City of Milwaukee

Milwaukee Water Works

Safe, Abundant Drinking Water.

City of Milwaukee
Department of Public Works
Milwaukee Water Works

Specifications for

Riverside Pumping Station

R-166: Pump #5 Replacement and VFD

WISCONSIN
DINAH G. GANT
E-24682
MILWAUKEE, WI
PROFESSIONAL ENGINEER

Dinah G. Gant, P.E.
Chief Design Engineer

Anthony J. Supinski, P.E.
Civil Engineer IV

Carrie M. Lewis
Superintendent

Philip J. Greuel, P.E.
Civil Engineer III

Bonnie S. Tesch, P.E.
Electrical Engineer III

GENERAL REQUIREMENTS

PART 1 DEPARTMENT OF PUBLIC WORKS - GENERAL SPECIFICATIONS
(NOTE: The Department of Public Works General Specifications applies to all contracts. These specifications are in a separate booklet.)

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

R-166: PUMP #5 REPLACEMENT AND VFD

TABLE OF CONTENTS

SECTION	SUBJECT	PAGE NUMBERS
-----	Official Notices	(i)-(ii)
JR	Job Requirements	1 - 7
01010	Summary of Work	1 - 8
01039	Coordination and Meetings	1 - 5
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
	Attachment "E"	1 - 1
01700	Contract Closeout	1 - 5
01810	Equipment Testing and Facility Startup	1 - 7
	Attachment "F"	1 - 1
	Attachment "G"	1 - 1
	Attachment "H"	1 - 2
02050	Demolition	1 - 2
03300	Concrete Work	1 - 6
03600	Grout	1 - 2
09900	Painting	1 - 3
15050	Miscellaneous Piping	1 - 6
15100	Piping, Valves and Fittings	1 - 13
15101	Flowtube, Instrumentation and Controls	1 - 3
15400	Pump Priming Equipment	1 - 5
15500	Pumping Units – General	1 - 4
15600	Horizontal Centrifugal Pump	1 - 7
15700	Electric Motors	1 - 8
16010	Basic Electrical Requirements	1 - 9
16111	Conduit	1 - 4
16121	Medium Voltage Cable (Above 600 Volts)	1 - 8
16123	Building, Wire and Cable (Below 600 Volts)	1 - 5
16130	Boxes	1 - 2
16190	Supporting Devices	1 - 2
16195	Electrical Identification	1 - 4
16260	Medium Voltage Variable Frequency Drivers Rated 300-10,000HP	1 - 19
-----	Appendix "A" – Lead Paint Analysis	1 - 3
-----	Drawings (attached)	

JOB REQUIREMENTS

R-166: PUMP #5 REPLACEMENT AND VFD

JR-1 FORM OF BID Contractor shall submit a lump sum bid for furnishing the complete job in accordance with plans and specifications.

JR-2 JOB LOCATION Riverside Pumping Station is located at 1311 East Chambers Street, Milwaukee, WI 53212.

JR-3 GENERAL DESCRIPTION OF WORK The work to be performed under this contract consists of the furnishing of all equipment, labor, supervision, materials and appurtenances for and in connection with the following projects as shown on the Contract Drawings and further specified herein. The Contractor shall ensure that all equipment installed under this contract is complete and operational before being put into service.

PUMP #5 REPLACEMENT AND VFD

The Contractor shall replace the existing 25MGD, single speed Pumping Unit #5 with a new variable speed with a range of operations of 15MGD to 25MGD pump, including variable frequency drive unit with soft start motor controller bypass. The new pumping unit shall include: drive, bypass motor controller, motor, pump, flowmeter, suction piping, discharge valves and piping, and all appurtenances & accessories needed to provide a complete and fully operational pumping unit.

VACUUM PRIMING SYSTEM REPLACEMENT

The Contractor shall replace the existing duplex multi-jet vacuum priming system with a new duplex multi-jet vacuum priming system. The new priming system shall include: tank, priming pumps, separation chamber, priming valves, starter controls, gauges, temperature switches, selector switches, check valves, and all piping, appurtenances and accessories needed to provide a complete and fully operational vacuum priming system.

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

Contract Drawing No.	Title
R-166-01	Pump #5 Replacement and VFD Location Map – Drawing Index
R-166-02	Pump #5 Replacement and VFD Pump Floor Plan - Demolition
R-166-03	Pump #5 Replacement and VFD Pump Floor Plan - Installation

R-166-04	Pump #5 Replacement and VFD Section Plan - Demolition
R-166-05	Pump #5 Replacement and VFD Section Plan - Installation
R-166-06	Pump #5 Replacement and VFD Pump Foundation, Valve & Pipe Supports, and Priming System Details
R-166-07	Pump #5 Replacement and VFD 5kV Switchgear Control Schematics
R-166-08	Pump #5 Replacement and VFD Electrical One-Line Modifications
R-166-09	Pump #5 Replacement and VFD Electrical Schedules
R-166-10	Pump #5 Replacement and VFD Soft Start Controller Schematics
R-166-11	Pump #5 Replacement and VFD Floor Plan – First Floor

JR-5 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, prior to the placement of equipment orders.

