compacted to a depth of at least 6 inches and shall meet the following:

Test method to determine maximum density and moisture:	ASTM D698
Relative compaction and moisture content relative to the optimum:	95%
Moisture content relative to the optimum:	-2% to +2%

2. This operation shall include any reshaping and wetting or drying required to obtain proper compaction. All soft, yielding, or otherwise unsuitable material shall be removed and replaced with suitable material.

3.03 GENERAL FILLS AND EMBANKMENTS

A. General

1. Fills and embankments not required or indicated to be designated fills shall be constructed as general fills and embankments. All fills and embankments shall be constructed to the lines and grades indicated on the drawings. Backfill materials shall be deposited in layers not to exceed 8 inches in uncompacted thickness. Unless otherwise specified herein, the following governing standards apply:

Test method to determine maximum density and moisture:	ASTM D698
Relative compaction and moisture content relative to the optimum:	95%
Moisture content relative to the optimum:	-2% to +2%

2. Backfilling and construction of fills and embankments during freezing weather shall not be done except by permission of City. No backfill, fill, or embankment materials shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill, fill, or embankment.

B. Sub-grade Preparation

1. After preparation of the fill or embankment site, the sub-grade shall be scarified and moisture conditioned to a minimum depth of 8 inches, leveled and rolled so that surface materials of the sub-grade will be at a moisture content and as compact and well bonded with the first layer of the fill or embankment as specified for subsequent layers.
2. Unless otherwise directed by City, the sub-grade shall be proof-rolled by a rubber-tired roller, a loaded dump truck, or other suitable rubber-tired equipment acceptable to City. A minimum of four passes of the proof-rolling equipment shall be provided such that the last two passes are made perpendicular to the first two passes.
3. All soft, yielding, or otherwise unsuitable material shall be removed and replaced with compacted fill.

C. Placement and Compaction

1. All fill and embankment materials shall be placed in approximately horizontal layers not to exceed 8 inches in uncompacted thickness. Material deposited in piles or windrows by excavating and hauling equipment shall be spread and leveled before compaction.

2. Each layer of material shall have the best practicable moisture content for satisfactory compaction. The material in each layer shall be wetted or dried to achieve the moisture content relative to optimum as specified above, and shall be thoroughly mixed to ensure uniform moisture content and adequate compaction. Each layer shall be thoroughly compacted to the required degree of compaction at the required moisture content. If the material fails to meet the density specified, compaction methods shall be altered. The changes in compaction methods shall include, but not be limited to, changes in compaction equipment, reduction in uncompacted lift thickness, increase in number of passes, and better moisture control.
3. Wherever a trench is to pass through a fill or embankment, the fill or embankment material shall be placed and compacted to an elevation not less than 12 inches above the top of pipe elevation before the trench is excavated.

D. Borrow Pits

1. Borrow pits are not permitted

3.04 DESIGNATED FILLS

A. General

1. Fills required or indicated to be designated fills shall be constructed using the specific materials and placement requirements as specified. In addition to the specific requirements specified herein, all requirements for general fills and embankments shall apply. These requirements include, but are not limited to organic or deleterious materials, subgrade preparation, lift thickness, and moisture conditioning requirements. All designated fills shall be constructed to the lines and grades indicated on the drawings. Backfilling and construction of fills during freezing weather shall not be done except by permission of City. No backfill, fill, or embankment materials shall be installed on frozen surfaces, nor shall frozen materials, snow, or ice be placed in any backfill, fill, or embankment.

B. Select Granular Fill

1. Granular fills shall be provided where indicated on the drawings. Granular fills shall be placed on suitably prepared sub-grades in uncompacted lift thickness of 6 inches or less and shall meet the following requirements:

Test method to determine maximum density and moisture:	ASTM D698
Relative compaction and moisture content relative to the optimum:	95%
Moisture content relative to the optimum:	-2% to +2%

2. Where granular fills are to be covered with concrete, the top surface shall be graded to the required sub-grade elevation. The completed fill shall be covered by a vapor barrier.

C. Dense Graded Base

1. The dense graded base beneath the asphaltic concrete pavement shall be placed in lift thicknesses not to exceed a compacted thickness of 6 inches per layer if using a pneumatic roller, or 8 inches if using a vibratory roller

3.05 FINAL GRADING AND PLACEMENT OF TOPSOIL

- A. After other outside work has been finished, and backfilling and embankments completed and settled, all areas that are to be graded shall be brought to grade at the indicated elevations, slopes, and contours. All cuts, fills, embankments, and other areas that have been disturbed or damaged by construction operations shall be surfaced with topsoil to a depth of 4 inches. Topsoil shall be of a quality at least equal to the existing topsoil in adjacent areas, free from trash, stones, and debris, and well suited to support plant growth.
- B. Use of graders or other power equipment will be permitted for final grading and dressing of slopes, provided the result is uniform and equivalent to manual methods. All surfaces shall be graded to secure effective drainage. Unless otherwise indicated, a slope of at least 1 percent shall be provided.
- C. Final grades and surfaces shall be smooth, even, and free from clods and stones, weeds, brush, and other debris.

3.06 DISPOSAL OF EXCAVATED MATERIALS

- A. Suitable excavated materials may be used in fills and embankments as needed. All excess excavated material shall be disposed of offsite at the expense of Contractor.
- B. All debris, stones, logs, stumps, roots, and other unsuitable materials shall be removed from the site and disposed of by, and at the expense of, Contractor.

3.07 RESTORATION

- A. All established lawn or greenspace areas cut by the line of trench, by excavation, or damaged during the work shall be restored and seeded, after completion of construction, to the complete satisfaction of the City. Refer to section 02930.

3.08 SETTLEMENT

- A. Contractor shall be responsible for all settlement of backfill, fills, and embankments which may occur within the correction period stipulated in the General Conditions.
- B. Contractor shall make, or cause to be made, all repairs or replacements made necessary by settlement within 30 days after notice from City.

END OF SECTION

ATTACHMENT "H"

CITY OF MILWAUKEE

DEPARTMENT OF PUBLIC WORKS

Erosion Control Implementation Plan

The Erosion Control Implementation Plan (ECIP) is an effort to conform to Chapter 290 of the Code of Ordinances. The ECIP shall be submitted to the City Engineer at least ten (10) working days prior to the start of any construction activity. **NO** construction activity may begin without an ECIP approved by the Department of Public Works.

<i>FOR OFFICE USE ONLY</i>		Application No. _____	
Meets Technical Standards <input type="checkbox"/>	Does Not Meet Technical Standards <input type="checkbox"/>		
Date Application Received: _____	Date all Information Received: _____	Reviewed By: _____	
Fee Paid <input type="checkbox"/>	Check No. : _____		
	APPLICANT (Contractor)	Erosion Control Consultant/Engineer	
Name			
Address			
City/State/Zip			
Phone	()		()
Relationship to Project			
Principal Contact Responsible for Installation, Maintenance and removal of erosion control measures :			
Name			
Phone	()	Fax	()
Type of Construction			
Proposed Construction Start Date			
Any public waterway within 1,000 feet of any location.	Yes <input type="checkbox"/>	No <input type="checkbox"/>	

ECIP REQUIREMENTS:

- Attach a description of erosion control devices and other best management practices to be utilized on the project(s). The description should include, but not be limited to: type of products; i.e., *Geotex Fabric*, Manufacturer's Names and Types of Equipment (i.e.; self-contained power broom)
- Attach the intended timetable and sequence of construction activities.
- Attach the intended timetable and sequence of best management practices and devices to be implemented for erosion control.
- Attach a site plan showing approximate locations(s) of erosion control devices. The site plan shall be at a scale of no less than 1" = 100'. The plan shall also indicate the direction of runoff flow, the construction limits, temporary stockpiles and any other significant information.

Upon receipt of all required information, the ECIP will be reviewed within ten (10) working days and all involved parties will be notified whether or not the plan meets technical standards.

Applicant's Signature: _____ **Date:** _____

SECTION 02930
SEEDING

PART 1 - GENERAL

1.01 SCOPE

- A. This section covers seeding to be performed after backfilling and final grading are complete. All areas disturbed by construction operations shall be treated as specified herein.
- B. All lawn, ditch, and shoulder areas that are damaged during the Work shall be restored, after completion of construction, to the complete satisfaction of City. All areas disturbed by Contractor outside the work area shall be restored, at Contractor's expense, to the satisfaction of the City. Occupying areas outside City property, street right-of-way, and utility easements for any purpose shall be done only with the written approval of the property owner and City.

1.02 GENERAL

- A. Governing Standard
 - 1. The governing standard for the seeding Work shall be Wisconsin Department of Transportation Standard Specifications for Highway and Structure Construction.
- B. Experience
 - 1. All Work shall be performed by a licensed seeding Contractor who is experienced in the type of Work required.
- C. Completion
 - 1. Seeding Work shall be completed at any time the City allows. At City's option, a portion of the final payment not to exceed one (1) percent of the contract price may be retained until acceptable a grass stand in all seeded areas is established. Seeding requirements are as follows:
 - a) Locations to be seeded: Disturbed sitework areas.
 - b) Area to be seeded: As required by the work on the drawings

1.03 SUBMITTALS

- A. All submittals of drawings and data shall be in accordance with the requirements of Section 01010 and this section.
- B. Soil Test
 - 1. A soil test for pH made of a composite sample of topsoil after finish grading shall be submitted to City. Testing shall be performed through the State Extension Service or an independent agricultural soil testing lab. Samples shall be taken and submitted in accordance with instructions from the extension service or lab. Recommendations accompanying the test shall be used for application rates of lime.

C. Invoices and Analysis Labels

1. A copy of supplier's invoices for all seed, mulch, and fertilizer which shows the quantity by weight purchased for the project and representative labels bearing the manufacturer's or vendor's guaranteed statement of analysis shall be submitted to City for review and approval to assure compliance with specified requirements for quality and application rates.

1.04 GUARANTEE

- A. Contractor shall guarantee a uniform stand of seeding, free of weeds to the extent practical, and acceptable to City.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Shipping shall be in accordance with the Shipping section. Handling and storage shall be in accordance with the Handling and Storage section.
- B. Prior to use, all products shall be kept dry and in a weatherproof location so that their effectiveness will not be impaired.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General

1. All materials shall conform to the requirements of the Governing Standard, except where otherwise specified. The source of materials shall be submitted to the City for review.

B. Starter Fertilizer

1. Fertilizer shall be a complete pelleted fertilizer. The analysis in percent by weight shall be as follows:

	<u>Seeded Areas</u>
Nitrogen	12%
Phosphorus	4%
Potassium	8%

2. Fertilizer shall be pre-mixed and packaged in standard size bags, showing weight, analysis, and name of manufacturer.

C. Seed

1. The seed mixture shall be Wisconsin Department of Transportation Seed Mixture No.40 listed as follows:

<u>Species</u>	<u>Mixture Proportions</u>
Kentucky Bluegrass	35%
Red Fescue	20%
Hard Fescue	20%
Improved Fine Perennial Ryegrass	25%

PART 3 - EXECUTION

3.01 GENERAL

- A. Execution of seeding Work shall conform to the Governing Standard, or shall be as specified herein, whichever is the most stringent.

3.02 SEEDING

A. Clearing

1. Prior to finish grading, areas to be seeded shall be cleared to remove any stumps, stones larger than 3 inches, roots, cable, wire, or other materials that might hinder subsequent seeding or maintenance

B. Finish Grading

1. Finish grading shall result in a surface conforming to the contours indicated on the drawings. Depressions shall be filled with topsoil.

C. Application of Fertilizer and Lime

1. After finish grading, any fertilizer or lime specified shall be applied uniformly to areas to be seeded.
2. Fertilizer application rate shall be according to the manufacturer's recommended rate.
3. Following application, fertilizer shall be harrowed or disked into the soil.

D. Seed Application

1. Seed shall be applied within 72 hours after preparation of the seedbed. Seed shall be applied with equipment designed to give uniform application. Any method or combination of methods which uniformly distributes the seed directly in contact with the soil, covers the seed, and firms the bed, may be selected. Seed shall be placed approximately 1/4 inch below the surface at a rate of 2 lbs/1000 sq ft.

E. Mulching

1. All seeded areas shall be mulched within 24 hours following seed application. Mulch shall be anchored with a mulch anchoring tool designed to punch the mulch into the top surface of the soil at a minimum depth of 1 ½ inches. The mulching operation shall be in general accordance with the Governing Standard. Mulch shall be placed at a rate of 1 ½ to 3 tons/acre. Mulch material shall be straw.

3.03 WATERING

- A. Seeded areas shall be thoroughly watered after application of seed and mulch. Subsequent watering for seeded areas will not be required; however, Contractor shall guarantee a uniform stand by seeding that is free of weeds to the extent practical, and acceptable to City.

3.04 REPLANTING

- A. Unacceptably seeded areas shall be overseeded or completely reseeded as instructed by City. Unless otherwise permitted by City, reseeded shall be performed during the next planting season.

3.05 MAINTENANCE

- A. All areas shall be maintained until final acceptance of the project. Maintenance shall include any necessary reseeded, repair of erosion damage, and replacement of displaced mulch until covered with seedlings. In the event erosion occurs from watering operations or rainfall, such damage shall be repaired.

END OF SECTION

SECTION 03301
CONCRETE

PART 1 - GENERAL

1.01 SCOPE

- A. This section covers all cast-in-place concrete, including reinforcing steel, forms, finishing, curing, and appurtenant work. All concrete shall be air-entrained.

1.02 GENERAL

- A. All cast-in-place concrete shall be accurately formed and properly placed and finished as indicated on the drawings and as specified herein.

1.03 SUBMITTALS

- A. All submittals of drawings and data shall be in accordance with the requirements of Section 01010 and this section.
- B. Schedule and Sequence of Placing Concrete.
- C. Drawings Showing Location of Construction Joints, if different from that shown.
- D. Concrete Mix Design.
- E. Certification for Aggregate Quality, including a statement from an independent laboratory that the aggregates to be used are not reactive.
- F. Product Data: Provide data on joint devices, attachment accessories, bonding agents, adhesive anchor systems and admixtures.
- G. Manufacturer's Installation Instructions: Indicate installation procedures and interface required with adjacent Work.

1.04 STORAGE AND HANDLING

- A. Cement shall be stored in suitable moistureproof enclosures. Cement which has become caked or lumpy shall not be used.
- B. Aggregates shall be stored so that segregation and the inclusion of foreign materials are prevented. The bottom 6 inches of aggregate piles in contact with the ground shall not be used.
- C. Reinforcing steel shall be carefully handled and shall be stored on supports that will prevent the steel from touching the ground.

PART 2 - PRODUCTS

2.01 LIMITING REQUIREMENTS

- A. General
 - 1. Unless otherwise specified, concrete shall be controlled within the following limited requirements.
- B. Cement Content

1. The quantity of Portland cement in the concrete shall be not less than that indicated in the following table:

Quantity of Cement (lb/yd ³)			
Coarse Aggregate Size from No. 4 Sieve to ---			
3/8 in.	1/2 in.	3/4 in.	1 in.
600	580	560	535

C. Maximum Water-Cementitious Ratio

1. The maximum water-cementitious ratio shall be 0.45 on a weight basis. If fly ash is used, the combined mass of cement plus fly ash shall be used to determine the water-cementitious materials ratio.

D. Fly Ash Content

1. At the option of the Contractor, fly ash may be substituted for up to 25 percent of the portland cement, but not less than 15 percent, on the basis of 1.0 lbs of fly ash added for each lb [kilogram] of cement reduction.

E. Coarse Aggregate

1. The maximum nominal coarse aggregate size shall be not larger than 1 inch [25 mm].

F. Slump

1. Concrete slump shall be kept as low as possible consistent with proper handling and thorough compaction. Unless otherwise authorized by the City, slump of concrete without a superplasticizer shall not exceed 4 inches. Slump of concrete with a superplasticizer, or a midrange water reducer, shall not exceed 8 inches.

G. Total Air Content

1. The total volumetric air content of concrete after placement shall be 6 percent \pm 1 percent.

H. Admixtures

1. The admixture content, batching method, and time of introduction to the mix shall be in accordance with the manufacturer's recommendations. A water-reducing admixture and an air-entraining admixture shall be included in all concrete. A midrange water reducer or a superplasticizer may be used at the Contractor's option. No calcium chloride or admixture containing chloride from sources other than impurities in admixture ingredients will be acceptable.

I. Strength

1. The minimum acceptable compressive strengths, as determined by ASTM C39 with 6 inch diameter by 12 inch cylinders, shall be:

Age	Minimum Compressive Strength
7 days	3,375psi
28 days	4,500psi

2.02 MATERIALS

Cement	ASTM C150, Type II or I/II, low alkali.
Fly Ash	ASTM C618, Class F, except loss on ignition shall not exceed 4 percent.
Fine Aggregate	Clean natural sand, ASTM C33. Artificial or manufactured sand will not be acceptable.
Coarse Aggregate	Non-reactive crushed rock, washed gravel, or other inert granular material conforming to ASTM C33, class 4S, except that clay and shale particles shall not exceed 1 percent.
Water	Potable.
<u>Admixtures</u>	
Water-Reducing	ASTM C494, Type A or D.
Air-Entraining	ASTM C260.
Superplasticizing	ASTM C494, Type F or G.
<u>Reinforcing Steel</u>	
Bars	ASTM A615, Grade 60, deformed.
Welded Wire Fabric	ASTM A185 or A497.
Bar Supports	CRSI Class 1, plastic protected; or Class 2, stainless steel protected.
Mechanical Connector (Couplers or Form Savers)	Classified Type 2 per ACI 318-02 or per UBC-97. Use only where indicated on the drawings.
<u>Water stops</u>	
Metal, at construction joints	Uncoated carbon steel, 12 gage, size as indicated on the drawings.

PVC, at construction joints	Extruded, virgin, elastomeric, polyvinyl chloride (PVC), white (no pigment), flat, ribbed, 3/8 inch thick. Reclaimed material will not be acceptable. Provide hog rings or grommets spaced at 12 inches on center entire length.
For concrete sections less than 12 inches in thickness	6 inches wide, 3/8 thick; Greenstreak "679" or Vinylex "R6-38"
For concrete sections 12 inches or more in thickness	9 inches wide, 3/8 inch thick; Greenstreak "646" or Vinylex "R9-38"

Forms

Plywood Product	Standard PS1, waterproof, resin-bonded, exterior type, Douglas fir.
Lumber	Straight, uniform width and thickness, and free from knots, offsets, holes, dents, and other surface defects.
Form Coating	Nonstaining and nontoxic after 30 days, VOCcompliant; Burke "Form Release (WB)", L&M Chemical "E Z Strip", Nox-Crete "Form Coating", or Symons "Thrift Kote E".
Pre-Cure Finishing Aid	Burke "Finishing Aid Concentrate", Euclid "Eucbar", L&M Chemical "E-Con", Master Builders "Confilm", or Sika "Sikafilm".

Membrane Curing Compound and Floor Sealer

VOC – EPA	ASTM C1315, Type I, Class A, maximum VOC 5.8 lb/gal [700 g/L], minimum 25 percent solids, acrylic, nonyellowing, unit moisture loss 0.40 kg/m ² maximum in 72 hours.
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2.03 PRELIMINARY REVIEW

- A. The source and quality of concrete materials and the concrete proportions proposed for the work shall be submitted to the City for review before concrete is placed.

2.04 FORMS

A. General

- Forms shall be designed to produce hardened concrete having the shape, lines, and dimensions indicated on the drawings. Forms shall be substantial and sufficiently tight to prevent leakage of mortar and shall be maintained in proper position and accurate alignment.

2. Forms for pavement, curbs, or gutters shall be made of steel and shall be supported on thoroughly compacted earth. The top face of pavement forms shall not vary from a true plane more than 1/4 inch in 10 feet.
3. Forms shall be thoroughly cleaned and oiled before concrete is placed.
4. Where concrete is placed against gravel or crushed rock which does not contain at least 25 percent material passing a No. 4 sieve, such surfaces shall be covered with polyethylene film to protect the concrete from loss of water. Joints in the film shall be lapped at least 4 inches.

B. Form Ties

1. Form ties shall be of the removable end, permanently embedded body type, and shall have sufficient strength and rigidity to support and maintain the form in proper position and alignment without the use of auxiliary spreaders.

C. Edges and Corners

1. Chamfer strips shall be placed in forms to bevel all salient edges and corners, except the top edges of walls and slabs which are to be tooled and edges which are to be buried. Unless otherwise noted, bevels shall be 3/4 inch wide.

D. Form Removal

1. Forms shall not be removed or disturbed until the concrete has attained sufficient strength to safely support all dead, live, and construction loads. Care shall be taken in form removal to avoid surface gouging, corner or edge breakage, and other damage to the concrete.

2.05 REINFORCEMENT

- A. Reinforcement shall be accurately formed and positioned and shall be maintained in proper position while the concrete is being placed and compacted. Unless otherwise indicated on the drawings, the details of fabrication shall conform to ACI 315 and 318. In case of conflict, ACI 318 shall govern.
- B. Reinforcement shall be free from dirt, loose rust, scale, and contaminants.
- C. Mechanical connections shall be used only as indicated on the drawings.

2.06 BATCHING AND MIXING

A. General

1. Concrete shall conform to ASTM C94 and shall be furnished by an acceptable ready-mixed concrete supplier.

B. Consistency

1. The consistency of concrete shall be suitable for the placement conditions. Aggregates shall float uniformly throughout the mass, and the concrete shall flow sluggishly when vibrated or spaded. The slump shall be kept uniform.

C. Delivery Tickets

1. A delivery ticket shall be prepared for each load of ready-mixed concrete and a copy of the ticket shall be handed to the City by the truck operator at the time of delivery. Tickets shall indicate the name and location of the concrete supplier, the project name, the mix identification, the quantity of concrete delivered, the quantity of each material in the batch, the outdoor temperature in the shade, the time at which the cement was added, and the numerical sequence of the delivery.

PART 3 - EXECUTION

3.01 PREPARATION

A. General

1. Contractor to verify all forms and reinforcement have been properly set and installed per drawings and specifications prior to placement of concrete.

B. Preparation of Existing Concrete

1. Prepare previously placed concrete by cleaning with steel brush or, (where indicated on the plans) by scarification to a minimum of 1/4 inch, and applying bonding agent in accordance with manufacturer's instructions.
2. In locations where new concrete is doweled to existing work, drill holes in existing concrete, clean holes, insert and adhesive anchor steel dowels into concrete. Hole size and use of adhesive anchor in accordance with manufacturer recommendations.

3. Bonding Agent

- a) Duralprep A.C., manufactured by Euclid Chemical Company.
- b) Armatec 110, manufactured by Sika
- c) Daraweld C, manufactured by Grace Construction Products
- d) Approved Equal.