Reference Drawing No.	Title
R-117-1	Riverside Pumping Station Pump Floor Plan
R-119-4	Riverside Station Breaker & Valve Control Schematics – 5KV
R-119-5	Riverside Station Breaker & Control Schematics Low Voltage
R-119-6	Riverside Station Switchgear Floor Plan

R-119-7	Riverside Station Power & Control Conduits Switchgear Room
R-119-8	Riverside Station Power & Control Conduits Pump Room & Basement Storage
R-119-9	Riverside Station Power & Control Conduits Building Section
R-119-17	Riverside Station Panel Details Panels 1 thru 6
R-119-18	Riverside Station Panel Details Panels 7 thru 12
R-119-19	Riverside Station Panel Details DC Power One-line Diagram
R-119-20	Riverside Station Electrical Details
R-124-1	Riverside Station Pumps, Piping & Foundations Pump Floor Plan
R-124-2	Riverside Station Pumps, Piping & Foundations Suction Piping Plan
R-124-4	Riverside Station Pumps, Piping & Foundations Pump Piping Section & Details
R-124-5	Riverside Station Pumps, Piping & Foundations Concrete & Grading Floor Plan
R-124-6	Riverside Station Pumps, Piping & Foundations Concrete Plan Below Pump Room Floor

R-124-8	Riverside Station Pumps, Piping & Foundations Concrete Sections and Misc. Details
R-124-9	Riverside Station Pumps, Piping & Foundations Concrete Details
R-124-10	Riverside Station Pumps, Piping & Foundations Piping Details
R-124-11	Riverside Station Pumps, Piping & Foundations Pump Priming System & Misc. Piping Details
R-152-14	Riverside Station 5KV Switchgear Control Schematics
R-152-24	Riverside Station Indoor 4160 V. 2000A, Metal-Clad Switchgear, A.C. Schematic, Units 1-75KV
R-152-30	Riverside Station 4.160 KV., 3-phase, 3wire, 60Hz, 5KV Class M.C .Switchgear, Motor Feeders Unit 2
R-152-31	Riverside Station 4.160 KV., 3-phase, 3wire, 60Hz, 5KV Class M.C .Switchgear, Top Compartment Unit 2

JR-6 PRE-BID MEETING: A **MANDATORY** Pre-Bid Meeting is scheduled for **THURSDAY, APRIL 18, 2013 at 10:00 AM** in the Linnwood 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 will be available at the **MANDATORY** Pre-Bid Meeting. **All attendees are required to e-mail anthony.supinski@milwaukee.gov and philip.greuel@milwaukee.gov at least 24 hours in advance of the Pre-Bid Meeting to be placed on the visitor list for access to the Linnwood Purification Plant.**

Site Visit: A site visit will take place at the conclusion of the **MANDATORY** Pre-Bid Meeting.

JR-7 PRE CONSTRUCTION MEETING Within **ten (10) business days** after Notice to Proceed is issued, a pre-construction (pre-submittal) meeting will be held at the job site. The meeting will include discussion of design and equipment function and system operation details of the project.

JR-8 PRE-INSTALLATION MEETING No less than **twenty (20) business days** prior to the start of construction, a meeting will be held at the job site to discuss security requirements, scheduling of work, equipment delivery and storage, and other construction details of the project.

JR-9 JOB SCHEDULE Within **ten (10) business days** after Notice to Proceed is issued, the contractor shall submit a construction/submittal 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 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.**

The contractor shall place all orders for materials promptly after award of the contract. With submittal of the construction schedule, he shall include a schedule of delivery of all major material and equipment required for the job.

The contractor shall immediately notify the City, in writing, of any problems with meeting this schedule. If the construction schedule cannot be met because of materials or equipment deliveries, the contractor shall be required to submit purchase orders and confirmations of delivery, showing the date the order was placed and the promised date of delivery.

JR-10 COMPLETION DATE All work on this project shall be completed according to the following schedule:

No Work Shall Begin Before:	**Notice to Proceed**
Substantial Completion:	**June 12, 2015**
Final Completion:	**July 31, 2015**

JR-11 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-12 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. Payment requests should be sent by U.S. mail to Ms. Carrie Lewis, Superintendent, Milwaukee Water Works, Room 409, Frank P. Zeidler Municipal Building, 841 N. Broadway, Milwaukee, WI 53202.

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.

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 (Field Engineer shall verify that material is as specified and 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.

JR-13 FORMAL CORRESPONDENCE Formal correspondence shall be addressed to: Ms. Carrie M. Lewis, Superintendent of Milwaukee Water Works, 841 North Broadway, Room 409, Zeidler Municipal Building, Milwaukee, WI 53202. Formal correspondence includes:

1. Progress Payments
2. Request for Change Order
3. Request for extension of Completion Date
4. Disputes concerning Payment or Field Issues
5. Submittals

END OF SECTION

SECTION 01010

SUMMARY OF WORK

PART 1 GENERAL

This contract shall include the furnishing of all equipment, labor, supervision, materials, and appurtenances for and in connection with the following projects as shown on the Contract Drawings and further specified herein.

1.01 PUMP #5 REPLACEMENT AND VFD

The work shall consist of all labor, equipment, supervision, and materials to remove one (1) single speed centrifugal pumping unit, and replace it with one (1) new variable speed centrifugal pumping unit, including variable frequency drive (VFD) with soft start bypass motor controller. Pumping unit shall include the following: pump, motor, drive, soft start bypass motor controller, suction piping, discharge valves, flowtube and piping, demolition, restoration, and all other appurtenances required for a complete and fully operational variable frequency driven pumping unit with manual soft start bypass. The work to be performed shall include but not be limited to the following:

A. Demolition, removal and disposal of the existing fixed speed 25 million gallons per day (MGD) Pumping Unit No. 5 and peripherals, including: pump, motor, baseplate, suction and discharge piping, venturi, couplings, discharge valves (5B & 5C), valve controller, and instrumentation (See Section 02050, DEMOLITION, for list of salvageable items to be turned over to the City). The Contractor shall be responsible for the removal and proper off-site disposal of all demolished equipment.

B. Demolition, removal and disposal of the existing concrete foundation pad and all discharge valve and piping supports.

C. Install new reinforced concrete pump foundation and all valve, discharge bend and piping supports as shown on the Contract Drawings.

D. Supply and installation of one new horizontal split-case, bottom-suction, side-discharge, double volute, double suction, centrifugal pumping unit rated for 25 MGD at a rated head of 295 feet, complete with induction motor and baseplate.

E. Supply and installation of one (1) VFD unit (with poured concrete pad) designed to operate the pumping unit at a range of 15 MGD to 25 MGD.

F. Supply and installation of one new soft start bypass motor controller designed to operate the 25 MGD pumping unit when in bypass mode.

G. Supply and installation of new suction and discharge piping, cone valve (electrically operated), BFV (manually operated with limit switches), electromagnetic flowtube, fittings, couplings, and specials as required.

H. Supply and installation of instrumentation equipment (pressure gauge, pressure switch, and flowtube transmitter) as shown.

I. Programming of GE469 Motor Feeder Protective Relay and 4.16kVswitchgear wiring modifications for Pump No. 5.

J. Finish paint of new pump, piping, valves, motor, etc.

K. Furnishing of shop drawings, as-built drawings, Operation and Maintenance Manuals with data, spare parts, and maintenance materials, as outlined later in this section.

L. Start-up training on the pump and VFD.

1.02 VACUUM PRIMING SYSTEM REPLACEMENT

The work shall consist of all labor, equipment, supervision, and materials to remove the existing duplex vacuum priming system, and replace it with a new duplex vacuum priming system. The new vacuum priming system shall include the following: tank, vacuum pumps, motor, separation chamber, starter control, gauges, switches, check valves, priming valves, piping, and appurtenances required for a complete and fully operational vacuum priming system. The work to be performed shall include but not be limited to the following:

A. Demolition, removal and disposal of the entire existing vacuum priming system to all nine pumping units. The Contractor shall be responsible for the removal and proper off-site disposal of the demolished equipment.

B. Supply and installation of vacuum tank with gauges and specified tapped connections.

C. Supply and installation of a duplex, multi-jet vacuum pump assembly with pump, motor, venturi, and separation chamber.

D. Supply and installation of two (2) vacuum check valves, two (2) vacuum gauges, and one (1) vacuum control switch for low vacuum alarm.

E. Supply and installation of a NEMA 2 UL listed control panel with selector switches.

F. Supply and installation of vacuum priming valves and electrode assemblies on all nine (9) water pumping units, including all associated piping, fittings and appurtenances.

G. Supply and installation of all vacuum and interconnecting piping, valves, air vents, fittings, pipe hangers, sleeves and appurtenances between vacuum pumping system and all nine pumping units.

1.03 PUMPING UNIT AND VACUUM PRIMING SYSTEM MANUFACTURER QUALIFICATIONS

The new pumping unit (pump, motor and VFD) and the vacuum priming system, as specified, shall be standard equipment manufactured by a company with no less than five (5) years experience in the manufacture of such equipment.

The contractor shall complete an Equipment Questionnaire for the pump, motor and VFD and shall submit the form along with the contract bid. A blank Equipment Questionnaire will be included in the bid package.

Upon request by the Project Engineer, the manufacturer of the vacuum priming system equipment shall provide proof of experience by providing installation lists, brochures, catalogue cuts, etc.