4. Adhesive Anchor Doweling System

- a) AC 100+ Gold Fastener by Powers Fasteners Inc.
- b) Acrylic-Tie by Simpson Strong Tie Company
- c) Approved Equal

3.02 PLACEMENT

A. General

1. The Contractor shall inform the City at least 24 hours in advance of the times and places at which he intends to place concrete.
2. Methods of conveying concrete to the point of final deposit and of placing shall prevent segregation or loss of ingredients. During and immediately after placement, concrete shall be thoroughly compacted and worked around all reinforcement and embedments and into the corners of the forms. Concrete shall be compacted by immersion-type vibrators, vibrating screeds, or other suitable

mechanical compaction equipment. The use of "jitterbug" tampers to compact concrete flatwork will not be permitted.

3. Ensure reinforcement, inserts, embedded parts and formed expansion and contraction joints are not disturbed during concrete placement.
4. Place concrete continuously between predetermined expansion, control and construction joints.
5. Do not interrupt successive placement; do not permit cold joints to occur.

3.03 WATER STOPS

A. General

1. Each water stop shall be continuous throughout the length of the joint in which it is installed. Water stops shall be clean, free from coatings, and shall be maintained in proper position until surrounding concrete has been deposited and compacted.
2. Junctions between adjacent sections of metal water stops shall be lapped 5 inches and securely bolted, screwed, or spot welded together.
3. Junctions between adjacent sections of elastomeric (PVC) water stops shall be spliced in strict conformity with the recommendations of the manufacturer.
4. Directional changes and intersections shall be factory fabricated by the water stop manufacturer prior to delivery to the site of the work. Field splices will be acceptable only in straight sections.

3.04 FINISHING

A. General

1. Recesses from form ties shall be filled flush with mortar. Fins and other surface projections shall be removed from all formed surfaces, except exterior surfaces that will be in contact with earth backfill.
2. Unless otherwise specified, unformed surfaces shall be screeded and given an initial float finish as soon as the concrete has stiffened sufficiently for proper working. Any piece of coarse aggregate which is disturbed by the float or which causes a surface irregularity shall be removed and replaced with mortar. Initial floating shall produce a surface of uniform texture and appearance, with no unnecessary working of the surface.
3. Initial floating shall be followed by a second floating at the time of initial set. The second floating shall produce a finish of uniform texture and color and the completed finish for unformed surfaces unless indicated otherwise.

B. Troweling

1. Interior floor surfaces which will be exposed after construction is completed; exposed top surfaces of equipment bases and interior curbs; and other surfaces designated on the drawings shall be steel trowel finished. Troweling shall be performed after the second floating when the surface has hardened sufficiently to prevent an excess of fines being drawn to the surface. Troweling shall

produce a dense, smooth, uniform surface free from blemishes and trowel marks.

C. Application of Pre-Cure Finishing Aid

1. Concrete flatwork subject to rapid evaporation due to hot weather, drying winds, and sunlight shall be protected with a pre-cure finishing aid. The finishing aid shall form a monomolecular film on the surface of fresh, plastic concrete to retard evaporation.
2. Immediately following screeding, pre-cure finishing aid shall be sprayed over the entire surface of fresh, plastic concrete flatwork at a rate of not less than 200 square feet per gallon in accordance with the manufacturer's recommendations. The spray equipment shall have sufficient capacity to continuously spray finishing aid at approximately 40 psi with a suitable nozzle as recommended by the manufacturer.
3. The sprayable solution shall be prepared as recommended by the manufacturer.
4. Under severe drying conditions, additional applications of finishing aid may be required following each floating or troweling, except the last finishing operation.

3.05 CURING

A. General

1. Concrete shall be protected from loss of moisture by water saturation or by membrane curing for at least 7 days after placement; however, when concrete is also being protected from low temperatures, the period of curing by saturation shall be 1 day less than the duration of the low temperature protection.
2. Water saturation shall be used on concrete which will be covered later with mortar or additional concrete. Water saturation or membrane curing compound may be used on all other concrete surfaces.
3. Water saturation of concrete surfaces shall begin as soon as possible after initial set. Unformed surfaces shall be covered with polyethylene film, tarpaulins, or sand to retain the water. Water shall be applied as often as necessary to keep the concrete saturated for the entire curing period. Acceptable methods of water curing are described in ACI 308.
4. Membrane curing compound shall be sprayed at a coverage rate of not more than 300 square feet per gallon. Unformed surfaces shall be covered with curing compound within 30 minutes after final finishing. If forms are removed before the end of the specified curing period, curing compound shall be immediately applied to the formed surfaces. Curing compound shall be suitably protected against abrasion during the curing period.
5. Concrete shall be protected against freezing for at least 8 days after placement.

3.06 REPAIRING DEFECTIVE CONCRETE

A. General

1. Defects in concrete surfaces shall be repaired to the satisfaction of the City. All concrete which is honeycombed or otherwise defective shall be cut out and removed to sound concrete, with edges cut square to avoid feathering.
2. Concrete repair work shall conform to Article 5.3.7 of ACI 301 and shall be performed in a manner that will not interfere with thorough curing of surrounding concrete. Repair work shall be adequately cured.

3.07 FIELD CONTROL TESTING

A. Air Content

1. An air content test shall be made on concrete from each batch of concrete from which concrete compression test cylinders are made. The Contractor shall provide all equipment and supplies necessary for the testing. Air content shall be determined in accordance with ASTM C231.

B. Slump

1. A slump test shall be made on concrete from each batch of concrete from which concrete compression test cylinders are made. Slump shall be determined in accordance with ASTM C143.

C. Test Cylinders

1. Compression test specimens shall be made, cured, stored, and delivered to the laboratory in accordance with ASTM C31 and C39.
2. Compressive strength tests will be evaluated in accordance with ACI 318 and as specified herein.
3. One set of 6 inch diameter by 12 inch concrete test cylinders shall be cast for each concrete pour. A set of test cylinders shall consist of four cylinders, two to be broken and to have compressive strengths averaged at 7 days, and two to be broken and to have compressive strengths averaged at 28 days. All concrete required for testing shall be furnished by, and at the expense of, the Contractor.
4. The cured cylinders shall be tested by an independent testing laboratory approved by the City at the expense of Contractor.

END OF SECTION

SECTION 03600
GROUT

PART 1 - GENERAL

1.01 SCOPE

- A. This section covers procurement and installation of grout. Unless otherwise specified, only non-shrink non-metallic grout shall be furnished.

1.02 SUBMITTALS

- A. All submittals of drawings and data shall be in accordance with the requirements of Section 01010 and this section.
- B. A letter of certification indicating the types of grout to be supplied and the intended use of each type shall be submitted.

1.03 DELIVERY, STORAGE AND HANDLING

- A. Materials shall be handled, transported, and delivered in a manner which will prevent damage of any kind. Materials shall be protected from moisture.

PART 2 - PRODUCTS

2.01 NON-SHRINK NON-METALLIC GROUT

- A. Non-shrink non-metallic grout shall be furnished factory premixed so that only water is added at the jobsite.
- B. Non-shrink non-metallic grout shall be in accordance with ASTM C1107.

2.02 WATER

- A. Water shall be clean and free from deleterious substances.

PART 3 - EXECUTION

3.01 PREPARATION

- A. The concrete foundation to receive non-shrink grout shall be saturated with water for at least 12 hours preceding grouting unless additional time is required by the grout manufacturer.

3.02 INSTALLATION

- A. Mixing
 - 1. Grout shall be mixed in a mechanical mixer. No more water shall be used than is necessary to produce a flowable grout.
- B. Placement
 - 1. Unless otherwise specified or indicated on the drawings, grout under baseplates shall be 1-1/2 inches [38 mm] thick. Grout shall be placed in strict accordance with the directions of the manufacturer so that all spaces and cavities below the baseplates are completely filled without voids. Forms shall be provided where structural components of baseplates will not confine the grout.

C. Edge Finishing

1. In all locations where the edge of the grout will be exposed to view, the grout shall be finished smooth after it has reached its initial set. Except where shown to be finished on a slope, the edges of grout shall be cut off flush at the baseplate.

D. Curing

1. Nonshrink grout shall be protected against rapid loss of moisture by covering with wet cloths or polyethylene sheets. After edge finishing is completed, the grout shall be wet cured for at least 3 days and then an acceptable membrane curing compound shall be applied.

END OF SECTION

SECTION 09900
PAINING

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. Provide all labor and materials to a complete painting job and related work as specified. The job consists of, but is not limited to, the following principal items:
 - 1. Blast cleaning and painting of interior surfaces of the centrifugal water pumps, piping and valves.
 - 2. Touch-up painting of the exterior surfaces of the pumps, pipes, valves and motor components surfaces that are damaged during reassembly as determined by field Engineer.

1.02 GENERAL CONDITIONS

- A. All work performed and all material furnished and installed under this contract shall be in complete conformance with applicable sections of Governing Codes and Standards; especially as required under U.S. Department of Labor-Occupational Safety and Health Act (OSHA) and United States Environmental Protection Agency (EPA).

1.03 SUBMITTALS

- A. All submittals of drawings and data shall be in accordance with the requirements of Section 01010 and this section.
- B. Provide product data on painting material.
- C. Submit manufacturers' application instructions.
- D. Submit paint color charts for approval.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in sealed and labeled containers; inspect to verify acceptance.
- B. Container labeling shall include manufacturer's name, type of paint, brand name, brand code, coverage, surface preparation, drying time, cleanup, color designation and instructions for mixing and reducing.
- C. Store paint materials at minimum ambient temperature of 45°F and a maximum of 90°F, in well ventilated area, unless required otherwise by manufacturer's instructions.
- D. Take precautionary measures to prevent fire hazards and spontaneous combustion.

PART 2 - PRODUCTS

2.01 PUMP, PIPE & VALVE INTERIOR SURFACES

- A. Primer:

1. TNEMEC Series 20 Porta-Pox II or equal
 2. 8 mils Dry Film Thickness (DFT)
 3. Color: Approved by CITY
- B. Finish Coat:
1. TNEMEC Series 20 Porta-Pox II or equal
 2. 8 mils DFT
 3. Color: Approved by CITY
- 2.02 PUMP, PIPE & VALVE EXTERIOR SURFACES
- A. Primer:
1. TNEMEC Series 30 or equal
 2. 8 mils DFT
 3. Color: Approved by CITY
- B. Finish Coat:
1. TNEMEC Series 30 or equal
 2. 8 mils DFT
 3. Color: Approved by CITY
- 2.03 MOTOR EXTERIOR
- A. Primer:
1. TNEMEC Series 30 or equal
 2. 8 mils DFT
 3. Color: Approved by CITY
- B. Finish Coat:
1. TNEMEC Series 30 or equal
 2. 8 mils DFT
 3. Color: Approved by CITY

PART 3 - EXECUTION

3.01 PROTECTION

- A. Protect elements surrounding the work from damage or disfiguration.
- B. Repair damage to other surfaces caused by the work.
- C. Furnish drop cloths, shields and protective methods to prevent dust, spray or drippings from disfiguring other surfaces. Electrical controls, gauges, pipe openings and other equipment in the compressor station shall be covered completely.

3.02 SURFACE PREPARATION

- A. Remove all dirt, mill scale, rust, paint, oxide, corrosion products and other foreign matter by commercial blast cleaning per SSPC-SP6. This preparation shall apply to all interior pump, pipe and valve parts.
- B. Remove all dirt, mill scale, rust, paint, oxide, corrosion products and other foreign matter by using hand held power tools to the extent of an SSPC-SP11 (Power tool cleaning to bare metal.) This preparation shall apply to the motor and exterior pump, pipe and valve parts.
- C. Roughen tightly adhered surfaces by using hand held disc abraders equipped with rough textured surface. Place extra emphasis on fasteners, fittings and gaps between flanges.
- D. Care shall be taken to roughen the substrate than polishing it. Blow down with compressed air before priming.

3.03 PAINT APPLICATION

- A. Apply paint in accordance with manufacturer's instructions.
- B. Paint application shall be by spray, roller or brush. Painting method shall be approved by the CITY.
- C. Coating shall be applied uniformly, free from runs, skips, streaks or brush marks.
- D. Allow a minimum of 24 hours to cure the first coat before applying second coat of paint.

3.04 CLEANING

- A. As work proceeds, promptly remove paint where spilled, splashed or spattered.
- B. During progress of work, maintain premises free of unnecessary accumulation of tools, equipment, surplus materials and debris.
- C. Collect cotton waste, cloths and other material which may constitute a fire hazard; place in closed metal containers and remove from site daily.

END OF SECTION

SECTION 15100
PIPING, VALVES & FITTINGS

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. Furnish and install all piping modifications, valves and fittings relating to the complete removal of water Pump #3, relocation of existing Pump #2 to new foundation of Pump #3, and installation of a new Pump #2 with VFD. Work shall include replacement of four (4) gate valves with four (4) new butterfly valves, and the replacement of two (2) butterfly valves with two (2) new ball type valves. The piping modifications shall be complete with all fittings, flanges, anchors, anchor bolts, gaskets, bolts and nuts, pipe supports, appurtenances and accessories for proper installation and functioning of the pumping/piping system.
- B. Contractor shall remove the existing 36" Check Valve designated as 19D, located on the existing 36" Discharge piping, and replace it with a 36" Butterfly valve with a DC modulating electric operator. This valve will be remotely controlled by the City SCADA System.

1.02 SUBMITTALS

- A. All submittals of drawings and data shall be in accordance with the requirements of Section 01010 and this section.
- B. The required SUBMITTALS shall include drawings, design calculations, specifications, piping and valve layouts and execution drawings. **NO PIPE, FITTINGS, VALVES OR SPECIALS SHALL BE MANUFACTURED UNTIL ALL SUBMITTALS HAVE BEEN APPROVED BY THE CITY.**

PART 2 - PRODUCTS

2.01 PIPING

- A. Steel piping shall be Schedule 40, with a minimum nominal wall thickness of 0.5000 inches. Pipe shall be of the nominal diameter (size) as indicated on the drawings and shall conform to all requirements of AWWA Standard C200, ASTM A139 Grade B, and ANSI B16.5. Piping shall be carbon steel and be one of the following:
 - 1. Seamless or ERW pipe manufactured according to ASTM A-53 Grade B.
 - 2. Spiral butt-weld pipe manufactured according to ASTM A-139 Grade B, ASTM A-252 Grade 2 or 3 and ASTM A-211.
- B. Fabricated pipe shall have all seams butt-welded. Pipe shall have no more than two (2) longitudinal seams. Girth seams shall be spaced not less than six (6) feet apart except in specials and fittings.

2.02 FLANGES

- A. All flanges shall be AWWA Class D, hub type, steel slip-on flanges conforming to the requirements of AWWA C207-07, Table 3. All flanges shall be flat faced with

concentric or spiral serrated finish, shall be back-faced or spot-faced on the back and shall have bores suitable for the pipe on which they will be installed.

2.03 BOLTS AND NUTS

- A. Flanges shall be bolted with bolt-stud and nuts. Bolts for AWWA flanges shall be of the diameters set forth in Table 3 of AWWA C207-07. Bolts, studs and nuts shall be carbon steel A307, Grade B, without heat treatment other than stress relief. Bolt heads and nuts shall be hexagonal.

2.04 FLANGE GASKETS

- A. All flange gaskets shall be of the full-faced type and made from 1/16-inch Garlock Style 3000 "Blue-Gard Compressed Gasketing", or approved equal.

2.05 WELDED JOINTS

- A. Basic requirements for all welds are that they be sound, free from embedded scale and slag, have a tensile strength across the weld not less than that of the thinner of the connected sections, and that all pipe welds be water-tight. Butt welds shall be used for all shop-welded joints in pipe, fittings, and specials except where fillet welds are specified or shown. Fillet welds shall be used for flange attachment in accordance with AWWA C207-07, Section 4.3. Fillet welds shall also be used in fabrication of pipe reinforcement, and in other locations where shown on the plans. Weld test specimens shall be furnished whenever requested by the Inspector. This contractor shall adhere to the requirements of AWWA C206 and shall furnish the operator certificates prior to any field welding.
- B. The use of back-up welding strips or rings for shop or field butt welds will not be permitted. Welding of field joints shall conform to the applicable requirements of AWWA C206.
- C. Leaks in welds shall be repaired by removing the defective material which caused the leak in each case and re-welding. No leak shall be repaired by mechanical caulking.

2.06 PROTECTIVE COATING

- A. The interior surfaces of the steel pipes, specials and fittings shall be prepared, primed and coated in accordance with Section 09900 of the specifications and the paint manufacturer's recommendations.
- B. Interior valve surfaces shall be coated and painted in accordance with AWWA C504 and AWWA C507. Extreme care shall be taken to prevent damage to resilient seat material.
- C. Exterior surfaces shall be prepared, primed and coated in accordance with Section 09900 of the specifications and the paint manufacturer's recommendations.

2.07 BUTTERFLY VALVES

- A. Valves shall be of the size indicated on the plans and shall be of the tight closing, rubber-seat type that fully complies with the latest revision of AWWA Standard C504 class 150. Valves shall be satisfactory for throttling service and frequent operation. Valve discs shall rotate 90° from the full open position to the tight shut position. Angular misposition of the disc shall be 1° off center without leakage. Valves shall meet the following requirements:
1. Valve Body and Flanges: All valve bodies shall be cast iron, ASTM A-126 Class B, narrow body design. Flange drilling shall be in accordance with ANSI B16.1 standard for cast iron flanges. Body thickness shall be in strict accordance with AWWA C504 where applicable.
 2. Valve Disc: All valve discs shall be constructed of ductile iron, ASTM A-536, with stainless steel seating edge. A built in adjustable stop shall limit disc rotation in the open position and shall limit disc rotation at any point between the one-half and the full open position. Disc and shaft connection shall be made with stainless steel pins.
 3. Valve Shafts: All shafts shall be turned, ground and polished and constructed of 18-8 Type 316 stainless steel. Shafts shall be two-piece, stub-type keyed for operator connection. Shaft diameters shall meet minimum requirements of AWWA C504 for Class 150.
 4. Valve Seat: All seats shall be of a synthetic rubber compound (HYCAR). Seats shall be retained in the valve body by mechanical means without retaining rings, segments, screws or hardware of any kind in the flow stream. Seats shall be a full 360° without interruption and have a plurality of grooves mating with a spherical disc edge-seating surface. All valve seats shall be field adjustable around the full 360° circumference and replacement without dismantling the operator, disc or shaft and without removing the valve from the pipeline. Manufacturer shall certify that seat is field replaceable.
 5. Valve Bearings: All valves shall be fitted with sleeve-type bearings. Bearings shall be corrosion resistant and self-lubricating.
 6. Valve Packing: On valve 30" and larger, the packing will be V-type. All packing shall be self adjusting and wear compensating. Valve packing arrangement shall be designed so that the actuator removal will not result in packing seal failure.
 7. Valve Tests: Hydrostatic and leakage tests shall be conducted in accordance with AWWA C504 for Class 150. Valves shall be factory tested with proper written certification provided of meeting requirements. Valves shall also be field tested to verify that valve is tight closing and leak-free after operators are installed.

8. Proof of Design: The manufacturer furnishing valves shall provide written certification that the valves proposed meet the design requirements of AWWA C504.

B. MANUAL OPERATOR:

1. Manual operator for the butterfly valves shall have all gearing totally enclosed.
2. Operator mounting arrangement will be indicated on shop drawings.
3. Operators shall be as manufactured by Philadelphia Gear Corp. or an approved equal.
4. Each operator shall have a torque rating as hereby specified. Valve operators shall be designed to produce the specified out-put torque with a hand wheel pull of 40 pounds.
5. Hand wheels shall have a diameter of not greater than 24" for valves 30" or smaller, and a diameter of not greater than 30" for valves 36" and larger.
6. Each hand wheel shall rotate counterclockwise to open the valve. Hand wheels shall have cast thereon the word "OPEN" and an arrow indicating the direction to open.
7. Hand wheels shall be identified by tagging with valve number, or be securely mounted to the operator in the operating position at the factory before shipment.
8. All valves shall be equipped with a position indicator that will indicate the position of the disc at all times.

C. LIMIT SWITCHES

1. Two limit switches shall be mounted in watertight enclosures and will be used for remote indication of valve position of the suction and isolation butterfly valves.
2. Limit switches shall be securely mounted and shall be operated by the pointer of the valve position indicator.
3. One switch shall be arranged to have its contacts open only when the valve is full open, and the other shall be arranged to have its contacts open only when the valve is full closed. The contacts of both switches shall be closed when the valve is partially open. These contacts shall be of the heavy-duty type and shall be rated for at least 1 ampere at 130 VDC.

D. WARRANTY

1. The rubber-seated butterfly valves and torque units shall be warranted for a minimum of five (5) years from the date of installation.

E. VALVE MANUFACTURER:

1. Butterfly valves shall be as manufactured by:
 - a) DeZURIK

- b) Henry Pratt Company
- c) Milliken Valve Company
- d) Approved Equal

2.08 BALL VALVE

- A. **GENERAL:** The pump will be started against the valve in the closed position. The valve will be required to cycle on each pump start. The valve and operator shall be expressly designed for a high frequency of operations under service conditions. The valve drive unit and its controller shall be designed to perform normally at low-speed during both the opening and closing operations, but to perform part of the closing operation at high-speed during emergency conditions.
- B. Ball valve construction shall be in complete accordance with the latest revision of AWWA Standard C507. The ball valve shall be designed for seating and unseating using rotary motion only. Valve shall be of the metal-to-metal seated type, rated for 150-psig service. The ball valve shall be a product of a manufacturer regularly engaged in the design and manufacture of this specific type of valve for a minimum of five (5) years. The ball valve shall consist of four (4) main elements:
 - 1. A valve body having a waterway inlet and outlet diameters equal to the nominal size of the valve.
 - 2. A rotatable ball closing element having a clear waterway diameter equal to the nominal size of the valve.
 - 3. A torque unit operating mechanism that can be attached to a motorized operator.
 - 4. Electric motor, hydraulic or manual operator.
- C. Ball Valve shall meet the following criteria:
 - 1. Valve Body and Flanges: Ball valve body shall be constructed of cast iron with a full, unrestricted circular inlet and outlet, with nominal diameter equal to the rated size of the valve. The valve body shall have flanges conforming to ANSI B16.1, Class 125lb, and shall house the ball. Also, the ball valve body shall have integrally cast, bronze bushed trunnions. Bronze bushing for body shall be ASTM B584-C93200. It shall provide rigid means for supporting the torque unit without the necessity of additional supports. The body shall have two (2) rigidly attached corrosion resistant metal seats made of 400 series MONEL metal. The body seats shall be machined, ground and polished to provide for a matched and tapered fit with the ball seats. There shall be two (2) pipe connections, one for an air vent and the other for a drain.
 - 2. Ball: The ball element shall be constructed of cast iron and have a full, unrestricted circular inlet and outlet, with nominal diameter equal to the body inlet and outlet diameter. The ball shall have integrally cast, bronze trunnions. Bronze journal for ball shall be ASTM B584-C93200. An operating shaft constructed of 17-4 high strength stainless steel shall connect to and extend from one trunnion. The operating shaft shall extend through the valve body, passing through a sealing device (o-ring retainer) and connecting to the torque unit.