1.04 SPECIFICATIONS AND STANDARDS

All materials, demolition, 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:

A. NEC, National Electric Code.

B. NEMA, Standards of National Electrical Manufacturers' Association.

C. IEEE, Institute of Electrical and Electronic Engineers.

D. AFBMA, Anti-Friction Bearing Manufacturers Association.

E. ANSI, American National Standards Institute.

F. SSPC, Steel Structures Painting Council.

G. ASTM, American Society for Testing and Material.

H. The Wisconsin Administrative Code.

I. OSHA, U.S. Department of Labor Occupational Safety and Health Act.

J. AWWA, American Water Works Association.

The contractor shall be familiar with the requirements of the above agencies. Any conflict in the contract drawings, these specifications, or the contractor's design or construction methods shall result in this contractor performing in a manner that conforms to the applicable requirements.

PART 2 SHOP DRAWINGS

A. Within three (3) weeks after Notice to Proceed is issued, the Contractor shall submit to the City for review a minimum of three (3) copies of all shop, fabrication, assembly, foundation, and other drawings 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.

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.

All shop drawing submittals should be sent to Ms. Carrie Lewis, Superintendent, Milwaukee Water Works, Room 409, Frank P. Zeidler Municipal Building, 841 N. Broadway, Milwaukee, WI 53202.

Three (3) revised copies of each drawing shall be submitted each time a drawing is returned to the contractor for revision. Upon final review of a drawing, eight (8) copies shall be submitted to the City for record and distribution to authorized persons.

After review 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 reviewed by the City and returned to the Contractor stamped "no exceptions". 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 acceptance of all dimensions, quantities, or details of the material or equipment shown by such drawings, nor shall such review relieve the Contractor of responsibility for errors contained therein.

B. 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®.

PART 3 GUARANTEE

The contractor shall furnish written Contractor and product warranties from the date of official acceptance against defective materials or workmanship before the final payment is made. The specific items and non-prorated warranties to be provided are as follows:

A. Pump and Motor – 5 years

B. Variable Frequency Drive – 2 years

C. Flowmeter – 2 years

D. Valves and operators - 2 years

E. Vacuum Priming System – 5 years

F. Vacuum Priming Valves – 2 years

G. Installation Workmanship and Materials – 2 years

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.

Whenever defective equipment or materials are replaced, the equipment or materials shall be guaranteed for two (2) years from the date that the replacement is performing satisfactorily.

If within ten (10) 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.

PART 4 OPERATION AND MAINTENANCE DATA AND MANUALS

A. Submit six (6) sets for each pump prior to final inspection, bound in 8½ x11 inch text pages, three D-side ring capacity expansion binders with durable plastic covers.

B. Prepare binder covers with printed title "OPERATION and MAINTENANCE INSTRUCTIONS", title of project, subject matter of binder when multiple binders are required.

C. Internally subdivided the binder contents with permanent page 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.

E. Special Requirements for Operations 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 of each type of equipment supplied.

F. Operation and Maintenance Manuals shall include the following:

1. All Sets of manuals shall be originals. Copies will not be acceptable.

2. Equipment function, normal operating characteristics, and limiting conditions.

3. Assembly installation, alignment, adjustment, and checking instructions.

4. Operation instructions for start-up, routine and normal operation, regulation and control, shutdown, and emergency conditions.

5. Lubrication and maintenance instructions, including lubrication cross referencing to a minimum of three locally available suppliers.

G. Guide to "troubleshooting."

H. Part lists and predicted life of parts subject to wear.

1. Outline, cross-section, and detailed assembly drawings; engineering data; and wiring diagrams.

2. Test data efficiency curves and performance curves, where applicable.

I. The operation and maintenance manuals shall be in addition to any instructions or parts lists packed with or attached to the equipment when delivered, or that may be required by the Contractor.

J. Manuals and other data shall be printed on heavy, first quality paper, 8 inch x 11 inch size with standard 3-hole punching. Drawings and diagrams shall be reduced to 8 1/2 inch x 11 inch or 11 inch x 17 inch. 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.

K. 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.

L. All submittals shall be marked with Contract identification, and inapplicable information shall be obliterated or deleted.

M. Shipment of equipment will not be considered complete until required manuals and data have been received.

N. Part 1: Directory, listing names, addresses, and telephone numbers of City, Contractor, Subcontractors, and major equipment suppliers.

O. Part 2: Operation and maintenance instructions arranged by system and subdivided by specification section. For each category, identify name, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:

1. Significant design criteria.

2. List of equipment.

3. Parts list for each component.

4. Operating instructions.

5. Maintenance instructions for equipment and systems. Maintenance instructions for special finishes, including recommended cleaning methods and materials and special precautions identifying detrimental agents.

P. Part 3: Project documents and certificates, including the following:

1. Shop drawings and product data.

2. Certificates.

3. Photocopies of warranties and bonds, if required.

Q. Copies will be returned after final inspection, with City's comments. Revise content of documents as required prior to final submittal.

R. Submit final volumes within ten days after receipt of City's comments.

S. Final Operation and Maintenance data shall be submitted in electronic media format, compatible with Microsoft® Office-2000 Applications and Microstation®.

PART 5 SPARE PARTS AND MAINTENANCE MATERIALS

A. Provide products, spare parts and equipment, maintenance and extra materials in quantities in individual Specification Sections.

B. Deliver to Project site and place in location as directed, obtain receipt prior to final payment.

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 of Milwaukee (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 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 line of structure. 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'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 work from weather and the extremes in temperature and humidity.

C. Remove, cut, and patch work in a manner to minimize damage and to 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 must 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 that are damaged, lifted, or 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 that affect:

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 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 which 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 PRE-CONSTRUCTION CONFERENCE

A. City will schedule a pre-construction conference after Notice to Proceed.

B. Attendance Required: City and Contractor.

C. Agenda:

1. Submission of executed bonds and insurance certificates.

2. Submission of list of all Subcontractors, Schedule of Values, and 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 and Contractor.

7. Construction facilities and controls provided by City, if any.

8. Temporary utilities and controls provided by City, 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 placed 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, record minutes, and distribute copies within three (3) 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. Agenda:

1. Review minutes of previous meetings.

2. Review of work.

3. Field observations, problems, and decisions.

4. Field observations of problems that impede planned progress.

5. Review of submittal 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 CONFERENCE

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 distributed copies within two days after conference to participants, with one (1) 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 (MWW) 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 MWW 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 by **Telephone: (414) 286-3465, or Facsimile: (414) 286-2672.**

2.02 SCOPE

A. Any and all City agencies and contractors engaged for work at MWW facilities shall be required to attend a "Pre-Construction Security Briefing" before any contracted work can be initiated. At this meeting, the contractor and subcontractors shall have a detailed briefing with discussions regarding the following items:

1. MWW site security policies and procedures
2. Contractor and subcontractor obligations
3. Permit system

2.03 POLICIES

A. During the "Security Briefing" portion of the "Pre-Construction Meeting", MWW Security staff shall provide the contractor with site polices to be reviewed by the contractor and subcontractors. These documents may include:

1. Lock-out/Tag-out Policy
2. Confined Space Entry Procedures
3. Evacuation Procedure for Propane, Lox, and 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 contractor shall be required to review these documents and is responsible for conveying the contents of these submittals to their employees, subcontractors 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 subcontract 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 contractor to facilitate gathering and submittal of the "Contractor Employee Registration Form" for all subcontractors working on the project. A subcontractor 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 contractor to add additional employees to the list of approved personnel, a minimum of 72 hours, or three (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 contractor be contacting MWW employees with issues or access requests. If a request for site access does not come from the 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 work 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 AND 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 MWW facility shall be in continuous operation during this contract. Contractor and subcontractors 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.

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 Riverside 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 subcontractors 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 reschedule 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:_____ DATE:_____

PRIMARY CONTACT PERSON

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

Updated August, 2007

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:_____ DATE: _____
Required

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:_____ DATE:_____
Required

Updated August, 2007

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 that 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 of Milwaukee (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 30 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 (1) person for eight (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 so as to avoid any conflict with other onsite testing or other manufacturers' onsite 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 onsite 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, the copies of all manufacturers' representatives' field notes and data to City.

4. Revisiting the site, as required, to correct problems until installation and operations 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 and facility startup and valuation.

7. Training of City's personnel in the operation and maintenance of respective products, as required.

8. Additional requirements may be specified elsewhere.

3.02 MANUFACTURERS' CERTIFICATE OF COMPLIANCE

A. When specified in 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. Certificate shall be signed by the product manufacturer certifying that product or material specified conforms to or exceeds specified. Attach supporting reference data, affidavits, and certifications as appropriate.

D. Certificate may reflect recent or previous test results on material or product, if acceptable to City.

3.03 MANUFACTURERS' CERTIFICATE OF PROPER INSTALLATION

A. The Manufacturers' Certificate of Proper Installation form (Attachments "C", "D" and "E"), copies of which are attached to this section, shall be completed and

signed by the equipment manufacturers' representative. 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, 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).

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 fourteen (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

3. Forms: Manufacturers' Certificate of Proper Installation for Variable Frequency Drive.

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)

ATTACHMENT "D"

MANUFACTURERS' CERTIFICATE OF PROPER INSTALLATION FOR MOTOR

LOCATION : MOTOR SERIAL NO :

MOTOR 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)

ATTACHMENT "E"

MANUFACTURERS' CERTIFICATE OF PROPER INSTALLATION FOR VARIABLE FREQUENCY DRIVE

LOCATION : MOTOR SERIAL NO :

MOTOR 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 01010 – Summary of Work

1.02 CLOSEOUT PROCEDURES

A. Submit written certification that contract has been reviewed, work has been inspected, and work is complete in accordance with the 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)** electronic version 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/her 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 8½ 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. A completed Unit Process Startup Form for each unit process.

4. A completed Facility Performance Demonstration/Certification Form.

5. A completed Contractor Startup Field Checklist for 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.

2. Unit Process Startup Form (Attachment "F"), 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 "G"), 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 "H"), 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, 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) Project Name and municipality.