The operating shaft shall be chrome plated where it passes through the sealing device. The sealing device shall be capable of being removed and having its seals replaced with the line under pressure, without removing the valve from the line. The ball shall have two (2) corrosion resistant metal seats of 300 series stainless steel rigidly attached and fully adjustable to provide drop-tight sealing in one or both directions. The ball shaft shall be so designed that the factor of safety for all combined stresses shall be at least five to one. Maximum torsional deflection shall not exceed 1/6 degree per foot of unsupported length using a seat coefficient of friction of 0.5 and a bearing coefficient of friction of 0.3. All materials of the ball element subject to friction shall be of significant differential hardness to prevent galling. The shaft shall be protected against corrosion where in contact with water.

3. Operating Mechanism: The valve operating mechanism (torque unit) shall employ a traveling crosshead to impart positive rotary movement to the ball element by means of a link and lever connected to a ball shaft. A ball shaft support bearing shall be connected to the ball shaft. The torque unit shall be designed so that during the initial 50% of stroke in closing, the flow area is reduced by approximately 81%. The remaining flow area shall be gradually reduced to a complete shutoff throughout the last 50% of stroke in closing. There shall be no rubbing between the body and ball seats during the opening and closing operation. The torque unit shall be cast iron construction and be designed to accept manual, hydraulic or electric motor actuators. All materials of the torque unit subject to friction shall be of significant differential hardness to prevent galling. The ball valve shall be provided with a position indicator that will indicate the position of the ball at all times. The torque unit shall be capable of being inspected, lubricated, removed and repaired without removing the valve proper from the line. The torque unit shall also be designed so that the o-ring seals on the main shaft can be replaced without removing the torque unit housing and while the valve is in the line under pressure.

D. **MATERIALS**: The materials of construction shall be as follows:

- | | | |
|----|-------------|---|
| 1. | Body Halves | a) Gray Cast Iron ASTM A48 CL35
b) Ductile Iron ASTM A536, grade 65-45-12 |
| 2. | Body Flange | a) Gray Cast Iron ASTM A48 CL35
b) Ductile Iron ASTM A536, grade 65-45-12 |
| 3. | Ball | a) Gray Cast Iron ASTM A48 CL35
b) Ductile Iron ASTM A536, grade 65-45-12 |
| 4. | Body Seats | 400 Series MONEL |
| 5. | Ball Seats | 300 Series Stainless Steel |
| 6. | Ball Shaft | Chrome Moly Steel ASTM A322 Grade, 4140/42
with Hard Chrome Plating through Seal Chamber |
| 7. | Shaft Seals | Solid VEE Packing Set of Glass Reinforced Nylon
and Polyester Based Elastomer |

- 8. Torque Unit Housing
 - a) Gray Cast Iron, ASTM A48, Class 35
 - b) Ductile Iron ASTM A536, grade 65-45-12

E. POSITION INDICATOR:

- 1. The position indicator mounted on the torque unit shall be heavy cast iron and operate over large cast markings on the torque unit cover.

F. WARRANTY:

- 1. The metal-seated ball valves and torque units shall be warranted for a minimum of five (5) years from the date of installation.

G. VALVE MANUFACTURER:

- 1. Ball valves shall be as manufactured by:
 - a) APCO Willamette
 - b) Henry Pratt Company
 - c) Approved Equal

2.09 ELECTRIC MOTOR ACTUATORS

- A. Ball valves as indicated on plans and the 36" Butterfly valve shall be equipped with new electrical motor actuator, complete with motor, reduction gearing, hand wheel mechanism, limit switches, torque switch, lubricants, heating elements, internal wiring, etc., enclosed in waterproof and weatherproof type NEMA-4 construction. The electric motor actuator shall be the latest standard product of a manufacturer whose electric actuators have been produced and have given satisfactory operating service for a period of not less than 5 years.
- B. Valve actuator shall conform to the operating requirements of the latest edition of AWWA standard C542 "Electric Motor Actuators for Valves and Slide Gates", and as specified herein.
 - 1. The rated torque capability of each actuator shall be sufficient to seat, unseat and rigidly hold in any intermediate position, the valve disc it controls under the operating conditions as specified.
 - 2. Valve actuator shall be equipped with adjustable mechanical stop limiting devices to prevent over-travel in the open and closed positions.
 - 3. Actuator housing supports and connections to the valve shall be designed with a minimum safety factor of 5, based on ultimate strength of the material used.
 - 4. The stall torque of the actuator shall not exceed the torque capability of the valve as determined by the valve manufacturer.
 - 5. Each valve actuator shall have a non-fused electrical disconnect switch mounted securely to the actuator housing.
 - 6. Each valve actuator shall have a 4-20 mA feedback signal transmitter installed, to indicate valve position to a remote indicator.

- C. Electric motor actuators shall be as manufactured by Limitorque, EIM or an approved equal. Contractor shall coordinate with the valve manufacturer to insure actuators are installed in an upright position, and shall be controlled by the City SCADA System.
- D. The valve manufacturer shall transmit the actuator sizing data, such as required torque, shaft diameter, thread characteristics and keyway dimensions to the actuator manufacturer for actuator sizing.

2.10 VALVE ACTUATOR MOTOR

- A. The motor shall be a high torque, low starting current, design made expressly for valve control service, and capable of operating the valve at the specified torque for at least two cycles of travel without overheating. The motor shall be capable of producing an actuator output of not less than one and one-half times the required valve operating torque. The motor shall be totally enclosed and non-ventilated, rated a minimum of 125 VDC and shall have minimum Class "B" insulation. The electric-motor enclosure shall meet NEMA 4, (National Electrical Manufacturers Association) watertight construction as a minimum. The motor shall operate successfully at any voltage within ± 10 percent of the specified voltage. The motor shall be sealed against the environment and protected against ingress of humidity and dust. Motors shall be factory lubricated for lifetime operation. Overload protection shall be by means of overload relays or inherent motor heat sensors embedded in the windings.

2.11 GEARING MECHANISM

- A. Reduction shall be accomplished by means of spur, helical, bevel and/or worm gears. Gears shall be steel. Worm gears shall be bronze. The use of non-metallic or aluminum gears is unacceptable. All gears and shafting shall be supported on anti-friction bearings. The unit shall be designed so that the motor comes up to full speed before the valve stem load is encountered in either the opening or closing operation. All gearing shall be designed for 100 percent overload conditions, permanently lubricated and effectively sealed against entrance of foreign matter. The unit shall be constructed to permit the reduction gear ratio to be changed if required. Gears shall be totally enclosed in waterproof housing with integrally cast mounting for motor and separate compartment with removable cover for limit controls.

2.12 HANDWHEEL MECHANISM

- A. The actuator shall be equipped with a hand wheel for manual operation. The hand wheel shall not rotate during motor operation and during hand wheel operation the motor rotor shall not turn. The drive unit shall be responsive to electrical control at all times and shall disengage the hand wheel instantly when the motor is energized. An arrow, indicating the direction of rotation, and the word "OPEN" or "CLOSE" shall be cast on the hand wheel. The hand wheel pull required to manually operate the valve shall not exceed 80 pounds on the rim for seating or unseating load or 60 pounds for running load.

2.13 LUBRICATION

- A. All gearing and bearings shall be grease or oil-lubricated. Seals shall be provided at all shaft penetrations of the gear case to prevent leakage of lubricant, regardless of position. Lubricants shall be suitable for year-round service based on prevailing ambient temperature conditions.

2.14 TORQUE SWITCHES

- A. The actuator shall include an adjustable torque-switch (and thrust-switch, where applicable) arrangement to break the control power circuit when a valve requiring torque seating has reached the fully open or fully closed position (stops), or when an obstruction has been encountered in either direction of travel. Open and close torque switches shall be adjustable by means of individually calibrated dials marked "OPEN" or "CLOSE". The torque spring supplied with the unit shall allow adjustment of torque to be increased a minimum of 25 percent beyond the required to open or close and seat the valve, i.e. the torque spring shall not be compressed beyond 75 percent of its travel to successfully close the valve. The gear head, gearing and valve capability required by the maximum torque switch setting specified above.

2.15 LIMIT SWITCHES

- A. Provisions shall be made for four (4) trains of geared limit switches, each train independently adjustable and with provisions for three (3) switch contacts. The switch contacts to be furnished shall be as follows:
 - GLS/1: Contact open only when the valve is fully open, used to de-energize "OPEN" contact, and to turn off "GREEN" indicating light (Gear Train No. 1).
 - GLS/2: Contact, open only when valve is fully closed; used to de-energize "CLOSE" contactor and to turn off "RED" indicating light (Gear Train No. 2).
 - GLS/3: Contact, open only when valve port is 90 percent closed to fully closed; used to switch out the high-speed solenoid-operated gearshift mechanism during emergency closure (Gear Train No. 3).
 - GLS/4: Contact, closed only when valve is fully closed; used to prevent pump from starting unless valve is fully closed (Gear Train No. 2).
 - GLS/5: Contact, closed only when valve is 95 percent closed to fully closed; used in series with auxiliary contact on "CLOSE" contactor to trip motor starter. This switch adjustment must be independently adjustable (Gear Train No. 4).
 - GLS/6: Contact, open only when the valve is fully open, used for supervisory control and remote indication (Gear Train No. 1).
 - GLS/7: Contact, open only when the valve is fully closed, used for supervisory control and remote indication (Gear Train No. 2).

- B. The proper operation of limit switches is essential to the successful operation of the pumping station.
- C. Limit switches shall be positive in action and make-up and shall be free of dead band such that GS/2 and GS/4 contacts are open simultaneously when the valve is 99 (plus) percent closed. Incorrect or erratic operation of the limit switches will be cause for rejection of the valve furnished.
- D. Open and close limit switches shall be geared to the drive mechanism and in step at all times whether the unit is operated electrically or manually. The switches shall be of the field-adjustable type capable of being set either fully open, fully closed, or at any intermediate position. Limit-switch gearing shall be appropriately lubricated and totally enclosed to prevent entrance of foreign material or loss of lubricant.
- E. Terminal strips, space heater, limit switches and torque switches shall be housed in compartment(s) integral to the actuator. Space heating elements shall be provided in both the motor housing and the geared limit switch compartment. The heating elements shall be rated for 208 VAC, and operate continuously energized. Terminal facilities for connection to motor leads, solenoid, switches and heaters shall be provided in the limit switch compartment. Threaded conduit hubs shall be provided for rigid conduit connections. As a minimum, the compartment(s) shall meet NEMA 4 watertight construction.

2.16 ELECTRICAL CONTROLS

- A. The valve controller shall be furnished by the manufacturer of the drive unit to insure complete compatibility of the equipment. The valve controller shall be housed in a Hoffman NEMA 12 disconnect type enclosure with disconnect handle and integral Square D circuit breaker catalog number "FAL26020". The valve controller shall have two modes of operation; "REMOTE" and "LOCAL".
- B. The following control and indication devices shall be located on the front door of the enclosure:
 1. Valve Closed Green Pilot Light NEMA 4/13
 2. Valve Open Red Pilot Light NEMA 4/13
 3. Valve Close Push Button Momentary NEMA 4/13
 4. Valve Open Push Button Momentary NEMA 4/13
 5. 2 Position Maintained Local/Remote Selector Switch NEMA 4/13
- C. The control of the DC valve actuator shall be PLC based via Allen-Bradley MicroLogix Logic Controller. The PLC shall control the amount of time the valve takes to open and close by pulsing the DC control power to the valve actuator.
- D. Limit Switch Dry Contacts GLS/1, GLS/2, GLS/3, GLS/4, GLS/5, GLS/6 and GLS/7 shall be wired from the valve actuator to terminal blocks in the valve controller. The available limit switches from the terminal blocks shall be used as feedback to the PLC logic to provide valve position for means of control.

E. REMOTE MODE:

1. The valve controller shall have three inputs in “REMOTE MODE” via dry contact (Request to Normal Open, Request to Normal Close, Request for Emergency Close).
2. **The motor operator shall require not less than 315 seconds to perform a complete opening cycle; not less than 270 seconds to perform a normal close operation. Under emergency conditions, such as a pump power failure, the valve shall close to 90 percent of opening in approximately 48 seconds.** The remainder of the closure shall be at normal closing speed.
3. In “REMOTE MODE” the front door located valve open/close push buttons shall be disabled.

F. LOCAL MODE:

1. In “LOCAL MODE” the operator will have full control of opening and closing the valve at maximum speed by use of the front door located valve open/close push buttons. The valve open/close push buttons must be maintained by the user for DC control power to be continuously provided to the valve actuator. Upon release of the valve open/close push buttons power shall be disconnected from the valve actuator.

G. Discharge Pressure Switch:

1. A discharge pressure switch for the water pump units shall be furnished and installed on the discharge lines at the increaser, and piped accordingly. Installation shall include all piping, fittings, valves, surge suppressor, and other items to facilitate a complete installation. The switch shall be a DA Snap Action switch as manufactured by Mercoïd. Switch shall be rated for 5 amperes at 125 VDC nominal, with a range of 1 to 200 psi. The switch shall close on a pressure increase. All materials and labor for electrical installation is to be included.

2.17 ACTUATOR TESTING

- A. Valve actuators shall be tested according to the test requirements of AWWA Standard C542. The tests shall prove that the design, material selection and manufacture of the actuator meet the requirements as specified. Performance test shall prove that each actuator is in working order prior to shipment. Test reports shall be submitted to the City for approval before the shipment of actuators to job-site.

2.18 NUMBER PLATES

- A. Valves shall have their number suitably shown on the valve operator. The motor operated valve shall also have the number suitably shown on the valve controller. The location of number plates and method of attachment shall be subject to the approval of the CITY.

PART 3 – EXECUTION

3.01 INSTALLATIONS

- A. All piping and valves shall be constructed to the lines and elevations shown on the drawings. In open or closed positions, valve stems shall not interfere with ceiling or other equipment.
- B. Flanged Joints: Care shall be taken in bolting flanged joints to insure that there is no restraint on the opposite end of the pipe, specials, fittings, and valves which would prevent pressure from being evenly and uniformly applied upon the gasket. The pipe or fitting must be free to move in any direction while bolting. Bolts shall be alternately tightened, each in turn, at a uniform rate of gasket compression around the entire flange.
- C. Connections to Pumping Unit: Special care shall be taken in attaching suction and discharge piping to the pumping unit to insure that no stresses are transmitted to or imposed on the pumping unit through the connected piping. Pumping unit shall be completely assembled and set in correct position and proper alignment by the contractor, but shall not be grouted until after the suction and discharge piping connections are completed. The contractor hereunder shall correctly align and support all piping and make proper connections to the pumping unit.
- D. The pump connections shall be checked for applied piping stresses by loosening the flange bolts which, if the piping is properly installed, should result in no movement of the piping relative to the pump or opening of the pump connection joints. Grouting of the pumping units shall be done after the piping connections have been completed and checked.
- E. The inside of all pipes, valves and fittings shall be smooth, clean, and free from blisters, loose mill scale, sand and dirt when erected. All lines shall be thoroughly flushed before placing in service.

3.02 TESTS

- A. All piping, valves, and accessories installed under this contract shall be tested for tightness and leakage for a one-hour period. The contractor shall provide all necessary equipment and shall perform all work required in connection with these tests. Piping will be tested by observation at normal operating pressures. The section tested shall be slowly filled with water, care being taken to expel all air from the pipes. If necessary, the pipes shall be tapped at high points to vent the air. All joints which are found to leak shall be made tight by approved methods or replaced by the contractor at no additional cost to the City.

END OF SECTION

2.02 FLOW TRANSMITTERS

- A. The Contractor shall furnish and install two (2) flow transmitters. The flow transmitters shall be ABB IP65 Remote Electronic Display unit Transmitter.
- B. The flow transmitter shall be suitable for wall mounting and shall have an integral LCD display and keypad for calibration and diagnostics. Transmitter supply voltage shall be 120VAC 60Hz and shall send a pulsed dc output to the flow tube to power the flow tube coil.
- C. Transmitter shall output a 4-20mA signal proportional to flow rate. The flow transmitter output shall be calibrated 0-20 MGD.

2.03 PRESSURE TRANSMITTERS

- A. The Contractor shall furnish and install two (2) pressure transmitters Endress Hauser Cerabar PMP51-AA-2-1-R-D-1S-D-F-RLJ-B-2-AA-F1-HA-KE-78.

2.04 ACCESSORIES

- A. The Contractor shall furnish two (2), 24VDC Current Loop Supplies, Action Instruments Model AP9046, or approved equal, for powering the pressure transmitter 4-20 mA loops. The power supply shall operate on 120 VAC 60 Hz. Turn over to Milwaukee Water Works for installation.

END OF SECTION

SECTION 15500
CENTRIFUGAL PUMPING UNIT

PART 1 - GENERAL

1.01 SUMMARY OF WORK

- A. The contractor shall furnish, test, and place in satisfactory operating condition one (1), Horizontal Split Case, Double Suction, Side Suction, Side Discharge, Centrifugal pumping unit in strict accordance with the plans and specifications.
- B. The term pumping unit shall be defined as a pump complete with electric motor, steel support, couplings, coupling guards, bed plates, and all other necessary and required appurtenances.

1.02 SERVICE CONDITIONS

- A. The pumping unit shall be used to pump filtered Lake Michigan water. Water temperature will vary from 32°F to 80°F. Pumping performance shall be based on a water temperature of 68°F.
- B. The pumping unit shall be used for pumping drinking water from an inline suction header to the City of Milwaukee distribution system. The space available for this equipment is limited and will require careful selection of pumping units and accessories to fit the specified clearances.
- C. All equipment furnished shall conform to OSHA, NEC, the “Wisconsin Electrical Code” and “City of Milwaukee Code of Ordinances” where applicable.
- D. Specified pump shall be the product of a single manufacturer. Motor shall be the product of a single manufacturer.
- E. The pumping building will be unattended and all equipment shall be designed and arranged for use in conjunction with the existing supervisory control.
- F. The specified pumping unit shall be designed so that one pumping unit may run simultaneously with the other pumping units. Pumping unit shall be designed so that reverse rotation caused by a reverse flow of water equal to 1-1/2 times the rated flow will not damage the unit.
- G. The specified pumping unit shall be equipped with operating accessories and meet the appropriate operating requirements specified hereafter.

1.03 QUALITY ASSURANCE

- A. The complete pump unit shall be supplied, tested, and warranted by the pump manufacturer.
- B. The equipment specified under this section shall be standard pumping equipment manufactured by a company with no less than ten years experience in the manufacture of such equipment. Upon request by the project City, the manufacturer shall provide proof of such experience by providing installation lists, brochures, catalogs cuts, etc.

- C. The specified pumping unit shall be provided with a stainless steel nameplate that shall contain the following information:
1. Pump Number
 2. Manufacturer's name, address and telephone number
 3. Model number
 4. Serial number
 5. Head, capacity and RPM at rated condition
 6. Motor horsepower, RPM and frame size
- D. Pumping units shall be as manufactured by:
1. American-Marsh Pumps
 2. ITT-Flygt Pumps
 3. Approved equal.

1.04 WARRANTY

- A. The specified centrifugal pumping unit shall be warranted for a minimum of five (5) year from the date of installation.

PART 2 - PERFORMANCE AND DESIGN REQUIREMENTS

2.01 PUMPING UNIT REQUIREMENTS

- A. The head, capacity, and related performance and design requirements for the specified pumping unit are as follows:
1. PUMP No. 2 (NEW):

Rated Capacity @ rated head	2,778 to 6,945 GPM (4.0 - 10.0 MGD)
Rated total head (TDH), feet	85
Maximum shutoff head, feet	114
Normal operating head range, feet	86 - 106
Pump discharge diameter:	14" inches
Pump suction diameter	16" inches
Motor voltage	460/3/60
Motor service factor (S.F.)	Supplied by Manufacturer
Maximum brake horsepower, HP	Supplied by Manufacturer

Motor horse power, HP	Supplied by Manufacturer
Minimum motor efficiency at full load, %	Supplied by Manufacturer
Motor thermal cut-off	Required
Motor Remote Temperature Detection (RTD)	Required
Maximum distance from suction Inlet centerline to discharge Flange face, inches	Supplied by Manufacturer

PART 3 - SUBMITTALS

3.01 SHOP DRAWINGS

- A. Make, model, weight, and horsepower of each equipment assembly.
- B. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
- C. Performance data curves showing head, capacity, horsepower demand, and pump efficiency over the entire operating range of pump, from shutoff to maximum capacity. Indicate separately the head, capacity, horsepower demand and overall efficiency at the guarantee point.
- D. Detailed structural, mechanical, and electrical drawings showing the equipment dimensions, size, and locations of connections and weights of associated equipment.
- E. Power and control wiring diagrams, including terminals and numbers.
- F. Complete motor nameplate data, as defined by NEMA, motor manufacturer, and including any motor modifications.

3.02 QUALITY CONTROL SUBMITTALS

- A. Factory Functional and Field Performance Test Reports.
- B. Special shipping, storage and protection, and handling instructions.
- C. Manufacturer's printed installation instructions.
- D. Operation and maintenance manual.

END OF SECTION

SECTION 15600
HORIZONTAL CENTRIFUGAL PUMP

PART 1 - GENERAL

1.01 PUMP TYPE

- A. The pump shall be of the horizontal split-case, double suction, side suction and discharge, centrifugal type.

1.02 PUMP CASING

- A. Pump casing shall be split horizontally and arranged so that top half can be removed without disconnecting either suction or discharge piping. Suction and discharge flanges shall be ASA class 125, cast integrally with the lower half of the case and spot faced. Material shall be ASTM A48 cast iron of thickness and rigidity to withstand operating and test pressures without deformation. The casing shall be designed for a minimum working pressure of 150 psi and shall be hydrotested to 1-1/2 times the working pressure. Stuffing boxes shall be provided with drain piping outlets for gland water waste collection. The casing shall be provided with all necessary vent, drain and gage connections on both the suction and discharge side. Drilled and tapped stuffing box seal water connections shall be provided. All connections shall have bronze plugs.

1.03 IMPELLER

- A. Impeller shall be of the double suction, enclosed, non-overloading type, dynamically balanced, and shall consist of a single bronze casting, machined and polished all over and dynamically and hydraulically balanced. Impellers shall have all surfaces finished. The impeller shall be keyed to its shaft and securely held in axial position by bronze shaft sleeves and lock nuts designed to tighten with normal shaft rotation. Impeller shall be dynamically balanced to avoid vibration and hydraulically balanced to prevent thrust. Rotating assembly shall be designed to withstand reverse rotation without damage.

1.04 SHAFT

- A. The pump shaft shall be made from high grade heat treated steel, machined, ground and polished true to gauge, and of sufficient strength and size to transmit the power required and sustain the imposed loads without undue deflection, whipping or vibration. Cold-rolled shafting will not be acceptable. Each shaft shall be tapered at the coupling end to facilitate removal of the coupling.
- B. The shaft material shall be 420 type stainless steel, ground and polished to a smooth surface. It shall be designed for extra stiffness to avoid all critical speeds in operation, and is threaded for bearing and impeller lock nuts. The portion of the shaft that is exposed to the pumped fluid is covered with renewable bronze shaft sleeves screwed on against the impeller with right and left hand threads which cannot work loose during operation. Shaft sleeves have external o-rings, in lieu of internal o-rings, to stop leakage.