   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 ten (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 ten (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 to 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 five (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 two (2) consecutive hours.

3. Failure of any critical equipment or unit process that is not satisfactorily corrected within five (5) hours after failure.

4. Failure of any noncritical equipment or unit process that is not satisfactorily corrected within eight (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 "F"

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 "G"

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: **Date: _____, 20____**

City: **Date: _____, 20____**

(Authorized Signature)

ATTACHMENT "H"

contractor STARTUP FIELD CHECKLIST PUMP/MOTOR ASSEMBLY AND CONTROL SYSTEM

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.
- ☐ Cone valve installed in accordance with manufacturers' recommendations.
- ☐ Cone 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)

SECTION 02050

DEMOLITION

PART 1 - GENERAL

1.01 SCOPE

A. Dismantle and remove existing Pumping Unit No. 5, including: pump, motor, suction and discharge piping, valves, bends, couplings, restraints, controls, etc., in accordance with the contract drawings.

B. Dismantle and remove existing concrete base foundation and valve, horizontal bend, and pipe supports for Pumping Unit No. 5. Concrete base for vacuum priming system may remain if acceptable to the vacuum priming system manufacturer.

C. Dismantle and remove existing 42” venturi (Pumping Unit No. 5 discharge).

D. Dismantle, remove and dispose of the existing vacuum tank and separation chamber with related vacuum pump assemblies. This includes gauges, switches, priming valves, starters, controls, and all piping up to the nine (9) water pumping units. The contractor shall be responsible for proper off-site disposal of the demolished equipment. **Note: Existing vacuum priming system must be available for service while new system is being installed.**

1.02 GENERAL

A. The contractor shall be responsible for all work under this section.

B. All structures and facilities of the Riverside Pumping Station that 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 that 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.

1.03 CITY’S OCCUPANCY

A. The Riverside Pumping Station will be in operation during the entire period of construction, and therefore, may be occupied by City personnel. Cooperate with City personnel in all construction operations so as to minimize conflict and to facilitate City usage.

1.04 SUBMITTALS

A. Provide the City with a schedule of demolition consistent with the project schedule. Also submit methods of demolition and equipment proposed, along with any authorizations and permits required to execute the work.

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 PREPARATION

A. General

1. Notify City and appropriate utilities to turn off affected services before starting demolition or alterations.
2. Do not remove reusable equipment or materials without approval of the City.
3. Any materials that will be reused shall be properly stored. City will determine where equipment / materials may be stored.

3.02 DEMOLITION

A. General

1. Drawings define minimum portion of structures to be removed. Unless otherwise shown, rough cuts or breaks may be made exceeding limits of demolition shown.
2. Remove all materials associated with existing equipment that is to be removed or relocated.
3. Dispose of debris and other non-salvaged materials in licensed landfills.
4. LEAD PAINT: A lead paint analysis has been performed on the pump/motor and discharge piping. The lead paint analysis report is included in Appendix "A" of the Contract Specifications.

   The contractor is responsible for lead abatement and 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 the City for review.
5. MATERIALS CONTAINING MERCURY: Any materials containing mercury are to be properly removed and disposed of by the contractor. Contractor shall submit proof of proper disposal to the City.

3.03 SALVAGE MATERIALS

A. During demolition, the contractor shall put aside equipment and materials that have been designated by the City for keeping; the items are to be complete and undamaged. All other items become the responsibility of the contractor.

B. Salvage items to be handed over to the City shall include:

1. All electric valve operators
2. Switchgear imposing relays
3. Pump motor
4. Pump impeller
5. Other items requested by City prior to bid

END OF SECTION

SECTION 03300

CONCRETE WORK

This section includes specifications for furnishing all labor and material to install a reinforced concrete pump foundation, VFD slab, and valve, bend and pipe supports as shown on the contract drawings and detailed in the specifications. Included are the following topics:

PART 1 GENERAL

1.01 SUBMITTALS

A. Submit shop drawings of reinforcing steel in accordance with Section 01010 Summary of Work, PART 2.

B. Initial submittal of reinforcement shop drawings shall be complete. No partial submittals will be accepted.

C. Indicate reinforcement sizes, spacing, locations and quantities of reinforcing steel, bending and cutting schedules, splicing, supporting and spacing devices.

D. Reinforcement placement shop drawings for foundations shall conform to ACI SP-66, providing full elevations.

E. Submit proposed mix design of each class of concrete to the City.

1.02 QUALITY ASSURANCE

A. Perform work in accordance with ACI 301, 305 and 306.

B. Conform to requirements of local, State and Federal rules and regulations applicable to work and project location.

1.03 ENVIRONMENTAL REQUIREMENTS

A. Concrete shall not be placed on frozen sub-grade or one that contains frozen materials. Forms and reinforcement shall have ice and snow completely removed before placing concrete. The removal of frozen materials shall be done by applying heat. The spreading of salts or chemicals on forms is not permitted. The method of heating materials shall be approved by the City.