1.05 SHAFT SLEEVES

- A. Each shaft shall be protected by 11-13% chrome sleeves where it comes in contact with water and where it passes through the stuffing box. Sleeves shall be removable. Each sleeve shall be keyed to the shaft and held in place by separate bronze shaft nuts. The sleeves shall be provided with "O" Rings to prevent leakage between the shaft and sleeves.

1.06 STUFFING BOX/GLAND AND PACKING

- A. The stuffing box shall be constructed of ASTM A48, Class 30 cast iron. The packing box shall be of the deep bore type with a minimum of six (6) rings of packing and a lantern ring capable of handling 450 psi and 210° F. Connections for grease inlet and pressure relief shall be provided. The packing gland shall be constructed of ASTM bronze B-584-836 split type and secured with stainless steel studs and brass nuts. A neoprene "O"-ring shall be used to seal the packing box to the discharge head.
- B. Stuffing boxes shall be arranged to provide for water sealing from the pump casing when pump is in service. Piping from stuffing box to pump casing and all necessary shutoff, control, and check valves shall be furnished. Each stuffing box shall be equipped with a bronze or Teflon lantern ring as required by pump suction pressures.
- C. Gland water drain reservoirs and piping to floor drains shall also be furnished as a part of this contract. Glands shall be designed to provide tight packing without excessive friction on the shaft. The stuffing boxes shall prevent air leakage into the pump under all operating conditions, including maximum suction lift. Glands shall be bronze, shall be split for easy removal, and shall have substantial extension lugs or ears and be provided with bolts or other approved fasteners which will hold the parts as rigidly as if the gland were a single piece. All surfaces of the gland shall be machined to a smooth finished surface.
- D. Packing shall be Marlo 500, Rains Flo Style RJ-12 or approved equal. Not less than two rings of packing inside and three rings of packing outside the lantern ring shall be provided.
- E. Removable gland covers shall be provided on each gland to prevent the spraying of water that may leak from the gland. Suitable water slingers shall also be provided on each shaft to prevent water entering the bearing housings.
- F. The stuffing boxes/seal chambers shall be extra deep, designed for packing and lantern ring or mechanical seals. Under each stuffing box is a drip pocket with tapped drain outlet. The stuffing boxes/seal chambers are completely removable and replaceable.

1.07 MECHANICAL SEAL ASSEMBLY

- A. The design of the mechanical seal system shall provide for easy and visually verifiable pump lateral adjustments. Setting shall not require the disassembly of any portion of the factory preset seal assembly and shall be accomplished without special tooling, gauges, or equipment. The rotating face shall be of carbon graphite and the stationary face shall be ni-resist. All metal seal parts shall be 18-8 stainless steel.

The seal housing shall be ASTM A48 Class 30 cast iron, machined to accept an "O"-ring face for positive sealing. The housing shall have an 1/8 inch diameter NPT orifice for seal circulation. The seal shall be machined from ASTM A36 steel and bored for stationary seat. The sleeve and drive cap shall be machined from ASTM 400 series stainless steel. The drive cap shall have a minimum of four (4) locking set screws. A bronze seal housing bearing shall be provided directly below the mechanical seal for stability.

1.08 BEARINGS

- A. Bearings shall be of the heavy duty double or single row anti-friction type, oil lubricated and capable of withstanding all running loads including reverse rotation. Both thrust bearings shall be provided with removable housings for ease of inspection, maintenance and replacement.
- B. All pump bearings shall be adequate size and capacity to carry all radial and end thrust loads imposed by the pump shaft with a minimum life of 100,000 hours.
- C. Bearing Lubrication
 - 1. Pump bearings shall be oil lubricated by design and provided with suitable large capacity oil reservoirs equipped with sight glasses to determine oil levels regardless of whether or not pump is running.
 - 2. Pump lubrication system shall be designed for a minimum of two weeks unattended service with remote or automatic control of operation.
- D. Bearings shall be separated from stuffing boxes and shall be equipped with suitable shaft seals to prevent leakage of lubricant along the shaft. All valves, flow indicators, gauges, piping and other accessories necessary for the proper cooling and lubrication of the bearings shall be furnished hereunder.
- E. Both the inboard and outboard ball bearings are of the single row, deep groove type, precision grade, with cartridge mounting, permitting the removal of the shaft without exposing or disturbing the bearing assembly. They are of extra large capacity for both radial and thrust loads. The outboard bearing is confined rigidly in the bearing housing to take end thrust, while the inboard bearing is set with sufficient clearance to allow for shaft expansion.
- F. Both bearings can be removed and replaced without removing the rotation assembly from the pump.

1.09 FOUNDATION PLATE

- A. The pump and motor assembly shall be mounted on a single heavy, fabricated steel bedplate which shall be grouted in place to which the pump driver stands will be bolted at installation. The pump and motor assembly plate shall be constructed of ASTM A36 carbon steel, with machined top sides. The sub-base plates shall be accurately machined to locate the driver stands and have center openings sufficient to allow removal of the discharge heads. Bedplate shall be neat appearing with welds ground smooth and shall have rounded corners.

A raised lip complete with suitable drain connections shall be provided on each bedplate. All support pads shall be machined, and tapered dowels shall be used to properly align each pump and motor on their respective pads. Motors shall be aligned and doweled to the bedplate in the field after erection of the pump and proper support of the bedplate. Several large openings shall be provided in the top of each bedplate to facilitate grouting. Air holes shall also be provided where necessary to insure that the entire space under each bedplate is filled with grout. Detailed drawings of the bedplate shall be submitted prior to fabrication.

1.10 PUMP NUMBER/NAMEPLATE

- A. The pump shall have the pump number suitably shown in an approved location. Pump numbers shall be 2-1/2" high reflective numbers and letters on a black background with pressure-sensitive adhesive backing. Plastic film material shall be suitable for indoor and/or outdoor service. Material shall be as manufactured by Seton Name Plate Corp. Style #RNL25, or an approved equal.

PART 2 - PERFORMANCE

2.01 FACTORY TESTING

- A. The pump and motor assemblies shall be hydrostatically tested by the pump manufacturer, according to the procedures of the Hydraulic Institute Standards.
- B. The completed pump shall be witness tested at the factory with calibrated test motors according to the procedures and standards of the Hydraulic Institute. A minimum of seven test points, including shut-off and design points, shall be included.
- C. Certified test reports, including curves showing capacity, head, efficiency and brake horsepower shall be submitted to the CITY for approval prior to shipment to the job site.
- D. If the guaranteed capacity at rated head is less than that set forth in these specifications, the pump will be rejected.

2.02 ROTATIONAL BALANCE

- A. All rotating parts shall be machined true and in as nearly perfect rotational balance as practicable. At any operating condition within the extreme operating range, the maximum permissible vibration at any point on the pumping unit shall be three mils peak to peak amplitude.

PART 3 – EXECUTION

3.01 DELIVERY, STORAGE AND HANDLING

- A. Handle the pumping unit carefully to prevent damage, breaking and scoring. Do not install damaged pumping units; these shall be replaced with new pumping units.
- B. Store the pumping unit in clean and dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

3.02 ELECTRIC WIRING

- A. Before start-up, the contractor shall field check the installations and hook-up of electrical wiring to the equipment and notify the City immediately if errors are found. The contractor shall check the wiring installations again after corrections have been made.

3.03 INSTALLATION

- A. Install new pumping unit at the location shown on the plans. Set the pumping unit, on foundation, grout the baseplate, install suction and discharge piping, and perform all other work required for a complete and operational installation.
- B. Protect work during all phases of work, to prevent damage by scratches, stains, discoloration or other causes. Damage to metal surfaces caused during fabrication, handling, shipment or erection, shall be remedied by Contractor.
- C. Start-up the pumping unit in accordance with the manufacturer's start-up instructions and in presence of manufacturer's representative.
- D. The pumping unit shall be installed strictly in accordance with the manufacturer's recommendations. Complete installation shall be checked and approved by an authorized representative of the pumping unit manufacturer through field inspection. Certification of such approval from the manufacturer shall be provided to the City before placing the units in service.

3.04 FIELD TESTS

- A. After installation of the pump, the contractor shall perform vibration testing to certify that rotational balance of all rotating parts on any point of the pump is not greater than 3 mils peak-to-peak amplitude.
- B. After installation of the pump, the contractor shall perform flow and pressure testing according the standards of the Hydraulic Institute to verify that the pump meets all specified performance specifications.

3.05 STARTING SERVICE

- A. After installation of the pumping unit is complete, the manufacturer shall provide three days (24 hours) service for training the employees. At least 7-day notice shall be given to schedule this training. Training shall be oriented to the operators and maintenance personnel. Individual training sessions shall be conducted as required to meet the needs of each group as directed by the City. This may involve multiple sessions to accommodate 3-shifts of personnel.

END OF SECTION

SECTION 15700
ELECTRIC MOTOR

PART 1 - GENERAL

1.01 MOTOR TYPE AND RATING

- A. Pump motor shall be horizontally mounted, Inverter Duty Rated, continuous duty, squirrel cage induction, TEFC, premium efficiency, speed as required by the pumping unit and operate on a 480 volt AC, 3 phase, 60 Hz supply.
- B. Motor shall be of the hollow-shaft type, designed, constructed and tested in accordance with the latest edition of the applicable standards of IEEE, ANSI/NEMA MG1 and ANSI/NEMA MG2.
- C. Motor shall be sized to operate pump continuously at all heads within the specified operating range without exceeding its specified rating.
- E. Motors shall be rated for a 1.15 service factor in a 40°C ambient temperature.

1.02 CODES AND STANDARDS

- A. All equipment shall be designed, fabricated, assembled and tested in accordance with the most current applicable standards as defined by the following institutions:
 - 1. American National Standards Institute (ANSI)
 - 2. Institute of Electrical and Electronic Engineers (IEEE)
 - 3. National Electric Manufacturers' Association
 - 4. Anti-Friction Bearing Manufacturers' Association (AFBMA)
- B. Equipment shall be labeled or listed as being approved by the Underwriters Laboratories (U.L.) whenever applicable.

1.03 SERVICE CONDITIONS

- A. Motor shall be suitable for operation in accordance with their rating under the following service conditions.
 - 1. Ambient temperature in a range of 5°F to 104°F.
 - 2. Indoor or outdoor installations in severe duty applications such as high humidity, corrosive or salty atmosphere.
- B. Motor shall be capable of continuous operation at full load and rated frequency with a voltage variation of +/- 10%.
- C. Motor shall be capable of continuous operation at full load and rated voltage with a frequency variation of +/- 5.0 %.
- D. Motor shall be suitable for 25% over speed in reverse direction without damage to bearings or from centrifugal forces.
- E. Motor shall be suitable for across-the-line starting and shall be able to start and accelerate the connected load to full load speed with 90% of rated voltage at the motor terminals.

- F. Motor starting current shall not exceed a value of 650% of the motor full load current.

1.04 OPERATING CHARACTERISTICS

- A. With rated voltage and frequency applied, motor performance shall be as follows for critical operating characteristics.
 - 1. TORQUES:
 - a) Motor shall meet or exceed the minimum locked rotor (starting) and breakdown torque specified in NEMA standard MG1 for design B for the ratings specified.
 - 2. CURRENTS:
 - b) Locked rotor (starting) currents shall not exceed NEMA Design B maximum values for the specified rating. Motors shall be capable of a 20 second stall at six times full load current without injurious heating to motor components.
 - 3. TEMPERATURE RISE:
 - c) The temperature rise, by resistance, shall be 80 degrees C or less when measured at rated load.

1.05 SUBMITTALS

- A. The following specific information shall be provided with proposal:
 - 1. Complete motor nameplate data in accordance with NEMA standards.
 - 2. Approximate motor weight
 - 3. Preliminary dimensions and size of motor and frame
 - 4. Motor performance data to include the following:
 - a) Guaranteed minimum efficiencies at 100%, 75%, and 50% of full load
Guaranteed minimum power factor at 100%, 75% and 50% of full load
 - b) Locked rotor current
 - c) Full load current
 - d) Starting Torque
 - e) Full load torque
 - f) Breakdown torque
 - g) Full load power factor and maximum correction capacitor kVa
 - h) Nominal efficiency in accordance with IEEE 112.
 - 5. Manufacturer's printed data on each motor type being provided to indicate compliance with specified performance and construction.
 - 6. Complete description of testing facilities
 - 7. Job site storage requirements

- B. The following information is required within six (6) weeks after order:
 - 1. Certified dimensional drawings of motor and frame.
 - 2. Recommended spare parts list with pricing.
- C. The following is required upon shipment of the units:
 - 1. Operations & Maintenance Manuals
 - 2. Connection diagrams
 - 3. Test reports as Specified.

1.06 WARRANTY

- A. The specified electric motor unit shall be warranted for a minimum of five (5) year from the date of installation.

PART 2 - MOTOR CONSTRUCTION AND ASSEMBLY

2.01 MOTOR ENCLOSURE

- A. Motor enclosure shall be Totally Enclosed Fan Cooled (TEFC), made of heavy-duty rugged cast iron or fabricated steel. The enclosure shall be of the weather-protected type. Enclosure shall be designed to protect internal components from falling water and debris.

2.02 STATOR

- A. The stator frame shall be made up of electrically welded fabricated steel construction with ample strength and rigidity to withstand motor torques and maintain core clamping pressure. Stator frame shall be provided with suitable eyebolts, lifting lugs or other suitable means for lifting. Stator core shall consist of high grade non-aging annealed electrical silicon steel laminations insulated with baked-on insulating coating. Laminations shall be of the segmental type and assembled and clamped between frame end plates and rings. Spacers for core ventilation shall be provided at frequent intervals along the core and at core ends between laminations and end plates. The stator shall have class F or better insulation material. Stator windings shall be Class "B", form wound, with special moisture resistant qualities designed and constructed to withstand high humidity conditions and to operate after long periods of idleness without preliminary drying out. The insulation shall consist of a mica base with Dacron and/or glass tape reinforcement and impregnated with suitable epoxy resins to form a solid composite mass with high mechanical and electrical strength. Coils shall be high frequency tested to detect any insulation weaknesses. Coils shall be assembled with suitable bracing and insulating wedges to prevent working of end turns during starting and to prevent movement of coils within slots. After coil assembly is complete and leads and coil ends are securely braced against any movement and stresses, the stator shall be impregnated in a solventless, heat reactive epoxy resin and cured by baking under controlled conditions. After the final impregnation, a final coat of epoxy varnish shall be applied to the stator.

Motors rated for inverter and variable frequency drive service shall meet NEMA MG-1, Part 31 dated 1993 and shall have an insulation system rated for such service.

2.03 ROTOR

- A. The rotor shall consist of a laminated core assembled and supported by a rigid cast or welded structure and pressed on and keyed or suitably high frequency induction brazed to rotor shaft to form an integral strong and stiff unit. Ventilation slots and openings shall be provided as required to provide an adequate volume of cooling air to all parts of the rotor. Cage winding shall be aluminum or brazed and silver soldered copper bars and end rings assembled to provide permanent torque characteristics and long life. Rotor fan shall be adequately secured to rotor end rings by bolting or integrally centrifugally casting as a part of windings. Rotor shaft shall be sized to withstand starting torques and as required to conform to pump requirements. The rotor shall be dynamically balanced for smooth running and operate in conjunction with air baffles to operate without objectionable windage noises or vibrations.

2.04 TEMPERATURE DETECTORS

- A. Motor shall have a minimum of two (2) Remote Temperature Detectors (RTD's) per phase for a total of six (6) in the stator winding located in the slots between the coil sides of different phases, and shall be of the nickel resistance type. Detector coils shall be wired to a common terminal box provided for external connections as specified above. Wiring shall be stranded copper not less than 16 gauge with approved moisture and heat resistant insulation. The conductors to each detector element shall be laid up in a single cable provided with galvanized steel armor or other approved jacket. One conductor from each element shall be grounded to the stator at the terminal box.
- B. Motor shall have a minimum of two (2) RTDs, RTD's one (1) per bearing, mounted as closely as possible to the outer surface of each bearing and shall be of the nickel resistance type. Detector coils shall be wired to a common terminal box provided for external connections as specified above. Wiring shall be stranded copper not less than 16 gauge with approved moisture and heat resistant insulation. The conductors to each detector element shall be laid up in a single cable provided with galvanized steel armor or other approved jacket. One conductor from each element shall be grounded to the stator at the terminal box.

2.05 SPACE HEATERS

- A. Motor shall be provided with space heaters to provide sufficient wattage to maintain the internal temperature at a level approximately 10°C above the ambient temperature and to prevent condensation on the core or windings while motors are not in operation. Heaters shall have rust proof sheaths and be connected to a common terminal box for external connection. Conductors shall have heat resistant insulation. Heaters shall be wired for connection to a single phase, 60 hertz, 120 volt AC service.

2.06 MOTOR BEARINGS

A. Motor bearings shall be grease lubricated, anti-friction type, of adequate size to provide long life under all operating conditions. Bearings and housings shall incorporate a liberal sized grease reservoir, grease seals to prevent grease from leaking along the shaft, purge relief hole, slingers and all necessary accessories to provide for positive lubrication of bearings and prevent grease leakage to motor interior. Motor bearing reservoirs shall be of liberal size for intended service and designed for a minimum of two weeks unattended operation. Bearings shall be rated for an in service B-10 life of 80,000 hours minimum.

1. Thrust Bearings

- a) Motors shall be designed and constructed with thrust bearings on top to allow inspection and/or replacement without requiring complete disassembly of the motor.
- b) Thrust bearings shall be deep-groove ball, angular contact ball, or spherical roller type. Bearings mounted back-to-back, or in tandem are acceptable and may be furnished when required per manufacturer's standard design
- c) Deep-groove ball bearings shall be used only on normal thrust design motors, and shall be capable of handling thrust loads in either direction.
- d) High thrust design motors shall be supplied with angular contact ball bearings whenever possible and in accordance with manufacturer's standard design.
- e) Where thrust requirements restrict the use of angular contact bearings, spherical roller bearings shall be furnished. Bearings shall be spring loaded to keep the bearing race in contact and prevent bearing damage during starting and momentary up-thrust conditions.
- f) Thrust bearings shall be oil lubricated and contained in an oil reservoir with sight level gauge and oil fill and drain openings with plugs.

2. Guide Bearings

- a) Guide bearings shall be deep-groove ball type and shall be located at the bottom of the motor.
- b) Guide bearings shall be stacked when necessary per manufacturer's standard design to accommodate specified up-thrust conditions
- c) Guide bearings or bearing assemblies shall be provided with sufficient means for preventing the leakage of lubricant or entrance of any foreign matter along the shaft.

3. Bearing Lubrication

- a) Deep-groove ball bearings furnished as thrust bearings for normal thrust motors shall be oil lubricated.
- b) Deep-groove ball bearings furnished as guide bearings for high thrust units shall be oil lubricated.
- c) Grease lubricated bearings shall be furnished with provisions for in-service positive lubrication. A drain shall be provided to guard against over lubrication.

2.07 TERMINAL BOX

- A. A terminal box shall be furnished and be of fabricated steel or cast iron construction, with a complete set of solderless lugs for terminal connection of cable. Box is to be compatible with motor enclosure specified and when possible, be diagonally split and capable of rotation in 90° increments. Conduit entrances shall be in the top of the terminal box. Boxes not suitable for rotation must be capable of top-entry. Terminal box shall be of a size that provides adequate space for terminals and other appurtenances. Motor leads shall be brought out and into this terminal box. A ground lug shall be provided in the compartment for grounding wire connection to the unit. Box to be fully gasketed to prevent entrance of foreign matter into the motor, and to provide support for the stator leads where they pass through the motor frame.

2.08 ACCESSORIES

- A. The motor manufacturer's standard complement of accessories for motors including lifting devices for bearing caps and rotors, eyebolts for crane handling of motors, special wrenches and miscellaneous items as required for installation and maintenance shall be included.

PART 3 - TESTS AND VIBRATION

3.01 MOTOR FACTORY TESTS

- A. The following standard tests shall be performed for all motors in accordance with IEEE 112 method B.
 1. Current Balance
 2. High Potential Test per MG 1-20.47
 3. Vibration Test
 4. Winding Resistance per IEEE Standard 112.4.1.
 5. Locked Rotor Current
 6. No Load Running Current measurements at 60 Hz in accordance with IEEE Standard 112.4.6.
 7. Full Load Heat Run

8. Full Load Percent Slip
9. Efficiency at 100%, 75%, and 50% Load.
10. Noise test per IEEE standard 85 decibel
11. Water immersion test per NEMA MG 1-20.48

3.02 VIBRATION

- A. The motor rotating elements shall be dynamically balanced as a complete unit at the manufacturer's shop. When tested without bolting to the test floor, no part of the motor shall have a vibration displacement in excess of 2 mils when tested with a light beam vibration indicator or other approved method. Any motor accessory or attachment shall have no sympathetic vibration period when the unit is operating under normal conditions. Motors shall be specially designed and constructed to avoid the generation of objectionable noise.

PART 4 - EXECUTION

(Same as described in Section 15600, Part 3.)

END OF SECTION

SECTION 16010
BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 PROJECT OVERVIEW

- A. The electrical work included in all other divisions is the responsibility of the contractor performing the division 16 work unless noted otherwise.

1.02 SCOPE

- A. Basic Electrical Requirements, which are applicable to all Division 16 sections. This section includes information common to two or more technical specification sections or items that are of a general nature, not conveniently fitting into other technical sections.

1.03 REFERENCE STANDARDS

- A. Abbreviations of standards organizations referenced in this and other sections are as follows:
1. ANSI - American National Standards Institute
 2. ASTM - American Society for Testing and Materials
 3. EPA - Environmental Protection Agency
 4. ETL - Electrical Testing Laboratories, Inc.
 5. IEEE - Institute of Electrical and Electronics Engineers
 6. IES - Illuminating Engineering Society
 7. ISA - Instrument Society of America
 8. NBS - National Bureau of Standards
 9. NEC - National Electric Code
 10. NEMA - National Electrical Manufacturers Association
 11. NESC - National Electrical Safety Code
 12. NFPA - National Fire Protection Association
 13. UL - Underwriters Laboratories Inc.

1.04 REGULATORY REQUIREMENTS

- A. All work and materials are to conform in every detail to applicable rules and requirements of the Wisconsin State Electrical Code, the National Electrical Code (ANSI/NFPA 70), other applicable National Fire Protection Association codes, the National Electrical Safety Code, and present manufacturing standards (including NEMA).
- B. All Division 16 work shall be done under the direction of a currently certified State of Wisconsin Certified Master Electrician.

1.05 QUALITY ASSURANCE

- A. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the contractor is responsible for all costs involved in integrating the equipment or accessories into the system and the assigned space and for obtaining the performance from the system into which these items are placed.
- B. Manufacturer references used herein are intended to establish a level of quality and performance requirements unless more explicit restrictions are stated to apply.
- C. All materials, except medium voltage equipment and components, shall be listed by and shall bear the label of an approved electrical testing laboratory. If none of the approved electrical testing laboratories has published standards for a particular item, then other national independent testing standards, if available, applicable, and approved by Milwaukee Water Works, shall apply and such items shall bear those labels. Where one of the approved electrical testing laboratories has an applicable system listing and label, the entire system, except for medium voltage equipment and components, shall be so labeled.

1.06 CONTINUITY OF EXISTING SERVICES AND SYSTEMS

- A. No outages shall be permitted on existing systems except at the time and during the interval specified by Milwaukee Water Works. Any outage must be scheduled when the interruption causes the least interference with normal schedules and business routines. No extra costs will be paid to the Contractor for such outages which must occur outside of regular weekly working hours.
- B. This Contractor shall restore any circuit interrupted as a result of this work to proper operation as soon as possible.

1.07 SEALING AND FIRESTOPPING

- A. Sealing and firestopping of sleeves/openings between conduits, cable trays, wireways, troughs, cablebus, busduct, etc. and the structural or partition opening shall be the responsibility of the contractor whose work penetrates the opening. The contractor responsible shall hire individuals skilled in such work to do the sealing and firestopping. These individuals hired shall normally and routinely be employed in the sealing and fireproofing occupation.

1.08 INTENT

- A. The Contractor shall furnish and install all the necessary materials, apparatus, and devices to complete the electrical equipment and systems installation herein specified, except such parts as are specifically exempted herein.

- B. If an item is either called for in the specifications or shown on the plans, it shall be considered sufficient for the inclusion of said item in this contract. If a conflict exists within the Specifications or exists within the Drawings, the Contractor shall furnish the item, system, or workmanship, which is the highest quality, largest, or most closely fits Milwaukee Water Work's intent (as determined by the Milwaukee Water Works Project Manager).
- C. It must be understood that the details and drawings are diagrammatic. The Contractor shall verify all dimensions at the site and be responsible for their accuracy.
- D. All sizes as given are minimum except as noted.
- E. Materials and labor shall be new (unless noted or stated otherwise), first class, and workmanlike, and shall be subject at all times to the Milwaukee Water Works and/or Engineer's inspections, tests and approval from the commencement until the acceptance of the completed work.
- F. Whenever a particular manufacturer's product is named, it is intended to establish a level of quality and performance requirements unless more explicit restrictions are stated to apply.

1.09 OMISSIONS

- A. No later than ten (10) days before bid opening, the Contractor shall call the attention of the Milwaukee Water Works to any materials or apparatus the Contractor believes to be inadequate and to any necessary items of work omitted.

1.10 SUBMITTALS

- A. Submit for all equipment and systems as indicated in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name and/or number, as indicated in the contract documents. Failure to do this may result in the submittal(s) being returned to the Contractor for correction and resubmission. Failing to follow these instructions does not relieve the Contractor from the requirement of meeting the project schedule.
- B. On request from the Milwaukee Water Works, the successful bidder shall furnish additional drawings, illustrations, catalog data, performance characteristics, etc.
- C. Submittals shall be grouped to include complete submittals of related systems, products, and accessories in a single submittal. Mark dimensions and values in units to match those specified. Include wiring diagrams of electrically powered equipment.
- D. The submittals must be approved before fabrication is authorized.

E. Submit sufficient quantities of submittals to allow the following distribution:

- | | |
|--------------------------------------|----------|
| 1. Operating and Maintenance Manuals | 2 copies |
| 2. Engineer | 2 copies |
| 3. Field Office | 2 copy |

1.11 PROJECT/SITE CONDITIONS

- A. Install Work in locations shown on Drawings, unless prevented by Project conditions.
- B. Prepare drawings showing proposed rearrangement of Work to meet Project conditions, including changes to Work specified in other Sections. Obtain permission of Milwaukee Water Works before proceeding.
- C. Tools, materials and equipment shall be confined to areas designated by the Milwaukee Water Works.

1.12 WORK SEQUENCE AND SCHEDULING

- A. Install work in phases to accommodate project requirements. During the construction period coordinate electrical schedule and operations with Milwaukee Water Work's Construction Representatives.

1.13 WORK BY OTHER TRADES

- A. Every attempt has been made to indicate in this trade's specifications and drawings all work required of this Contractor. However, there may be additional specific paragraphs in other trade specifications and addenda, and additional notes on drawings for other trades which pertain to this Trade's work, and thus those additional requirements are hereby made a part of these specifications and drawings.
- B. Electrical details on drawings for equipment to be provided by others are based on preliminary design data only. This Contractor shall lay out the electrical work and shall be responsible for its correctness to match equipment actually provided by others.

1.14 SALVAGE MATERIALS

- A. No materials removed from this project shall be reused. All materials removed shall become the property of and shall be disposed of by the Contractor.

1.15 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. Assemble material in three-ring or post binders, using an index at the front of each volume and tabs for each system or type of equipment. In addition to the data indicated in the General Requirements, include the following information:
 - 1. Copies of all approved submittals
 - 2. Manufacturer's wiring diagrams for electrically powered equipment

3. Records of tests performed to certify compliance with system requirements
4. Certificates of inspection by regulatory agencies
5. Parts lists for manufactured equipment
6. Preventive maintenance recommendations
7. Warranties
8. Additional information as indicated in the technical specification sections

1.16 TRAINING OF MILWAUKEE WATER WORKS PERSONNEL

- A. Instruct Milwaukee Water Works personnel in the proper operation and maintenance of systems and equipment provided as part of this project; video tape all training sessions. Include not less than 40 hours of instruction, using the Operating and Maintenance manuals during this instruction. Demonstrate startup and shutdown procedures for all equipment. All training sessions are to be held during normal working hours at the Florist Pumping Station. Furnish training materials for 10 Milwaukee Water Works employees.

1.17 RECORD DRAWINGS

- A. The Contractor shall maintain at least one copy each of the specifications and drawings on the job site at all times.
- B. Milwaukee Water Works will provide the Contractor with a suitable set of contract drawings on which daily records of changes and deviations from contract shall be recorded. Dimensions and elevations on the record drawings shall locate all buried or concealed piping, conduit, or similar items.
- C. The daily record of changes shall be the responsibility of Contractor's field superintendent. No arbitrary mark-ups will be permitted.
- D. At completion of the project, the Contractor shall submit the marked-up record drawings to the Milwaukee Water Works prior to final payment.

PART 2 PRODUCTS

2.01 NON-RATED PENETRATIONS

- A. In exterior wall openings below grade, use a modular mechanical type seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the uninsulated conduit and the cored opening or a water-stop type wall sleeve.
- B. At conduit and cable tray penetrations of non-rated interior partitions, floors and exterior walls above grade, use urethane caulk in annular space between conduit and sleeve, or the core drilled opening.

PART 3 EXECUTION

3.01 EXCAVATION AND BACKFILL

- A. Perform all excavation and backfill work to accomplish indicated electrical systems installation in accordance with section 02200 - Earthwork.

3.02 CONCRETE WORK

- A. The Division 3 Contractor will perform all cast-in-place concrete unless noted otherwise elsewhere. Provide all layout drawings, anchor bolts, metal shapes, and/or templates required to be cast into concrete or used to form concrete for the support of electrical equipment.

3.03 EQUIPMENT ACCESS

- A. Install all piping, conduit, ductwork, and accessories to permit access to equipment for maintenance. Coordinate the exact location of wall and ceiling access panels and doors with the General Contractor, making sure that access is available for all equipment and specialties.

3.04 COORDINATION

- A. The Contractor shall cooperate with other trades and Milwaukee Water Works personnel in locating work in a proper manner. Should it be necessary to raise or lower or move longitudinally any part of the electrical work to better fit the general installation, such work shall be done at no extra cost to the Milwaukee Water Works, provided such decision is reached prior to actual installation.
- B. The Contractor shall verify that all devices are compatible for the surfaces on which they will be used. Coordinate all work with other contractors prior to installation. Any installed work that is not coordinated and that interferes with other contractor's work shall be removed or relocated at the installing contractor's expense.
- C. Cooperate with the testing consultant in ensuring specification Section 16020 compliance. Verify system completion to the testing consultant. Demonstrate the starting, interlocking and control features of each system so the testing contractor can perform its work.

3.05 SLEEVES

- A. Pipe sleeves for conduits 6" in diameter and smaller, in new poured concrete construction, shall be schedule 40 steel pipe, plastic removable sleeve or sheet metal sleeve, all cast in place.

- B. In wet area floor penetrations, top of sleeve to be 2 inches above the adjacent floor. In existing wet area floor penetrations, core drill sleeve openings large enough to insert schedule 40 sleeve and grout the area around the sleeve. If a pipe clamp resting on the sleeve supports the pipe penetrating the sleeve, weld a collar or struts to the sleeve that will transfer weight to the existing floor structure. Wet areas for this paragraph are rooms or spaces containing air handling unit coils, converters, pumps, chillers, boilers, and similar waterside equipment.
- C. Pipe penetrations in existing concrete floors that are not in wet areas may omit the use of schedule 40 sleeve and use the core drilled opening as the sleeve.

3.06 SEALING AND FIRESTOPPING

A. Fire and/or Smoke Penetrations:

1. Install approved product in accordance with the manufacturer's instructions where a pipe (i.e. cable tray, bus, cable bus, conduit, wireway, trough, etc.) penetrates a fire rated surface.
2. Where firestop mortar is used to infill large fire-rated floor openings that could be required to support weight, provide permanent structural forming. Firestop mortar alone is not adequate to support any substantial weight.

B. None-Rated Surfaces:

1. When the opening is through a non-fire rated wall, floor, ceiling or roof the opening must be sealed using an approved type of material.
2. Use galvanized sheet metal sleeves in hollow wall penetrations to provide a backing for the sealant. Grout area around sleeve in masonry construction.
3. Install escutcheons or floor/ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces for this paragraph include only those rooms with finished ceilings and the penetration occurs below the ceiling.
4. In exterior wall openings below grade, assemble rubber links of mechanical seal to the proper size for the conduit and tighten in place, in accordance with the manufacturer's instructions. Install so that the bolts used to tighten the seal are accessible from the interior of the building or vault.
5. At interior partitions, conduit penetrations are required to be sealed for all clean rooms, laboratories, and most hospital spaces, computer rooms, dormitory rooms, tele/data/com rooms and similar spaces where the room pressure or odor transmission must be controlled. Apply sealant to both sides of the penetration in such a manner that the annular space between the conduit sleeve and the conduit is completely filled.

3.07 HOUSEKEEPING AND CLEAN UP

- A. The Contractor shall clean up and remove from the premises, on a daily basis, all debris and rubbish resulting from its work and shall repair all damage to new and existing equipment resulting from its work. When job is complete, this Contractor shall remove all tools, excess material and equipment, etc., from the site.

END OF SECTION

SECTION 16111
CONDUIT

PART 1 GENERAL

1.01 SCOPE

- A. Raceways shall be installed as a complete system continuous from service to outlet or equipment, mechanically and electrically connected, constituting a continuous ground system.

PART 2 PRODUCTS

2.01 RIGID METAL CONDUIT AND FITTINGS

- A. Conduit: Heavy wall, galvanized steel, schedule 40, threaded.
- B. Fittings and Conduit Bodies: Use all steel threaded fittings and conduit bodies.

2.02 PVC COATED RIGID METAL CONDUIT

- A. PVC Externally Coated Conduit: Rigid heavy wall, schedule 40, steel conduit with external 40 mil (0.1 mm) PVC coating. Conduit must be hot dipped galvanized inside and out including threads. The PVC coating bond to the galvanized steel conduit shall be stronger than the tensile strength of the coating itself.
- B. Fittings and Conduit Bodies: Threaded type, material to match conduit. PVC coated fittings and couplings shall have specially formed sleeves to tightly seal to conduit PVC coating. The sleeves shall extend beyond the fitting or coupling a distance equal to the pipe outside steel diameter or two inches (50 mm) whichever is greater.

2.03 INTERMEDIATE METAL CONDUIT (IMC) AND FITTINGS

- A. Conduit: Galvanized steel, threaded.
- B. Fittings and Conduit Bodies: Use all steel threaded fittings and conduit bodies.

2.04 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

- A. Conduit: Steel, galvanized tubing.
- B. Fittings: All steel, set screw, water tight, concrete tight. No push-on or indenter types permitted.
- C. Conduit Bodies: All steel threaded conduit bodies.

2.05 FLEXIBLE METAL CONDUIT AND FITTINGS

- A. Conduit: steel, galvanized, spiral strip.
- B. Fittings and Conduit Bodies: All steel, galvanized, or malleable iron.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT AND FITTINGS

- A. Conduit: flexible, steel, galvanized, spiral strip with an outer Liquidtight, nonmetallic, sunlight-resistant jacket.
- B. Fittings and Conduit Bodies: ANSI/NEMA FB 1, compression type. There shall be a metallic cover/insert on the end of the conduit inside the connector housing to seal the cut conduit end.

2.07 ELECTRICAL NONMETALLIC TUBING (ENT) AND FITTINGS

- A. Conduit: ENT (smurf tube), UL listed and NEC recognized.
- B. Fittings: One piece quick connect fittings for 1/2 inch to 1 inch size and schedule 40 cemented fittings for larger size. When installed in concrete, fittings shall be suitable for damp locations and shall be concrete-tight, stub-ups and stub-downs kits shall meet manufacturer's recommendations.

2.08 RIGID NONMETALLIC CONDUIT AND FITTINGS

- A. Conduit: Schedule 40 PVC minimum, Listed, sunlight resistant, rated for 90° C conductors.
- B. Fittings and Conduit Bodies: NEMA TC 2, Listed.

2.09 CONDUIT SUPPORTS

- A. See section 16190.

2.10 GENERAL

- A. All steel fittings and conduit bodies shall be galvanized.
- B. No cast metal, split or gland type fittings permitted.
- C. Condulets larger than 2 inch (50 mm) not permitted except as approved or detailed.
- D. All conduit covers must be fastened to the conduit body with screws and be of the same manufacture.
- E. Wireways and gutters shall not be used in lieu of pull boxes and condulets.

PART 3 EXECUTION

3.01 CONDUIT SIZING, ARRANGEMENT, AND SUPPORT

- A. EMT is permitted to be used in sizes 4" (50 mm) and smaller for power and telecommunication systems. See CONDUIT INSTALLATION SCHEDULE below for other limitations for EMT and other types of conduit.

- B. Size power conductor raceways for conductor type installed. Conduit size shall be 1/2 inch (13 mm) minimum except as specified elsewhere. **Caution: Per the NEC, the allowable conductor ampacity is reduced when more than three current-carrying conductors are installed in a raceway. Contractor must take the NEC ampacity adjustment factors into account when sizing the raceway and wiring system.**
- C. Size conduit for all other wiring, including but not limited to data, control, security, fire alarm, telecommunications, signal, video, etc. shall be sized per number of conductors pulled and their cross-section. 40% fill shall be maximum for all new conduit fills.
- D. Arrange conduit to maintain headroom and present a neat appearance.
- E. Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.
- F. Maintain minimum 6 inch (150 mm) clearance between conduit and piping. Maintain 12 inch (300 mm) clearance between conduit and heat sources such as flues, steam pipes, and heating appliances.
- G. Arrange conduit supports to prevent distortion of alignment by wire pulling operations. Fasten conduit using galvanized pipe straps, conduit racks (lay-in adjustable hangers), clevis hangers, or bolted split stamped galvanized hangers.
- H. Group conduit in parallel runs where practical and use conduit rack (lay-in adjustable hangers) constructed of steel channel with conduit straps or clamps. Provide space for 25 percent additional conduit.
- I. Do not fasten conduit with wire or perforated pipe straps. Before conductors are pulled, remove all wire used for temporary conduit support during construction.
- J. Support and fasten metal conduit at a maximum of 8 feet (2.4 m) on center.
- K. Supports shall be independent of the installations of other trades, e.g. ceiling support wires, HVAC pipes, etc., unless so approved or detailed.
- L. In general, all conduit shall be concealed except where noted on the drawings or approved by the Architect/Engineer. Contractor shall verify with Architect/Engineer all surface conduit installations except in mechanical rooms.
- M. Changes in direction shall be made with symmetrical bends, cast steel boxes, stamped metal boxes or cast steel conduit bodies.
- N. No continuous conduit run shall exceed 100 feet (30 meters) without a junction box.

3.02 CONDUIT INSTALLATION

- A. Cut conduit square using a saw or pipecutter; de-burr cut ends.
- B. Conduit shall not be fastened to the corrugated metal roof deck.

- C. Bring conduit to the shoulder of fittings and couplings and fasten securely.
- D. Use conduit hubs for fastening conduit to cast boxes. Use sealing locknuts or conduit hubs for fastening conduit to sheet metal boxes in damp or wet locations (sheet metal boxes 4 & 11/16th" square and larger, shall contain NO pre-punched or concentric knockouts).
- E. All conduit terminations (except for terminations into conduit bodies) shall use connectors or conduit hubs with one locknut or shall use double locknuts (one each side of box wall) and insulating bushing. Provide bushings for the ends of all conduit not terminated in box walls. Refer to Section 16170-Grounding and Bonding for grounding bushing requirements.
- F. Install no more than the equivalent of three 90 degree bends between boxes.
- G. Use hydraulic one-shot conduit bender or factory elbows for bends in conduit larger than 2 inch (50 mm) size unless sweep elbows are required.
- H. Conduit shall be bent according to manufacturers recommendations. Torches or open flame shall not be used to aid in bend of PVC conduit.
- I. Use suitable conduit caps or other approved seals to protect installed conduit against entrance of dirt and moisture.
- J. Provide 1/8 inch (3 mm) nylon pull string in empty conduit, except sleeves and nipples.
- K. Install expansion-deflection joints where conduit crosses building expansion joints. Note: expansion-deflection joints are not required where conduit crosses building control joints if the control joint does not act as an expansion joint. Install expansion fitting in PVC conduit runs as recommended by the manufacturer.
- L. Avoid moisture traps where possible. Where moisture traps are unavoidable, provide junction boxes with drain fittings at conduit low points.
- M. Where conduit passes between areas of differing temperatures such as into or out of cool rooms, freezers, unheated and heated spaces, buildings, etc., provide Listed conduit seals to prevent the passage of moisture and water vapor through the conduit.
- N. Route conduit through roof openings for piping and ductwork where possible.
- O. Conduit is not permitted in any slab topping of two inches (50 mm) or less.
- P. Ground and bond conduit under provisions of Section 16170.
- Q. Maximum Size Conduit in Slabs Above Grade: 3/4 inch (19 mm). Do not route conduits to cross each other in slabs above grade.
- R. PVC conduit shall transition to galvanized rigid metal conduit before it enters a concrete pole base, foundation, wall (where exposed) or up through a concrete floor.
- S. Identify conduit under provisions of Section 16195.

- T. Use PVC-coated rigid steel factory elbows for bends in plastic conduit larger than 2". PVC elbows are allowed in PVC conduit runs 2" and smaller.
- U. All conduit installed underground (exterior to building) shall be buried a minimum of 24" below finished grade, whether or not the conduit is concrete encased.
- V. PVC conduit shall be cleaned with solvent, and dried before application of glue. The temperature rating of glue/cement shall match weather condition. Apply full even coat of cement/glue to entire area that will be inserted into fitting. The entire installation shall meet manufacturers recommendations.
- W. Medium voltage conduit may be installed in interior locations other than electrical vaults only with special permission from Architect/Engineer.

3.03 CONDUIT INSTALLATION SCHEDULE

- A. Conduit other than that specified below for specific applications shall not be used.
- B. Exposed Outdoor Locations: Rigid steel conduit.
- C. Concealed in Concrete and Block Walls: Rigid steel conduit. Schedule 40 PVC conduit. Electrical Nonmetallic Tubing (ENT).
- D. Wet Interior Locations: PVC coated rigid steel conduit.
- E. Concealed Dry Interior Locations: Rigid steel conduit. Intermediate metal conduit. Electrical metallic tubing.
- F. Exposed Dry Interior Locations: Rigid steel conduit. Intermediate metal conduit. Electrical metallic tubing.
- G. Motor and equipment connections: Flexible PVC coated metal conduit (wet, damp, or dry locations). Flexible metal conduit (dry locations only). Minimum length shall be one foot (300 mm), maximum length shall be three feet (900 mm). Conduit must be installed perpendicular to direction of equipment vibration to allow conduit to freely flex.
- H. Light fixtures: Direct box or conduit connection for surface mounted and recessed fixtures. Flexible metal conduit from a J-box for recessed lay-in light fixtures. Conduit size shall be 3/8" (10 mm) minimum diameter and six foot (1.8 M) maximum length. Conduit length shall allow movement of fixture for maintenance purposes.
- I. Medium Voltage Applications (Interior Locations): Rigid steel conduit.

END OF SECTION

SECTION 16118
UNDERGROUND DUCTBANKS

PART 1 GENERAL

1.01 SCOPE

- A. Watertight underground cast-in-place concrete ductbanks for electrical power and signal distribution.

1.02 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 16010
- B. Indicate material specifications, and provide product data on conduit, spacers, terminators, reinforcing steel and related components.

PART 2 PRODUCTS

2.01 CONDUIT

- A. As indicated on plans.

2.02 ELBOWS

- A. Material to match conduit; minimum bend radius of 36 inches (915 mm).

2.03 SPACERS

- A. Plastic, to maintain 3" minimum between conduits.

2.04 CONDUIT TERMINATION IN MANHOLES AND BUILDINGS

- A. Bushings: Steel bushings shall be used on all metal conduit.
- B. Seals: When entering an existing building or manhole below grade, the concrete shall be core drilled for the appropriate size conduit and seal. The seal shall be a mechanical interlocking assembly seal of modular synthetic rubber links properly sized to fit the pipe and tightened in place, in accordance with the manufacturer's instruction.

2.05 PLUGS

- A. Closure plugs or caps of same material as conduit at ends of unused sections.

2.06 PULL TAPE

- A. Nylon pull tape with measurement markings in uniform lengths in each empty duct.

2.07 GROUNDING

- A. Steel grounding bushings shall be grounded to manhole or junction box ground.
- B. On steel conduit with end bells, provide an Appleton Catalog No. XJB series or equal bonding fitting with bonding strap.
- C. Connect bonding strap to ground wire in manhole or junction box.

PART 3 EXECUTION

3.01 EXCAVATIONS

- A. Excavate trenches for ductbank to adequate width, depth, and proper slope as specified.
- B. Install forms on sides of ductbank if trench is not of proper firmness to prevent cave-in.
- C. Bottom of trench shall be undisturbed earth. If trench bottom is too low for proper grade, fill to proper level with sand and mechanically compact it.
- D. Each excavated section from manhole to manhole and from manhole to building shall be completely excavated and graded before any duct is laid in that section.