B. Arrangements for covering, insulating or housing newly placed concrete shall be made, in advance of placement, to maintain adequate protection in all parts of the concrete. Methods of protection and curing shall be such as to prevent evaporations of moisture from the surface of concrete for period of not less than five (5) days. Means of protection and curing shall be approved by the City.

PART 2 PRODUCTS

2.01 FORM MATERIALS

A. Plywood Forms: Douglas Fir or Spruce species: sound, undamaged sheets with clean true edges, exterior glue, facing material to provide finish specified.

B. Lumber: Douglas Fir or Spruce species; construction grade or better; with grade stamp clearly visible.

C. Preformed Steel Wall Forms: Minimum 16 gage thick, matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and surface appearance.

D. Form Ties for Exposed Surfaces: Plastic cone snap ties with 1 inch outside diameter by 1 inch (nominal) long cones, with no metal within one (1) inch of concrete face after removal; manufactured by Dayton Superior, Richmond Screw Anchor Co., or an approved equal.

E. Form Ties for Hidden Surfaces: Metal spreader type, removable to a depth of 1 inch from concrete face; manufactured by Dayton Superior, Richmond Screw Anchor Co., or an approved equal.

2.02 REINFORCING STEEL

A. Reinforcing Steel: ASTM A615, 60 ksi yield grade billet steel deformed bars; uncoated finish.

2.03 CONCRETE MATERIALS

A. Cement: ASTM C150, Portland, grey color.
B. Fine and Coarse Aggregates: ASTM C33.
C. Water: Potable and clean.

2.04 CHEMICAL ADMIXTURES

A. Admixtures are to be approved in writing by the City prior to use.
B. Chemical admixtures shall be in accordance with ASTM C494.
C. Admixtures are to be used in accordance with manufacturer's recommendations.
D. Chemical admixtures containing chlorides, sulfides or nitrides are not permitted.
E. Admixtures permitted shall be supplied by a single manufacturer.

2.05 CURING MATERIALS

A. Water: Potable and clean.

B. Membrane Curing Compound: ASTM C309; Type II white pigmented as manufactured by W.R. Meadows, "WP40"; Dayton Superior, "J10"; Symons, "Resi-Chem, MI48" or approved equal.

2.06 CONCRETE MIX

A. Concrete mix shall comply with Section 902.7 "Ready-Mixed Concrete" of the City of Milwaukee Street Construction Specifications.

B. Schedule of Mixes: Class C, maximum aggregates size 3/4 inch, slump 3 inches, minimum cement 6 sacks/cu. yd., minimum compressive strength 4000 psi/28 days.

PART 3 EXECUTION

3.01 FORMWORK ERECTION

A. Concrete Forms: Forms shall be designed to produce concrete having the shape, lines, and dimensions shown on the plans. Forms shall be constructed and maintained in proper position and accurate alignment.

Concrete with formed surfaces which will be exposed to view when construction is completed shall be placed against plywood forms or forms that are lined with plywood or fiberboard. Plywood or lined forms will not be required for surfaces which are buried or not ordinarily exposed to view. Other types of forms, such as unlined wooden forms or steel forms, which have been approved by the City, may be used for surfaces that are not restricted to plywood or lined forms, and may be used as backing for form linings.

Lumber used in forms for unexposed surfaces shall be straight, dressed to uniform width and thickness, and free from loose knots, offsets, warping, buckling, dents, holes, other surface irregularities, sags, and other defects.

B. Design: Forms shall be substantial and sufficiently tight to prevent leakage of mortar. They shall be properly braced or tied in such a manner that they will maintain the desired position, shape, and alignment during and after placing concrete herein. Walers, studs, internal ties, and other form supports shall be of sufficient size and number and shall be so located and spaced that proper working stresses therein are not exceeded.

C. Form Ties: Form ties shall be of the removable end, permanently embedded body type and shall have sufficient strength, stiffness, and rigidity to support and maintain the form in proper position and alignment without the use of auxiliary spreaders. Cones shall be provided on the outer ends of each tie, and the permanently embedded portions shall be at least one inch back from adjacent outer concrete faces. Permanently embedded portions of form ties which are not provided with threaded ends shall be of a design and construction such that the removable ends are broken off by twisting only and are removed without damage to the concrete or concrete surface. All form ties shall be approved by the City. All form tie holes in concrete exposed to view shall be patched before providing rubbed finish surface.

3.02 REINFORCEMENT

A. The fabrication of all reinforcing steel shall conform to the "Manual of Standard Practice for Detailing Reinforced Concrete Structures", ACI 315.

B. A detail plan and corresponding bill of material showing all bedding details, placement diagrams, and accessories shall be submitted to and shall receive the final approval of the City before steel is placed.

C. Reinforcement shall be in full lengths as shown on the plans, and where splices are necessary, a minimum lap of 24 diameters shall be used, except as noted.

D. At time of placement, all reinforcing bars shall be free of mortar, mud, oil, or other non-metallic coatings that adversely affect the bond with concrete.