3.02 PLACEMENT OF CONDUIT

- A. Within five (5) feet of each building wall or manhole wall penetration, install heavy wall galvanized steel conduit within the concrete envelope to provide protection against vertical shearing. This requirement is waived if the reinforcing steel in the ductbank is poured into the wall or the reinforcing steel from the ductbank is doweled into the wall to provide protection against vertical shearing.
- B. When entering an existing building or manhole, core drill existing walls and waterproof using an assembly of rubber links of mechanical seal to the proper size for the pipe and tighten in place, in accordance with the manufacturer's instruction, after the new conduit is installed.
- C. Install spacers as recommended by conduit manufacturer and requirements stated above, but not to exceed a maximum of 8 ft-0 in. on center for steel conduit. Bottom spacers shall rest on 8" X 16" X 2" minimum concrete pads to prevent them from sinking into the ground and reducing the bottom concrete cover. Stagger conduit joints in concrete encasement 6 in. minimum horizontally.
- D. Pitch conduit properly for drainage to manhole or pull box and to prevent low pockets or irregular dips between conduit ends. Minimum pitch to be 4 in. per 100 ft.
- E. Install not more than one 90 degree bend or equivalent between pull points for primary conduit and two 90 degree bends or equivalent for signal conduit.
- F. In ductbanks with both primary and signal conduit, primary conduit shall be straight and the signal conduit shall contain bends as necessary to accommodate the primary duct.
- G. Install insulated grounding bushings on steel duct ends.
- H. Install nylon pull tape with measurement markings in uniform lengths in each empty duct.

- I. Install closure plugs or caps on empty conduits at building entrances and at terminations in equipment pedestals to prevent the entrance of moisture and gases.

3.03 PLACEMENT OF REINFORCING BARS

- A. Install the bars - one in each corner minimum, overlap the joints 12" and tie into the connecting walls of manholes, vaults, and buildings, etc.
- B. At new building and manhole walls, tie duct and manhole reinforcing steel together to provide a permanent connection.
- C. At existing building and manhole walls, dowel reinforcement bar into the wall to provide protection against vertical shearing.

3.04 PLACEMENT OF CONCRETE

- A. After ducts are in place and before the concrete is poured, the installation shall be inspected by the Engineer. Notify the Engineer at least two days before the time of inspection.
- B. The Contractor shall supervise the placement of concrete in the ductbank.
- C. Complete entire section of conduit from manhole to manhole or from manhole to building before encasement by concrete.
- D. Top of concrete envelopes shall be not less than 24 inches below grade.
- E. Provide minimum of 3"(76 mm) of concrete cover over conduit at the top, bottom and sides of the duct bank. Provide troweled crowned top on the concrete to prevent water accumulation.
- F. Place concrete continuously from manhole to manhole to building without interruption.
- G. Extend concrete envelope to finish floor grade or interior wall surface in buildings at finish pad grade at equipment. Maintain moisture seal.
- H. Pull mandrels and swabs (diameter 1/4 in. smaller than conduit) through each conduit in completed ductbank before installing cables.

3.05 BACKFILL

- A. Install underground warning tape 12" below finish grade over all ductbanks. Tape shall be red with the words "CAUTION-Electric Line Buried Below". Tape shall be Seton Catalog No. 210 or equal.
- B. Compact backfill around ductbank.
- C. After completion of ductbank installation, return all ground and pavement surfaces to original condition or to condition as indicated on the drawings. This includes all sidewalks, curbs, streets, parking areas, lawns, shrubs, etc.

END OF SECTION

SECTION 16121
MEDIUM VOLTAGE CABLE
(ABOVE 600 VOLTS)

PART 1 GENERAL

1.01 SCOPE

- A. Furnishing and installing medium voltage cable including pulling, racking, splicing, and terminating.

1.02 DEFINITION

- A. Manufacturer: the Company which owns controlling interest in the factory actually producing the cable being furnished for this project.

1.03 SUBMITTALS

- A. Submit product data under the provisions of Section 16010.
- B. Submit product data indicating cable and accessory construction, materials, ratings, and all other parameters identified in Part 2 - Products below.
- C. Submit manufacturer's installation instructions.
- D. Submit manufacturer's certificate stating that medium voltage cable meets or exceeds all requirements specified below.

1.04 PROJECT RECORD DOCUMENTS

- A. Submit record documents under provisions of Section 16010.
- B. Accurately record exact sizes, lengths, types, locations, and quantities of cables. Also show where all splices are located for each cable.

1.05 QUALITY ASSURANCE

- A. The manufacturer shall be a company specializing in the manufacture of medium voltage cable and/or accessories with minimum five years documented experience in producing cable and/or accessories similar to those specified below.
- B. The cable materials and manufacture shall meet or exceed all applicable requirements of the latest editions of ICEA Standard S-93-639, AEIC and NEMA standards.
- C. The cable shall be manufactured using the triple tandem extrusion process in which all layers, from the conductor to, and including, the tape shield jacket, are installed at essentially the same time without an intervening storage period on reels or other storage devices.
- D. The Contractor shall be a company specializing in installation of medium voltage cable and accessories with a minimum of five years documented experience in installation of the type of cable and accessories described below.

- E. The electricians employed for this work shall be experienced in medium voltage cable installation. Workmen involved in splicing and termination of cables shall have been specifically trained in the procedures required for the splices and terminations used in this project. At the discretion of the Engineer, documentation of experience and/or training in medium voltage cable splicing and termination shall be furnished by the Contractor.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to and receive products at the site under provisions of Section 16010.
- B. Cable shall be stored according to manufacturer's recommendations as a minimum. In addition, cable must be stored in a location protected from vandalism and weather. If cable is stored outside, it must be covered with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather. If air temperature at cable storage location will be below 40 degrees F., the cable shall be moved to a heated (50 degrees F minimum) location. If necessary, cable will be stored off site at the Contractor's expense.

PART 2 PRODUCTS

2.01 GENERAL

- A. All cable shall be new, delivered to the site, and be less than two years since manufacture. **It shall be from manufacturer's stock; not suppliers' warehouse stock.** Manufacturer's certification of factory test values shall be submitted for all cable furnished. All specified dimensions are nominal.
- B. Provide a 600 volt insulated copper ground conductor in all conduits with medium voltage cable. This ground conductor shall be the same size as the phase conductors. See Section 16170 for more grounding requirements.

2.02 MEDIUM VOLTAGE CABLE – SHIELDED

- A. Usage: This cable shall be used for all above and under ground applications (except for jumper cable applications, see JUMPER CABLE below) and shall be contained in conduit or other raceways. It may be used in cable trays in electrical vaults only.
- B. Cable: Single conductor, insulated cable rated 35 KV or 5 KV, 133% insulation level, ungrounded, NEC-UL Type MV-105. Sizes and ratings as indicated on the Drawings.
- C. Conductor: Soft copper, annealed, uncoated, Class B compressed, compact, or concentric stranded, having nominal direct-current resistance equal to or less than that required in section 2.4.1 or 2.4.2 and Table 2-2 of ICEA S-93-639.

- D. Conductor shield: extruded semiconductor with resistivity requirements of section 3.3 of ICEA S-93-639 for discharge-free designs and nonconducting high permittivity compound for discharge-resistant designs. Material shall be clean stripping from the conductor and firmly bonded to the overlying insulation.
- E. Insulation 5 KV: Extruded EPR (ethylene propylene rubber), rated at 5 KV, 133 per cent insulation level, minimum nominal thickness of .115 inches.
- F. Insulation 35 KV: Extruded EPR (ethylene propylene rubber), rated at 35 KV, 133 per cent insulation level, minimum nominal thickness of .421 inches.
- G. Insulation Shield: The insulation shield shall consist of an extruded semiconducting layer directly over the insulation and a copper tape over the semiconducting covering. The copper tape shall be coated on cable containing a CSPE outer jacket. The tape shall be at least 5 mils (0.127 mm) thick and be spiral wrapped with a minimum 12.5 per cent overlap. The insulation shield shall meet all requirements of section 5 of ICEA S-93-639.
- H. Jacket: Polyvinyl Chloride (PVC), chlorosulfonated polyethylene (CSPE), Chlorinated Polyethylene (CPE), or Low Smoke Zero Halogen (LSZH), black color with a minimum nominal jacket thickness of 80 mils (2.03 mm), meeting all requirements of ICEA S-93-639.
- I. Cable Rating: Continuous duty at 105 degrees C., wet or dry locations, suitable for underground duct installations, NEC-UL type MV-105.

2.03 JUMPER CABLE

- A. Usage: This cable may only be used as a flexible power lead between adjacent equipment such as between the primary switch and the transformer where adequate through-air clearance can be achieved between the conductors. It is not designed for and shall not be used in metallic raceways.
- B. Cable: Single conductor, flexible, non-shielded, insulated cable rated 5 KV or 35 KV, ungrounded. Sizes as indicated on the Drawings.
- C. Conductor: Soft annealed copper, uncoated, concentric stranded.
- D. Conductor shield: extruded semiconductor, clean stripping from the conductor and firmly bonded to the overlying insulation.
- E. Insulation: Extruded EPR (ethylene propylene rubber), rated at 5 KV or 35 KV, minimum thickness of .175 inches for 5 KV or .421 inches for 35 KV
- F. Cable Rating: Continuous duty at 90 degrees C., dry locations.

2.04 CABLE TERMINATIONS

- A. Modular Molded Shrink Type Termination: IEEE 48; Class 1. Kit form, suitable for use with cable specified, including slip-on type flexible skirted polymer or silicon rubber insulator. Termination shall be hot or cold shrink type with internal stress relief tube to distribute electric field (10% to 90% equipotential lines) over entire length of skirted insulator.
- B. Submittal for approval shall show electric field distribution (via equipotential lines) of termination device.
- C. Lugs shall be copper, long barrel, two hole or four hole and rated for the voltage applied. The lugs shall match the pads on the equipment to which the cable will be mounted. For example, if the equipment has a four hole pad, the cable lug shall be four hole type.
- D. If there will be more than one cable on an equipment pad approved spiders (or spacers) must be used. Cable attachment to equipment must match the equipment manufacturers UL labeling requirements (if the equipment is UL Listed) as a minimum. Unless the equipment is designed or listed for it, cable lugs may not be placed back to back on the equipment pad. In all cases, the termination and equipment must be taped with approved anti-tracking tape.

2.05 CABLE SPLICES

- A. Modular Molded Shrink Type Splice: IEEE 404-1986; Class 1. Kit form, suitable for use with cable specified, including slip-on type flexible polymer or silicon rubber insulator. Splice shall be hot or cold shrink type with internal stress relief tube to distribute electric field (10% to 90% equipotential lines) over entire length of insulating material.
- B. Molded body shall contain a built-in internal semiconducting layer which covers and contacts the splice barrel and the cable insulation layer to prevent electrical stress buildup inside the body. This semiconducting layer shall be bonded to and covered with a cured EPDM rubber or polymer insulating layer which, in turn, shall be bonded to and covered with a semiconducting layer and metallic shield and jacket.
- C. Splicing sleeves shall be long barrel type and rated for the voltage applied.
- D. The completed splice shall be approved for underground direct burial and water immersion service.
- E. Submittal for approval shall show electric field distribution (via equipotential lines) of termination device.

2.06 CABLE LABELING

- A. Cable labels shall be engraved, laminated plastic plates suitable for use from -40 deg. F. to 150 deg. F., and shall be resistant to oil, water and solvents. Nameplate shall be minimum size 1-1/2" X 4". Face shall be white and the letters shall be black. Fasten label to cable with nylon tie-wraps. See paragraphs below for information type and label locations.

PART 3 EXECUTION

3.01 CABLE PULLING

- A. Prior to pulling cable, a mandrel/swab 1/4 inch smaller than the duct diameter shall be pulled through duct run to insure adequate opening of duct run. Thoroughly swab conduits to remove foreign material before pulling cables.
- B. Cables shall not be pulled from an outdoor (exterior) location when the outdoor (exterior) air temperature is below 40 deg. F.
- C. Contractor shall furnish all required installation tools to facilitate cable pulling without damage to the cable jacket. Such equipment is to include, but be not limited to, sheaves, winches, cable reels and/or cable reel jacks, duct entrance funnels, pulling tension gauge, and similar devices. All equipment shall be of substantial construction to allow steady progress once pulling has begun. Makeshift devices which may move or wear in a manner to pose a hazard to the cable shall not be used.
- D. Cable ends shall be sealed and firmly held in the pulling device during the pulling operation.
- E. Cable pulling shall be done in accordance with cable manufacturer's recommendations, except as modified herein, and ANSI/IEEE C2 standards. Manufacturer's recommendations shall be a part of the cable submittal. Recommended pulling tensions shall not be exceeded. Pulling bending radius shall not be less than that determined by the manufacturer or the NEC. Restrictions of pulling bending radius dimensions shall be strictly observed. Training bending radius shall not be less than 12 times cable diameter. Any cable bent or kinked to radius less than recommended dimension shall not be installed.
- F. Actual pulling tensions shall be continuously monitored and permanently recorded in a log and submitted to the Engineer at the end of the project.
- G. During pulling operation an adequate number of persons shall be present to allow cable observation at all points of duct entry and exit as well as to feed cable and operate pulling machinery.
- H. Pulling lubricant shall be used to ease pulling tensions. Lubricant shall be of a type which is noninjurious to the cable material used. Lubricant shall not harden or become adhesive with age.
- I. Avoid abrasion and other damage to cables during installation.

- J. Where cables are left in manhole or switchgear overnight or more than 8 hours prior to termination, the cable ends shall be sealed with paraffin or shrink wrap caps and supported in a manner which will prevent entrance of moisture into the cable. Cable shall be terminated and energized as soon as possible.

3.02 CABLE ROUTING IN SWITCHGEAR

- A. Cables within switchgear shall be routed in a manner which will allow adequate room for bending and terminating cables. Cables must be secured in a manner which will not result in cable weight being placed on the termination electrical joint. Cable support shall be made in a manner that does not force cable against grounded metal or which compresses cable diameter. Cable training bending radius shall be at least 12 times cable diameter. Any cable bent to a radius less than recommended dimension will not be accepted.
- B. Jumper cable shall be routed in a manner that maintains adequate through-air clearance between adjacent conductors and between conductors and any metallic or grounded surface.

3.03 SPLICES AND TERMINATIONS INSTALLATION

- A. Splices are to be held to a minimum. Splice locations shall be determined by cable lengths available, pulling conditions and termination points. **Splice locations are to be listed by the Contractor prior to cable purchase and a listing of such locations submitted to the Electrical Engineer for approval before final cable lengths are determined.**
- B. Only experienced electricians shall be employed in this phase of the work. Refer to **QUALITY ASSURANCE** above.
- C. Follow cable manufacturer's and splice or termination manufacturer's installation instructions and ANSI/IEEE C2 standards.
- D. Clean, white lint-free gloves shall be used to handle end of cable during tape wrapping procedures.
- E. Termination or splicing of the copper conductors (both power and ground conductors) shall be made only with tool applied compression (swaged) fittings.
- F. Ground system connections:
 - 1. Cable to bus: compression cable fitting bolted to bus with lock washers under nut.
 - 2. Cable to ground rod: approved bolted fitting with backing plate between cable and rod.
- G. Ground cable shield at each termination and splice.
- H. Splice or termination failure upon high potential acceptance test will require complete reconstruction of the joint to manufacturer's specifications. Make sure that there is enough free cable at each termination or splice for two more terminations or splices to be performed.

- I. Install Scotch #70 tape for anti-tracking on all exposed terminations.
- J. All splices and terminations are to be tagged using embossed plastic tags with plastic attachment devices indicating date splice or termination was made, name of electrician involved, name of Contractor installing cable, feeder number and circuit to and from data.
- K. Lugs shall be bolted to termination pads in equipment using corrosion resistant bolts, nuts, and washers. Use Belleville washers for bolting aluminum to aluminum, and lock washers for bolting copper to copper or as recommended by equipment manufacturer. Washers shall be in the lug side. Torque to manufacturer's recommendations.

3.04 FIREPROOFING OF MEDIUM VOLTAGE CABLES

- A. Exposed cables in manholes, vaults, and cable trays shall be fireproofed. Additionally, cables shall be fireproofed in pull boxes, troughs, switchgear pull sections, bases, and pulling pits containing two or more sets of cable. Entire installation shall conform to manufacturer's recommendations.
- B. Arc proofing material shall be Scotch #77 electrical arc and fireproofing tape, or approved equal.
- C. Install the fireproofing on the cables as follows:
- D. Install tightly applied fireproofing tape, approximately 1/16 inch thick by 1-1/2 inches wide minimum, around each feeder spirally in one half-lapped wrapping.
- E. Install the tape with the coated side towards the cable and extend it not less than one inch into each duct.
- F. Install random wrappings of Scotch #69 glass cloth tape around the installed fire proofing tape per manufacturer's instructions to prevent it from unraveling.

3.05 CABLE ACCEPTANCE TESTS

- A. Acceptance tests will be performed on all cable after installation and prior to energization. All splices and terminations are to be completed and tested as part of the acceptance test.
- B. In the event that test results are not satisfactory, the Contractor shall make repairs and replace components as necessary to correct faults. Following corrections, tests will be repeated to the extent required to prove the deficiencies are corrected.

3.06 CABLE IDENTIFICATION AND LABELING

A. Provide the following information on cable identification label:

1. Main feeder circuit breaker number
2. Phase
3. To and From Data

EXAMPLE:

FDR C.B.: 1

PHASE: B

TO: TRANSFORMER T1

FROM: SWG SECTION 2

B. Install cable labels on each conductor at each cable termination, each cable splice, in each manhole and in each pullbox. Additionally, at these locations, provide one inch (1") colored vinyl plastic electrical tape wrap identification, (Scotch 35 or approved equal) around each conductor and cable as follows:

1. 5 KV individual conductor system
 - A - phase - one (1) yellow wrap
 - B - phase - two (2) yellow wraps with 1/2" space between wraps
 - C - phase - three (3) yellow wraps with 1/2" space between wraps
2. 35 KV individual conductor system
 - A - phase - one (1) red wrap
 - B - phase - two (2) red wraps with 1/2" space between wraps
 - C - phase - three (3) red wraps with 1/2" space between wraps

C. See paragraph above under **SPLICES AND TERMINATIONS INSTALLATION** for splice label requirements. This is in addition to identification labels.

D. During entire cable installation, phasing of conductors shall be maintained and identified. Where final connections to equipment are made, phasing shall be verified and proper phase rotation determined prior to connection.

END OF SECTION

SECTION 16123
BUILDING WIRE AND CABLE
(BELOW 600 VOLTS)

PART 1 GENERAL

1.01 SCOPE

- A. Furnishing and installing required wiring and cabling systems including pulling, terminating and splicing.

1.02 SUBMITTALS

- A. Submit under provisions of General Conditions of Section 16010.
- B. Submit product data: Provide for each cable assembly type.
- C. Submit factory test reports: Indicate procedures and values obtained.

1.03 PROJECT CONDITIONS

- A. Verify that field measurements are as shown on Drawings.
- B. Conductor sizes are based on copper.
- C. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.
- D. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

PART 2 PRODUCTS

2.01 GENERAL

- A. All wire shall be new, delivered to the site in unbroken cartons and shall be less than one year old out of manufacturer's stock.
- B. All conductors shall be copper.
- C. Insulation shall have a 600 volt rating.
- D. In mechanical rooms, light fixtures, and other high temperature applications, the insulation shall be rated 90 degrees C. Other areas shall use insulation rated 75 degrees C unless stated otherwise in other parts of these specifications and drawings.
- E. All conductors must be suitable for the application intended. Conductors #10 and larger must be stranded. Conductors #12 and smaller may be solid or stranded with the following requirements or exceptions:
- F. All conductors terminated with crimp type devices must be stranded.

- G. Stranded conductors may only be terminated with UL OR ETL Listed type terminations or methods: e.g. stranded conductors may not be wrapped around a terminal screw but must be terminated with a crimp type device or must be terminated in an approved back wired method.

2.02 BUILDING WIRE

- A. Description: Single conductor insulated wire.
- B. Insulation: Type THHN/THWN, XHHW-2 insulation for feeders and branch circuits. Type XHHW-2 insulation for feeders with aluminum conductors.

2.03 UNDERGROUND WIRE FOR EXTERIOR WORK

- A. Description: Stranded single or multiple conductor insulated wire.
- B. Insulation: Type XHHW-2 or USE.

2.04 REMOTE CONTROL AND SIGNAL CABLE

- A. Control Cable for Class 1 Remote Control and Signal Circuits: 600 volt insulation, individual conductors twisted together, [shielded], and covered with an overall PVC jacket. Cable shall be Listed, temperature rated, and plenum or non-plenum rated for the application as required in the National Electrical Code.
- B. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits shall be constructed, Listed, temperature rated, and plenum or non-plenum rated for the application as required in the NEC Article 725.

2.05 WIRING CONNECTORS

- A. Split Bolt Connectors: Not acceptable.
- B. Solderless Pressure Connectors: High copper alloy terminal. May be used only for cable termination to equipment pads or terminals. Not approved for splicing.
- C. Spring Wire Connectors: Solderless spring type pressure connector with insulating covers for copper wire splices and taps. Use for conductor sizes 10 AWG and smaller.
- D. All wire connectors used in underground or exterior pull boxes shall be gel filled twist connectors or a connector designed for damp and wet locations.
- E. Mechanical Connectors: Bolted type tin-plated; high conductivity copper alloy; spacer between conductors; beveled cable entrances.
- F. Compression (crimp) Connectors: Long barrel; seamless, tin-plated electrolytic copper tubing; internally beveled barrel ends. Connector shall be clearly marked with the wire size and type and proper number and location of crimps.

PART 3 EXECUTION

3.01 GENERAL WIRING METHODS

- A. All wire and cable shall be installed in conduit. However, low voltage control and signal cables may be installed without conduit above accessible ceilings if the cable meets NEC requirements for the application unless specified to be in conduit in other sections of the specifications.
- B. Do not use wire smaller than 12 AWG for power and lighting circuits, 14 AWG for control wiring greater than 60 volts, or #18 AWG for voltages less than 60 volts, all sizes subject to NEC 725 requirements.
- C. All conductors shall be sized to prevent excessive voltage drop at rated circuit ampacity. As a minimum use 10 AWG conductor for 20 ampere, 120 volt branch circuit home runs longer than
- D. 100 feet (30 m), and for 20 ampere, 277 volt branch circuit home runs longer than 200 feet (61 m).
- E. Make conductor lengths for parallel conductors equal.
- F. Splice only in junction or outlet boxes.
- G. No conductor less than 10 AWG shall be installed in exterior underground conduit (except low voltage cabling).
- H. Identify ALL low voltage, 600v and lower, wire per section 16195.
- I. Neatly train and lace wiring inside boxes, equipment, and panelboards.

3.02 WIRING INSTALLATION IN RACEWAYS

- A. Pull all conductors into a raceway at the same time. Use Listed wire pulling lubricant for pulling 4 AWG and larger wires and for other conditions when necessary.
- B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.
- C. Completely and thoroughly swab raceway system before installing conductors.
- D. Place all conductors of a given circuit (this includes phase wires, neutral (if any), and ground conductor) in the same raceway. If parallel phase and/or neutral wires are used, then place an equal number of phase and neutral conductors in same raceway or cable.

3.03 FREE-AIR CABLE INSTALLATION

- A. 'Free-Air' (exposed cabling) cable installation shall only be allowed with low voltage control or signal cables. No cabling shall be installed 'Free-Air' unless specifically noted on the drawings for each occurrence.

- B. When permitted in exposed ceiling areas, 'Free-Air' wiring runs shall avoid areas of high traffic (i.e. aisle way), shall be run as close as possible to outlining walls and shall be a minimum of ten (10) feet above finished floor.
- C. Cabling shall be neatly run at right angles and be kept clear of other trades work.
- D. Cabling shall be supported at a maximum of 4-foot intervals utilizing 'bridal-type' mounting rings anchored to ceiling concrete, piping supports or structural steel beams. If cable sag at mid-span exceeds 12-inches, another support shall be provided. Mounting rings shall be designed to maintain cables bend to larger than the minimum bend radius (typically 4 x cable diameter).
- E. Cabling shall not be attached to or supported by existing cabling, plumbing or steam piping, ductwork, suspended ceiling supports or electrical conduit. Additionally, cabling shall not be laid directly on the ceiling grid.
- F. To reduce or eliminate Electro-Magnetic Interference (EMI), the following minimum separation distances for 'Free-Air' cabling installations shall be adhered to:
 - 1. Twelve (12) inches from power lines of less than 5kV.
 - 2. Thirty-nine (39) inches from power lines of 5kV or greater.
 - 3. Eighteen (18) inches from lighting fixtures.
 - 4. Thirty-nine (39) inches from transformers and motors.
- G. A coil of 2 feet in each cable shall be placed in the ceiling at each 'free-air' wired device. These coils shall be secured (wire tied) at the last cable support before the cable reaches the device and shall be coiled from 100% to 200% of the cable recommended minimum bend radius.
- H. All cable shall be free of tension at both ends. Nylon strain relief connectors shall be provided at each device and junction box where cables enter. In cases where the cable must bear some stress, Kellum type grips may be used to spread the strain over a longer length of cable.
- I. Cable manufacturers minimum bend radius shall be observed in all instances. Care should be taken in the use of cable ties to secure and anchor the station cabling. Ties should not be over tightened as to compress the cable jacket. No sharp burrs should remain where excess length of the cable tie has been cut.
- J. All exposed vertical cable extensions to devices located below the finished ceiling shall be in conduit.
- K. Provide protection for exposed cables where subject to damage.
- L. Control cables for controlling HVAC and lighting equipment connected to emergency power shall be routed in raceway.
- M. Use suitable cable fittings and connectors.

3.04 WIRING CONNECTIONS AND TERMINATIONS

- A. Splice only in accessible junction boxes.
- B. Wire splices and taps shall be made firm, and adequate to carry the full current rating of the respective wire without soldering and without perceptible temperature rise.
- C. All splices shall be so made that they have an electrical resistance not in excess of two feet (600 mm) of the conductor.
- D. Use solderless spring type pressure connectors with insulating covers for wire splices and taps, 10 AWG and smaller.
- E. Use mechanical or compression connectors for wire splices and taps, 8 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor.
- F. Thoroughly clean wires before installing lugs and connectors.
- G. At all splices and terminations, leave tails long enough to cut splice out and completely re-splice.

3.05 WIRE COLOR

- A. For wire sizes 10 AWG and smaller - Wire shall be colored as indicated below.
- B. For wire sizes 8 AWG and larger - Identify wire with colored tape at all terminals, splices and boxes. Colors to be as indicated below.
- C. Use black and red for single phase circuits at 120/240 volts, use Phase A black, Phase B red and Phase C blue for circuits at 120/208 volts single or three phase, and use Phase A brown, Phase B orange and Phase C yellow for circuits at 277/480 volts single or three phase. Note: This includes fixture whips except for Listed whips mounted by the fixture manufacturer on the fixture and Listed as a System.
- D. Neutral Conductors: White for 120/208V and 120/240V systems, Gray for 277/480V systems. Where there are two or more neutrals in one conduit, each shall be individually identified with the proper circuit.
- E. Branch Circuit Conductors: Three or four wire home runs shall have each phase uniquely color coded.
- F. Feeder Circuit Conductors: Each phase shall be uniquely color coded.
- G. Ground Conductors: Green for 6 AWG and smaller. For 4 AWG and larger, identify with green tape at both ends and at all access points, such as panelboards, motor starters, disconnects and junction boxes. When isolated grounds are required, contractor shall provide green with yellow tracer.

3.06 BRANCH CIRCUITS

- A. The use of multi-wire branch circuits with a common neutral feeding load is not permitted.
- B. All branch circuits shall be furnished and installed with an individual accompanying neutral, sized the same as the phase conductor.

3.07 EMERGENCY CIRCUITS

- A. All emergency system wiring shall be installed in raceways separate from all other systems.

END OF SECTION

SECTION 16130
BOXES

PART 1 GENERAL

1.01 SCOPE

- A. Wall and ceiling outlet boxes, floor boxes, pull and junction boxes for power, low voltage, fire alarm, and telecommunications including fiberoptic installations.

1.02 SUBMITTALS

- A. Submit product data under provisions of Section 16010.
- B. Provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.

PART 2 PRODUCTS

2.01 GENERAL

- A. All boxes shall be of sufficient size to provide free space for all conductors enclosed in the box and shall comply with NEC requirements.

2.02 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: galvanized steel, with stamped knockouts.
- B. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 3/8 inch male fixture studs where required.
- C. Concrete Ceiling Boxes: Concrete type.
- D. Cast Boxes: Cast ferroalloy, or aluminum type deep type, gasketed cover, threaded hubs.

2.03 PULL AND JUNCTION BOXES

- A. Pull boxes and junction boxes shall be minimum 4 inch square (100 mm) by 2 1/8th inches (54 mm) deep for use with 1 inch (25 mm) conduit and smaller. On conduit systems using 1 1/4 inch (31.75 mm) conduit or larger, pull and junction boxes shall be sized per NEC but not less than 4 11/16 inch square (117 mm).
- B. For telecommunication, fiber optic, security, and other low voltage cable installations the NEC box size requirements shall apply. All boxes, used on telecommunication, security, other low voltage and fiber optic systems with conduits of 1 1/4" and larger, shall be sized per the NEC conduit requirements. For determining box size, the conduit is the determining factor not the wire size.
- C. Sheet Metal Boxes: code gauge galvanized steel, screw covers, flanged and spot welded joints and corners.

- D. Sheet Metal Boxes Larger Than 12 Inches (300 mm) in any dimension shall have a hinged cover or a chain installed between box and cover.
- E. Cast Metal Boxes for Outdoor and Wet Location Installations: Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight. Galvanized cast iron or aluminum box and cover with ground flange, neoprene gasket, and stainless steel cover screws.
- F. Fiberglass or Concrete Handholes with weatherproof cover of non-skid finish shall be used for underground installations.
- G. Box extensions and adjacent boxes within 48" of each other are not allowed for the purpose of creating more wire capacity.
- H. Junction boxes 6" x 6" or larger size shall be without stamped knock-outs.
- I. Wireways shall not be used in lieu of junction boxes.

PART 3 EXECUTION

3.01 COORDINATION OF BOX LOCATIONS

- A. Provide electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.
- B. Electrical box locations shown on Contract Drawings are approximate unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough-in.
- C. No outlet shall be located where it will be obstructed by other equipment, piping, lockers, benches, counters, etc.
- D. It shall be the Contractor's responsibility to study drawings pertaining to other trades, to discuss location of outlets with workmen installing other piping and equipment and to fit all electrical outlets to job conditions.
- E. In case of any question or argument over the location of an outlet, the Contractor shall refer the matter to the Engineer and install outlet as instructed by the Engineer.
- F. The proper location of each outlet is considered a part of this contract and no additional compensation will be paid to the Contractor for moving outlets which were improperly located.
- G. Locate and install boxes to allow access to them. Where installation is inaccessible, coordinate locations and provide 18 inch (450 mm) by 24 inch (600 mm) access doors.
- H. Locate and install to maintain headroom and to present a neat appearance.

- I. Install boxes to preserve fire resistance rating of partitions and other elements, using approved materials and methods.

3.02 OUTLET BOX INSTALLATION

- A. Do not install boxes back-to-back in walls. Provide minimum 6 inch (150 mm) separation, except provide minimum 24 inch (600 mm) separation in acoustic-rated walls.
- B. Power: Recessed (1/4" maximum) outlet boxes in masonry, concrete or tile construction shall be masonry type, minimum 4 inch square. Device covers shall be square-cut except rounded corner plaster rings are allowed in drywall applications. Angle cut plaster rings are not permitted. Coordinate masonry cutting to achieve neat openings for boxes.
- C. Low Voltage: Recessed (1/4" maximum) outlet boxes in masonry, concrete or tile construction shall be masonry type, minimum 4 11/16 inch square. Device covers shall be square-cut except rounded corner plaster rings are allowed in drywall applications. Angle cut plaster rings are not permitted. Coordinate masonry cutting to achieve neat openings for boxes.
- D. Provide knockout closures for unused openings.
- E. Support boxes independently of conduit except for cast boxes that are connected to two rigid metal conduits, both supported within 12 inches (300 mm) of box.
- F. Use multiple-gang boxes where more than one device are mounted together; do not use sectional boxes. Provide non-metallic barriers to separate wiring of different voltage systems.
- G. Install boxes in walls without damaging wall insulation.
- H. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
- I. Ceiling outlets shall be 4 inch (100 mm) octagon or 4 inch square, minimum 2-1/8 inch (54 mm) deep except that concrete boxes and plates will be approved where applicable. Position outlets to locate luminaires as shown on reflected ceiling plans. All ceiling outlets shall be equipped with 3/8 inch (10 mm) fixture studs.
- J. In inaccessible ceiling areas, position outlets and junction boxes within 6 inches (150 mm) of recessed luminaire, to be accessible through luminaire ceiling opening.
- K. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioning to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.
- L. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.
- M. Provide cast ferroalloy or aluminum outlet boxes in exterior and wet locations.

- N. Surface wall outlets shall be 4 inch (100 mm) square with raised covers for one and two gang requirements. For three gang or larger requirements, use gang boxes with non-overlapping covers.

3.03 PULL AND JUNCTION BOX INSTALLATION

- A. Locate pull boxes and junction boxes above accessible ceilings, in unfinished areas or furnish and install access panels in non-accessible ceilings where boxes are installed.
- B. Support pull and junction boxes independent of conduit.

END OF SECTION

SECTION 16170
GROUNDING AND BONDING

PART 1 GENERAL

1.01 SCOPE

- A. Grounding electrodes and conductors, equipment grounding conductors and bonding.

1.02 REFERENCES

- A. NFPA 70 - National Electrical Code.
- B. ANSI/IEEE 142 (Latest edition) - Recommended Practice for Grounding of Industrial and Commercial Power Systems.

1.03 SUBMITTALS

- A. Submit product data under the provisions of Section 16010.
- B. Product Data: Provide data for grounding electrodes and connections.
- C. Test Reports: Indicate overall resistance to ground and resistance of each electrode.
- D. Manufacturer's Instructions: Include instructions for preparation, installation and examination of exothermic connectors.

1.04 PROJECT RECORD DOCUMENTS

- A. Submit record documents under provisions of Section 16010.
- B. Accurately record actual locations of grounding electrodes.

1.05 REGULATORY REQUIREMENTS

- A. Conform to requirements of NFPA 70.
- B. Furnish products listed and classified by Underwriters Laboratories, Inc. or testing firm acceptable to authority having jurisdiction as suitable for purpose specified and shown.

PART 2 PRODUCTS

2.01 ROD ELECTRODE

- A. Material: Copper-clad steel.
- B. Diameter: 3/4 inch (19 mm) minimum.
- C. Length: 10 feet (3.5 m) minimum.

2.02 MECHANICAL CONNECTORS

- A. The mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers and lockwashers shall be made of Silicon Bronze and supplied as a part of the connector body and shall be of the two bolt type.

- B. Split bolt connector types are NOT allowed.
- C. The connectors shall meet or exceed UL 467 and be clearly marked with the catalog number, conductor size and manufacturer.

2.03 COMPRESSION CONNECTORS

- A. The compression connectors shall be manufactured from pure wrought copper. The conductivity of this material shall be no less than 99% by IACS standards.
- B. The connectors shall meet or exceed the performance requirements of IEEE 837, latest revision.
- C. The installation of the connectors shall be made with a compression, tool and die system, as recommended by the manufacturer of the connectors.
- D. The connectors shall be clearly marked with the manufacturer, catalog number, conductor size and the required compression tool settings.
- E. Each connector shall be factory filled with an oxide-inhibiting compound.

2.04 EXOTHERMIC CONNECTIONS

- A. As manufactured by Cadweld or similar.

2.05 WIRE

- A. Material: Stranded copper (aluminum not permitted).
- B. Grounding Electrode Conductor: Size as shown on drawings, specifications or as required by NFPA 70, whichever is larger.
- C. Feeder and Branch Circuit Equipment Ground: Size as shown on drawings, specifications or as required by NFPA 70, whichever is larger. Differentiate between the normal ground and the isolated ground when both are used on the same facility.

2.06 BUS

- A. Material: Copper (aluminum not permitted).
- B. Size: 1/4" X 2" minimum.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.02 GENERAL

- A. Install Products in accordance with manufacturer's instructions.
- B. Mechanical connections shall be accessible for inspection and checking. No insulation shall be installed over mechanical ground connections.

- C. Ground connection surfaces shall be cleaned and all connections shall be made so that it is impossible to move them.
- D. Attach grounds permanently before permanent building service is energized.
- E. All grounding electrode conductors shall be installed in PVC conduit or rigid galvanized steel conduit bonded at both ends to the grounding electrode conductor with an approved grounding fitting.

3.03 MEDIUM VOLTAGE SYSTEM GROUNDING

- A. Provide separate 4/0 copper conductor from ground bus to:
 - 1. XO terminal of each transformer.
 - 2. Each high voltage switch ground bus.
 - 3. Secondary service equipment ground bus.
 - 4. Transformer high voltage grounded terminal (if required).
- B. Provide full size 600V copper THHN/THWN or XHHW-2 grounding conductor in each conduit, raceway or enclosure which contains high voltage conductors. Terminate at ground bus of equipment containing high voltage terminations. Connect to ground rod and grounding conductor in manhole.
- C. Bond each enclosure containing high voltage parts (switches, fuses, transformers, pull boxes, etc.) to room ground bus with 4/0 copper conductor.
- D. Bond all conduits containing high voltage conductors or secondary service conductors to penetrated enclosures using grounding bushing and #4 copper conductor. Attach to penetrated enclosures using grounding bushing and #4 copper conductor. Attach to penetrated enclosure using compression lug on stud or bolt and Belleville washers.
- E. Bond all conduits carrying individual grounding or grounding electrode conductors with grounding bushing and separate #4 copper grounding conductor to ground bus.
- F. Provide #10 stranded wire from each termination shield drain wire to ground bus within enclosure. Connect to nearest grounded conductor if ground bus is not within 24". Route shield drains away from energized parts. Make connections with "Sta-Kon" type terminals or tool applied tap connectors.
- G. Provide ground rod in each section of each secondary switchboard. Make Exothermic or UL Listed Mechanical connection between 4/0 copper to ground rod and to switchgear ground bus.

3.04 LESS THAN 600 VOLT SYSTEM GROUNDING

- A. Provide code sized copper grounding electrode conductor from secondary switchboard ground bus, each separately derived system neutral, secondary service system neutral to street side of water meter, building steel, ground rod, and any concrete encased electrodes.

- B. Bond together system neutrals, service equipment enclosures, exposed non-current carrying metal parts of electrical equipment, metal raceway systems, grounding conductor in raceways and cables, receptacle ground connectors, and plumbing systems.
- C. Equipment Grounding Conductor: Provide separate, insulated equipment grounding conductor within each raceway. Terminate each end on suitable lug, bus, enclosure or bushing. Provide a ground wire from each device to the respective enclosure.

3.05 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.

END OF SECTION

SECTION 16190
SUPPORTING DEVICES

PART 1 GENERAL

1.01 SCOPE

- A. Conduit and equipment supports, straps, clamps, steel channel, etc, and fastening hardware for supporting electrical work.

1.02 SUBMITTALS

- A. Submit product data under the provisions of Section 16010.
- B. Product Data: Provide data for support channel.

1.03 QUALITY ASSURANCE

- A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

PART 2 PRODUCTS

2.01 MATERIAL

- A. Support Channel: Galvanized.
- B. Hardware: Corrosion resistant.
- C. Minimum sized threaded rod for supports shall be 1”.
- D. Conduit clamps, straps, supports, etc., shall be steel or malleable iron. One-hole straps shall be heavy duty type. All straps shall have steel or malleable backing plates when conduit is installed on the interior or exterior surface of any exterior building wall.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Fasten hanger rods, conduit clamps, outlet, junction and pull boxes to building structure using expansion anchors, or spring steel clips (interior metal stud walls only).
- B. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs and wood screws in wood construction.
- C. Do not use powder-actuated or plastic anchors.
- D. File and de-bur cut ends of support channel and spray paint with cold galvanized paint to prevent rusting.
- E. Do not fasten supports to piping, ductwork, mechanical equipment, cable tray or conduit.

- F. Do not drill structural steel members unless approved by Engineer.
- G. Fabricate supports from galvanized structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.
- H. In wet locations, mechanical rooms and electrical rooms install free-standing electrical equipment on 3.5 inch concrete pads.
- I. Install surface-mounted cabinets and panelboards with minimum of four anchors. Provide steel channel supports to stand cabinet one inch off wall.
- J. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.
- K. Furnish and install all supports as required to fasten all electrical components required for the project, including free standing supports required for those items remotely mounted from the building structure, catwalks, walkways etc.

END OF SECTION

SECTION 16195
ELECTRICAL IDENTIFICATION

PART 1 GENERAL

1.01 SCOPE

- A. This section describes the products and execution requirements relating to labeling of power, lighting, general wiring, and telecommunications wire and cabling. Further, this section includes labeling of all terminations and related sub-systems, including but not limited to nameplates, stenciling, wire and cable marker labeling of all backbone fiber optic (inter-building, tie & riser) cables, terminating equipment and labeling of inner duct (fiber optic).

1.02 SUBMITTALS

- A. Submit shop drawings under provisions of Section 16010.
- B. Include schedule for nameplates and stenciling.
- C. Prior to installation, the Contractor shall provide samples of all label types planned for the project. These samples shall include examples of the lettering to be used. Samples shall be mounted on 8 1/2" x 11" sheets annotated, explaining their purposed use.

PART 2 PRODUCTS

2.01 MATERIALS

- A. Labels: All labels shall be permanent, and machine generated. **NO HANDWRITTEN OR NON-PERMANENT LABELS ARE ALLOWED.**
- B. Label size shall be appropriate for the conductor or cable size(s), outlet faceplate layout and patch panel design. All labels shall be self-laminating, white/transparent vinyl and be wrapped around the cable or sheath. Flag type labels are not allowed. The labels shall be of adequate size to accommodate the circumference of the cable being labeled and properly self-laminate over the full extent of the printed area of the label.
- C. Nameplates: Engraved three-layer laminated plastic, black letters on a white background. Emergency system shall use white letters on red background.
- D. Tape (phase identification only): Scotch #35 tape in appropriate colors for system voltage and phase.
- E. Adhesive type labels not permitted except for phase and wire identification.

PART 3 EXECUTION**3.01 GENERAL**

- A. Where mixed voltages are used in one building (e.g. 4160 volt, 480 volt, 208 volt) each switch, switchboard, junction box, equipment, etc., on each system must be labeled for voltage in addition to other requirements listed herein.
- B. All branch circuit and power panels must be identified with the same symbol used in circuit directory in main distribution center.
- C. Clean all surfaces before attaching labels with the label manufacturer's recommended cleaning agent.
- D. Install all labels firmly as recommended by the label manufacturer.
- E. Labels shall be installed plumb and neatly on all equipment.
- F. Install nameplates parallel to equipment lines.
- G. Secure nameplates to equipment fronts using screws, or rivets. Secure nameplate to inside of recessed panelboards in finished locations.
- H. Embossed tape will not be permitted for any application.

3.02 JUNCTION AND PULLBOX IDENTIFICATION

- A. The following junction and pullboxes shall be identified utilizing spray painted covers

<u>System</u>	<u>Color(s)</u>
Secondary Power – 480Y/277V	Brown
Secondary Power – 208Y/120V, 240/120V	White
Emergency Power – 480Y/277V	Brown/Red
Emergency Power – 208Y/120V	White/Red
Fire Alarm	Red
Temperature Control	Green
Door Control and Door Monitoring System	Orange
Sound and Intercom Systems	Blue
Video Surveillance System/MATV	Yellow

3.03 INNERDUCT LABELING

- A. All innerduct containing fiber optic cable installed under this project shall be labeled where exposed. This includes areas where the innerduct is (1) installed alone in risers, tunnels or trays, (2) where they transit manholes and/or pull boxes and (3) in equipment rooms.
- B. The innerduct shall be labeled with a durable Yellow Polyethylene tag which reads "CAUTION FIBER OPTIC CABLE" and includes blank spaces for adding fiber count and destination information. The destination of the cable(s) contained in the innerduct and the fiber count shall be marked on the tag. Hand lettering is acceptable on this tag, using an indelible type ink.
- C. The tag shall be secured to the innerduct(s) using self-locking ties.
- D. Innerduct shall be labeled on each floor in a riser installation, in each manhole and/or handhole or at 25-foot intervals in a tunnel or tray installation.

3.04 POWER AND CONTROL WIRE IDENTIFICATION

- A. Provide wire markers on each conductor in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection. Identify with branch circuit or feeder number for power and lighting circuits, and with control wire number as indicated on schematic and interconnection diagrams or equipment manufacturer's shop drawings for control wiring.
- B. All wiring shall be labeled within 2 to 4 inches of terminations. Each end of a wire or cable shall be labeled as soon as it is terminated including wiring used for temporary purposes.

3.05 NAMEPLATE ENGRAVING

- A. Provide nameplates of minimum letter height as scheduled below.
- B. Panelboards, Switchboards and Motor Control Centers: 1 inch (25 mm); identify equipment designation. 1/2 inch (13 mm); identify voltage rating, source and room location of the source.
- C. Equipment Enclosures: 1 inch (25 mm); identify equipment designation.
- D. Circuit Breakers, Switches, and Motor Starters in Panelboards or Switchboards or Motor Control Centers: 1/2 inch (13 mm); identify circuit and load served, including location.
- E. Individual Circuit Breakers, Disconnect Switches, Enclosed Switches, and Motor Starters: 1/2 inch (13 mm); identify source and load served.
- F. Transformers: 1 inch (25 mm); identify equipment designation. 1/2 inch (13 mm); identify primary and secondary voltages, primary source, and secondary load and location.

- G. Junction boxes: 1 inch (25 mm); identify system source(s) and load(s) served. Junction boxes may be neatly identified using a permanent marker.

3.06 PANELBOARD DIRECTORIES

- A. Typed directories for panels must be covered with clear plastic, have a metal frame. Room number on directories shall be Owner's numbers, not Plan numbers unless Owner so specifies.

END OF SECTION

SECTION 16461
DRY TYPE TRANSFORMERS
(LESS THAN 600 VOLTS)

PART 1 GENERAL

1.01 SCOPE

- A. Dry type general purpose two winding transformers meeting the requirements of NEMA TP-1, and dry type isolation transformers.

1.02 SUBMITTALS

- A. Submit product data under provisions of Section 16010.
- B. Include outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVA, and impedance ratings and characteristics, loss data, efficiency at 25, 50, 75 and 100 percent rated load, sound level, tap configurations, insulation system type, and rated temperature rise.

1.03 DELIVERY, STORAGE, AND HANDLING

- A. Store and protect equipment in a dry location with uniform temperature. Cover ventilating openings to keep out dust.
- B. Handle transformers using only lifting eyes and brackets provided for that purpose. Protect units against entrance of rain, sleet, or snow if handled in inclement weather.

PART 2 PRODUCTS

2.01 DRY TYPE GENERAL PURPOSE TWO WINDING TRANSFORMERS

- A. Dry Type General Purpose Transformers: Factory-assembled, air cooled, dry type general purpose two winding transformers per NEMA-TP1; ratings as shown on the Drawings.
- B. Transformers shall meet the energy efficiency standards of NEMA TP-1 and the DOE 'ENERGY STAR' label.
- C. Transformer losses shall conform to NEMA TP-1 requirements.
- D. Insulation system shall be rated at 220 degrees C.
- E. Winding temperature rise shall be rated at 150 degrees C above a 40 degree C ambient.
- F. Case temperature shall not exceed 50 degrees C rise above a 40 degrees C ambient at its warmest point.
- G. Winding Taps, Transformers 15 KVA and Larger: Four 2-1/2 percent taps, two above and two below rated voltage, full capacity taps on primary winding.

H. Sound Levels: Maximum sound levels are as follows:

KVA	Sound
<u>Rating</u>	<u>Level</u>
15-50	45 dB
51-150	50 dB
151-300	55 dB
301-500	60 dB

- I. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap sized to meet NEMA and UL standards.
- J. Coil Conductors: Continuous windings with termination pads brazed or welded.
- K. Isolate core and coil from enclosure using vibration absorbing mounts.
- L. Enclosure: NEMA Type 1. Provide lifting eyes or brackets.
- M. Nameplate: Include transformer connection data.
- N. Mounting: Transformers 75 KVA and less shall be suitable for wall, floor, or trapeze mounting; transformers larger than 75 KVA shall be suitable for floor or trapeze mounting.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Set transformer plumb and level.
- B. Use flexible conduit, 2 ft. (0.6 m) minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- C. Mount transformers on vibration isolating pads suitable for isolating the transformer noise from the building structure.
- D. Provide sufficient space around transformer for cooling as recommended by the manufacturer.

3.02 FIELD QUALITY CONTROL

- A. Check for damage and tight connections prior to energizing transformer.
- B. Measure primary and secondary voltages and make appropriate tap adjustments within 2-1/2 % of the normal operating load after the building is in full operation.

END OF SECTION

SECTION 16465
THREE-PHASE PAD-MOUNTED TRANSFORMERS
(ABOVE 600 VOLTS)

PART 1 GENERAL

1.01 SCOPE

- A. This specification covers the electrical and mechanical characteristics of Three-Phase Step-Down Pad-Mounted Distribution Transformers.

1.02 APPLICABLE STANDARDS

- A. All characteristics, definitions, and terminology, except as specifically covered in this specification, shall be in accordance with the latest revision of the following ANSI/IEEE, NEMA, and Department of Energy standards.
1. C57.12.00 – IEEE Standard for Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
 2. C57.12.28 – Pad-Mounted Equipment - Enclosure Integrity.
 3. C57.12.34 – IEEE Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers.
 4. C57.12.90 – IEEE Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers and IEEE Guide for Short-Circuit Testing of Distribution and Power Transformers.
 5. C57.12.91 – Guide for Loading Mineral-Oil-Immersed Transformers.
 6. NEMA TR 1-1993 (R2000) – Transformers, Regulators and Reactors, Table 0-2 Audible Sound Levels for Liquid-Immersed Power Transformers.
 7. NEMA 260-1996 (2004) – Safety Labels for Pad-Mounted Switchgear and Transformers Sited in Public Areas.
 8. 10 CFR Part 431 – Department of Energy – Energy Conservation Program for Commercial Equipment: Distribution Transformers Energy Conservation Standards; Final Rule.

PART 2 - PRODUCTS

2.01 RATINGS

- A. The transformer shall be designed in accordance with this specification and the kVA rating shall be:
1. QTY (2) 1000 kVA
 2. QTY (2) 2000 kVA

- B. The primary voltage, configuration, and the basic lightning impulse insulation level (BIL) shall be 150 (kV).
- C. The secondary voltage, configuration, and the basic insulation level (BIL) of the secondary voltage shall be:
 - 1. 30 (kV) for 480Y/277V secondary voltage
 - 2. 60 (kV) for 4160Y/2400V secondary voltage
- D. All the transformers shall be furnished with full capacity high-voltage taps. The tap changer shall be clearly labeled to reflect that the transformer must be de-energized before operating the tap changer as required in Section 4.3 of ANSI C57.12.34. The tap changer shall be operable on the higher voltage only for transformers with dual voltage primaries. The transformers shall have the following tap configurations:
 - 1. Two – 2 ½% taps above and below rated voltage (split taps)
- E. The average winding temperature rise above ambient temperature, when tested at the transformer rating, shall not exceed 55°C. When tested at 112% of the base rating, shall not exceed 65°C.
- F. The percent impedance voltage, as measured on the rated voltage connection, shall be per Table 1. For target impedances, the tolerance on the impedance shall be +/- 7.5% of nominal value for impedance values greater than 2.5%. The tolerance on the impedance shall be +/- 10.0% for impedance values less than or equal to 2.5%.

**Table 1
Percent Impedance Voltage**

KVA Rating (Low voltage < 700 V)	Impedance
75	1.10 - 5.75
112.5-300	1.40 - 5.75
500	1.70 - 5.75
750-3750	5.75 nominal

KVA Rating	Low voltage > 700 V (all nominal values)		
	≤150 kV BIL	200 kV BIL	250 kV BIL
1000 - 5000	5.75	7.00	7.50
7500 - 10000	6.50	7.00	7.50

2.02 GENERAL CONSTRUCTION

- A. The core and coil shall be vacuum processed to ensure maximum penetration of insulating fluid into the coil insulation system. While under vacuum, the windings will be energized to heat the coils and drive out moisture, and the transformer will be filled with preheated filtered degassed insulating fluid.

The core shall be manufactured from burr-free, grain-oriented silicon steel and shall be precisely stacked to eliminate gaps in the corner joints. The coil shall be insulated with B-stage, epoxy coated, diamond pattern, insulating paper, which shall be thermally cured under pressure to ensure proper bonding of conductor and paper.

Coils shall be copper.

- B. The dielectric coolant shall be listed less-flammable fluid meeting the requirements of National Electrical Code Section 450-23 and the requirements of the National Electrical Safety Code (IEEE C2-2002), Section 15. The dielectric coolant shall be non-toxic*, non-bioaccumulating and be readily and completely biodegradable per EPA OPPTS 835.3100. The base fluid shall be 100% derived from edible seed oils and food grade performance enhancing additives. The fluid shall not require genetically altered seeds for its base oil. The fluid shall result in zero mortality when tested on trout fry *. The fluid shall be certified to comply with the US EPA Environmental Technology Verification (ETV) requirements, and tested for compatibility with transformer components. The fluid shall be Factory Mutual Approved, UL Classified Dielectric Medium (UL-EOUV) and UL Classified Transformer Fluid (UL-EOVK), Envirotemp[®] FR3 fluid.

*(Per OECD G.L. 203)

2.03 TANK AND CABINET ENCLOSURE

- A. The high-voltage and low-voltage compartments, separated by a metal barrier, shall be located side-by-side on one side of the transformer tank. When viewed from the front, the low-voltage compartment shall be on the right. Each compartment shall have a door that is constructed so as to provide access to the high-voltage compartment only after the door to the low-voltage compartment has been opened. There shall be one or more additional fastening devices that must be removed before the high-voltage door can be opened. Where the low-voltage compartment door is of a flat panel design, the compartment door shall have three-point latching with a handle provided for a locking device. Hinge pins and associated barrels shall be constructed of corrosion-resistant material, passivated AISI Type 304 or the equivalent.
- B. A recessed, captive, penta-head or hex-head bolt that meets the dimensions per ANSI C57.12.28 shall secure all access doors.
- C. The compartment depth shall be in accordance with C57.12.34, unless additional depth is specified.
- D. The tank base must be designed to allow skidding or rolling in any direction. Lifting provisions shall consist of four lifting lugs welded to the tank.
- E. The tank shall be constructed to withstand 7 psi without permanent deformation, and 15 psi without rupture. The tank shall include a 15 psig pressure relief valve with a flow rate of minimum 35 SCFM.

- F. The exterior of the unit shall be painted Munsell 7GY3.29/1.5 green (STD) in color. The cabinet interior and front plate shall be painted gray for ease of viewing the inside compartment.
- G. The tank shall be complete with an anodized aluminum laser engraved nameplate. This nameplate shall meet Nameplate B per ANSI C57.12.00.

2.04 HIGH VOLTAGE BUSHINGS AND TERMINALS

- A. High voltage bushings will be installed in the high voltage termination compartment located on the front left of the transformer and requiring access via the low voltage termination compartment on the front right.
- B. Bushing Style
 - 1. 15/25 KV DEADFRONT, CURRENTS BELOW 200 AMPS: The high voltage bushings shall be 15/25 kV 200A bushing wells with bushing well inserts installed. The bushings shall be externally removable and be supplied with a removable stud.
- C. Bushing Configuration
 - 1. 15/25 KV RADIAL FEED DEADFRONT: The transformer shall be provided with three (3) high voltage bushings in accordance with Figure 1 dimensions from ANSI C57.12.34 for radial feed configurations. The bushing heights shall be in accordance with Figure 3 dimensions of ANSI C57.12.34.

2.05 LOW VOLTAGE BUSHINGS AND TERMINALS

- A. Bushing Style
 - 1. Voltages less than 700 Volts: The transformer shall be provided with tin-plated spade-type bushings for vertical takeoff. The spacing of the connection holes shall be 1.75” on center, per ANSI C57.12.34 figure 13a. The quantity of connection holes shall be 4, 6, 8, 12, 16, or 20 holes.

**Table 2
Standard / Maximum Bushing Hole Quantities**

KVA	208Y/120	480Y/277 and higher
45-300	4 standard, 16 maximum	4 standard, 16 maximum
500	6 standard, 12 maximum	4 standard, 16 maximum
750-1500	12 standard, 20 maximum	6 standard, 12 maximum
2000-3750	N/A	12 standard, 20 maximum

- 2. Bushing supports shall be provided for transformers requiring 10 or more connection holes. Bushing supports shall be affixed to the cabinet sidewalls; tank-mounted supports mountings are not acceptable.

B. Bushing Configuration

1. The transformer shall be provided with bushings in a staggered arrangement in accordance with Figure 11a dimensions of ANSI C57.12.34.
2. Voltages greater than 700 Volts: Secondary arrangements shall be dead-front. Dead-front application with a required neutral shall have a porcelain XO bushing. Provide additional front barrier for high voltage live front secondary, creating an additional barrier after the low voltage door has been opened.

2.06 SWITCHING

- A. Primary Switching: The primary switching scheme provided with the transformer shall be one on-off under-oil load-break switch.

PART 3 - EXECUTION

3.01 LABELING

- A. A temporary bar code label shall be attached to the exterior of the transformer in accordance with ANSI C57.12.34.

3.02 FINISH PERFORMANCE REQUIREMENTS

- A. The tank coating shall meet all requirements in ANSI C57.12.28 including:
 1. Salt Spray
 2. Crosshatch adhesion
 3. Humidity
 4. Impact
 5. Oil resistance
 6. Ultraviolet accelerated weathering
 7. Abrasion resistance – taber abraser
- B. The enclosure integrity of the tank and cabinet shall meet the requirements for tamper resistance set forth in ANSI C57.12.28 including but not limited to the pry test, pull test, and wire probe test.

3.03 PRODUCTION TESTING

- A. All units shall be tested for the following:
 1. No-Load (85°C or 20°C) losses at rated current
 2. Total (85°C) losses at rated current
 3. Percent Impedance (85°C) at rated current
 4. Excitation current (100% voltage) test
 5. Winding resistance measurement tests

6. Ratio tests using all tap settings
 7. Polarity and phase relation tests
 8. Induced potential tests
 9. Full wave and reduced wave impulse test
- B. Minimally, transformers shall conform to efficiency levels for liquid immersed distribution transformers, as specified in Table I.1 of the Department of Energy ruling. “10 CFR Part 431 Energy Conservation Program for Commercial Equipment: Distribution Transformers Energy Conservation Standards; Final Rule; October 12, 2007.” Manufacturer shall comply with the intent of all regulations set forth in noted ruling. This efficiency standard does not apply to step-up transformers.
- C. In addition, the manufacturer shall provide certification upon request for all design and other tests listed in C57.12.00, including verification that the design has passed short circuit criteria per ANSI C57.12.00 and C57.12.90.
- 3.04 APPROVED MANUFACTURERS
- A. Cooper Power Systems—Waukesha WI
- 3.05 ACCESSORIES
- A. The following accessories and options shall be provided:
1. Bolted main tank cover (1000 kVA & below)
 2. Welded main tank cover with bolted handhole (1500 kVA & above)
 3. 1.0” upper fill plug
 4. 1.0” drain valve w/ sampling device in LV compartment (750 kVA & above)
 5. Automatic pressure relief valve
 6. Ground provisions per C57.12.34 section 9.11.
 7. Upper fill valve
 8. Pressure vacuum bleeder
 9. Ground connectors
 10. Mr. Ouch warning & danger signs
 11. Danger high voltage warning signs
 12. Miscellaneous stenciling
 13. Non-PCB decal
 14. Touch-up paint
 15. Liquid level gauge with auxiliary contacts
 16. Dial-type thermometer gauge with auxiliary contacts
 17. Pressure vacuum gauge with auxiliary contacts

18. Winding temperature indicator
19. Combination UL Listed & Classified transformer (to comply with NEC 450-23 listing restrictions for installations on, near, or inside of buildings) per UL XPLH
20. UL Listed transformer (certifying compliance with ANSI standards only) per UL XPLH

3.06 SHIPPING

- A. Transformers, 1000 kVA and below, shall be palletized. Transformers, 1500 kVA and larger, shall be loaded and unloaded with overhead cranes, so a pallet is not to be provided for these transformers.

3.07 SERVICE

- A. The manufacturer of the transformer shall have regional service centers located within 2 hours flight time of all contiguous 48 states. Service personnel shall be factory trained in commissioning and routine service of quoted transformers.

END OF SECTION

SECTION 16470
PANELBOARDS

PART 1 GENERAL

1.01 SCOPE

- A. Main, distribution and branch circuit panelboards.

1.02 SUBMITTALS

- A. Submit shop drawings for equipment and component devices under provisions of Section 16010.
- B. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, and circuit breaker arrangement and sizes.

1.03 SPARE PARTS

- A. Keys: Furnish 2 keys for each panelboard to Owner.

PART 2 PRODUCTS

2.01 BRANCH CIRCUIT PANELBOARDS

- A. Lighting and Appliance Branch Circuit Panelboards: Circuit breaker type.
- B. Enclosure: Type 1; Minimum cabinet size: 5-3/4 inches (144 mm) deep; 20 inches (508 mm) wide with 5" minimum gutter space top and bottom. Constructed of galvanized code gauge steel. Panel enclosure (back box) shall be of non-stamped type (without KO's) to avoid concentric break out problem.
- C. Provide flush cabinet front with concealed trim clamps, concealed hinge and flush cylinder lock all keyed alike. Front cover shall be hinged to allow access to wiring gutters without removal of panel trim. Hinged trim shall be held in place with screw fasteners. Finish in manufacturer's standard gray enamel.
- D. Provide metal directory holders with clear plastic covers.
- E. Provide panelboards with copper bus (phase buses, bus fingers, etc.), ratings as scheduled on Drawings. Provide ground bars in all panelboards. Neutral and ground bars can be dual rated ALCU9. All spaces shall have bus fully extended and drilled for the future installation of breakers.
- F. Minimum System (i.e. individual component) Short Circuit Rating: As shown on the Drawings.
- G. Molded Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers. Provide UL Class A ground fault interrupter circuit breakers where shown on Drawings. Provide circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.

- H. Do not use tandem circuit breakers.
- I. Circuit breakers shall be bolt-on type with common trip handle for all poles. No handle ties of any sort will be approved.
- J. All of the panelboards provided under this section shall be by the same manufacturer.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install panelboards plumb with wall finishes.
- B. Height: 6 ft (2 m) to top.
- C. Install a crimp type stud termination to stranded conductor when terminating on circuit breakers without a captive assembly rated for terminating stranded conductors.
- D. Provide filler plates for unused spaces in panelboards.
- E. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes required to balance phase loads.
- F. Stub three (3) empty $\frac{3}{4}$ " conduits to accessible location above ceiling or below floor out of each recessed panelboard.

3.02 FIELD QUALITY CONTROL

- A. The Contractor shall circuit the panelboards as shown on the drawings. Measure the steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 10 percent, rearrange circuits in the panelboard to balance the phase loads within 10 percent.

3.03 INSPECTION

- A. Visual and Mechanical Inspection
 - 1. Inspect for physical damage, proper alignment, anchorage, and grounding.
 - 2. Check proper installation and tightness of connections.

END OF SECTION

SECTION 16800
LOW VOLTAGE VARIABLE FREQUENCY DRIVE

PART 1 – GENERAL

1.01 SUMMARY

- A. The contractor shall furnish materials, equipment and incidentals required to manufacture, assemble, shop test and provide field services and coordination with the pumps and motors for the variable frequency drive, as specified herein. The variable frequency drive shall be furnished by the contractor as part of total the pumping unit.
- B. The work shall include the services of factory representatives of the variable frequency drive manufacturers to inspect the final installation, to perform all field acceptance tests on the installed equipment and to instruct the regular operating personnel in the care, operation and maintenance of the equipment.

1.02 DESCRIPTION OF SYSTEM

- A. The variable frequency drive shall operate the 250 HP, 460 VAC, 3 phase, 60 cycle squirrel cage, induction motor for the 10 MGD Pump Unit No. 2, as specified in Section 15600. The drive shall be totally compatible with the motor to be supplied.
- B. The drive shall provide for terminations of remote operated operator and field devices.

1.03 MANUFACTURER

- A. Variable Frequency Drive:

1. Rockwell Automation PowerFlex 700S VFD with SMC Bypass shall be furnished to match Rockwell Automation Milwaukee Water Works Drawing Set KXTS47. NOTE: DUE TO COMPATIBILITY WITH UNIT PROGRAMMING, SCADA SYSTEM, AND MAINTENANCE ISSUES, NO SUBSTITUTIONS WILL BE PERMITTED.

1.04 SUBMITTALS

- A. The contractor shall submit copies of all materials required to establish compliance with this section. Submittals shall include but not be limited to the following:
 - 1. Certified shop and erection drawings showing all important details of construction, dimensions and anchor bolt locations. Details shall include front elevations with designation of devices and equipment on doors and internal to the enclosure. Also included shall be internal layout of components showing dimensions and space requirements. Drawings shall be for the specified project, not marked up catalog cuts. Include all descriptive literature, bulletins and catalogs of the equipment.

2. Data on the characteristics and performance of the variable frequency drive. This data shall include a manufacturer's certificate that states this equipment is warranted for use with the equipment specified in Sections 15500 and 15600.
3. Complete drawings shall be furnished for approval before release to manufacture and shall consist of job specific master wiring diagrams, control schematics including coordination with other electrical devices, if any, acting in coordination with the variable frequency drive, and suitable outline drawings with sufficient detail for conduit stubs and field wiring.
4. The total weight of the equipment, including the weight of the largest single item, shall also be included, along with a complete total bill of materials of all the equipment, and a list of the manufacturer's recommended spare parts.

1.05 OPERATING INSTRUCTIONS

- A. The operating and maintenance manuals shall be furnished, prepared specifically for this installation, and shall include all required cuts, drawings, equipment and spare parts lists, and descriptions that are required to instruct and train operators who may be unfamiliar with this type of equipment.
- B. During factory training, detailed manuals to supplement the training shall be provided. A copy of the training presentation, including all slide/video presentations shall be given to the City upon conclusion of the training. The training shall be coordinated with the schedules of the City for operations convenience.

1.06 ON SITE TRAINING

- A. The on-site training conducted at the City's site shall provide detailed hands-on instruction to the City's personnel on all shifts covering: system debugging, program modification, trouble shooting, maintenance procedures, calibration procedures, and system operation. The training shall be conducted for the necessary operations staff, and scheduled to accommodate all shifts.

1.07 TOOLS AND SPARE PARTS

- A. One (1) set of any special tools required for normal operation and maintenance shall be given to the City.
- B. The manufacturer of the drive shall provide a complete list of recommended spare with prices for the first five (5) years of operation. Six (6) spares per drive of all expendable items, such as control fuses and pilot lamps, shall be provided, along with one (1) complete set of power fuses of each type, and one (1) quart of touch-up paint.

1.08 PRODUCT HANDLING

- A. All parts shall be properly protected so that no damage or deterioration will occur during any prolonged delay that could occur from the time of shipment until installation is completed. The VFD shall be stored indoors in a clean place, and space heaters or other means shall be used to prevent condensation.

- B. All equipment and spare parts shall be properly protected against any damage during any storage period before installation.

1.09 WARRANTY

- A. All equipment supplied under this section shall be warranted by the manufacturer for a period two (2) years from the date of final project completion, or 30 months from shipment, whichever occurs first.
- B. The equipment shall be warranted to be free from defects in workmanship, design and manufacture, and it shall be stated that if any part of the equipment shall fail in the warranty period, it shall be replaced and the unit restored to service at no cost to the City.
- C. The variable frequency drive converter and inverter modules/components/sections shall be warranted for a period of five (5) years from the date of final project completion.

END OF SECTION