E. Furnish and install all metal spacers, chairs, ties, and other devices necessary for properly placing, spacing, supporting, and fastening reinforcement in place.

F. Provide spacers with tie wire at proper intervals to hold slab bars in position and to raise them to provide the clearances required. Provide chairs for all bars at such intervals so as to prevent bar sagging between chairs. Tie bars to chairs. All reinforcing shall be supported on bolsters or chairs and carrying bars, not by bricks or other unapproved materials.

G. Position reinforcement to a plus or minus 1/4 inch and, unless otherwise specified or shown, secure against displacement by tying in place with 16 gauge soft annealed wire or suitable clips at a spacing adequate to prevent movement by the workers movement or by the concrete pour.

3.03 PLACING CONCRETE

A. Notify the field engineer a minimum of 24 hours prior to placing concrete. Failure to notify may result in rejection of concrete placed without observation.

B. Except as modified herein, the placing of all concrete shall conform to the requirements of Chapter IV of ACI 304 Recommended Practices of Measuring, Mixing, and Placing of Concrete.

C. No concrete shall be placed until foundation forms, reinforcing steel, anchors, inserts and all other work required to be built into concrete have been inspected and approved by the City. All water shall be removed from all excavations prior to placing concrete.

D. All footings and slabs are to be placed on compacted crushed stone subgrade. The subgrade shall be wetted slightly prior to pouring concrete. If earth indicates tendency to cave, securely brace the side wall to prevent earth from falling into concrete when pouring footings.

E. After completion of mixing, concrete must be handled rapidly from place of mixing to place of final deposit, and under no circumstances shall concrete be used that has partly set. Every precaution shall be taken to prevent separation or loss of ingredients while transporting concrete.

F. Concrete interfacing with forms shall be well spaded and mortar flushed to surface to forms. Concrete shall be worked around reinforcement and into corners of forms by continuous puddling with proper implements.

G. Vibration with "Spud" type internal vibrator with flexible shaft shall be used where possible to consolidate entire mass of concrete as it is being placed.

H. All surfaces to be exposed in the completed project shall be finished smooth and uniform. The holes left after removal of form ties shall be carefully filled. If, in spite of properly pouring concrete, a honey comb should develop, it shall be repaired in an approved manner.

3.04 FORM REMOVAL AND CURING

A. Forms may be removed after concrete has developed sufficient strength to safely sustain its own weight and any superimposed loads, but no sooner than 24 hours.

B. Immediately after finishing operations are completed, just after the concrete has attained its initial set or upon removal of forms, all exposed concrete shall be coated with a curing compound. Applications shall be at a rate and quality sufficient to obtain the necessary water retention and to form a continuous, coherent, water impermeable film. The rate of application shall not be less than that recommended by the manufacturer of the compound.

C. The new poured concrete shall be protected against any appreciable loads other than workmen, hand tools, etc., for a period not less than seven (7) days, or as long as determined by the City.

3.05 CONCRETE TESTS

Concrete cylinders (if requested by the City) will be taken for test purposes during the progress of the concrete work. The test cylinders will be taken by the City job inspector from the concrete being poured and the contractor shall cooperate in securing the samples. The contractor shall provide safe storage for the cylinders pending their removal to the testing laboratory. Samples of concrete shall be obtained in accordance with Section 902.5.1 of MSCS and shall be transported to a place on the site where tests can be made and cylinders stored without being disturbed the first 24 hours.

Slump tests shall be made at the option of the City following the procedure in MSCS. Slump tests shall always be made of concrete from any batch from which strength tests are made. Concrete slump shall not exceed 3 inches.

Contractor shall be responsible for the delivery of all test samples to a City approved testing laboratory. Costs of all tests required shall be borne by the contractor.

A strength test for any class of concrete shall consist of one (1) set of four 6" x 12" standard concrete cylinders. Two cylinders shall be tested at 7 day age and two cylinders shall be tested at 28 day age.

The compressive strength level of the concrete at 28 day age will be considered satisfactory if the averages of all sets of three (3) consecutive strength test results equal or exceed the required design strength (f'c) and no individual strength test falls below the required f'c by more than 500 psi. A record will be made of the delivery ticket number for the concrete and the exact location in the work at which each load represented by a strength test by the City.

If individual tests of laboratory-cured specimens produce strengths more than 500 psi below the required minimum compressive strength (f'c), tests on drilled cores from the area may be required. Tests shall conform to ASTM C42. Cores will be tested dry if concrete will be dry during use. Cores will be tested in a saturated surface dry condition if the concrete will be wet during use. Three (3) cores will be taken for each case of a cylinder test more than 500 psi below f'c. Strength cores will be considered adequate if the average compressive strength is greater than 85% of f'c and no individual test is less than 75% of f'c. Should any core fall below 75% of f'c, the concrete is considered unsatisfactory and shall be removed and replaced with satisfactory concrete and all costs shall be borne by the 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 twelve (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. Non-shrink 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 three (3) days and then an acceptable membrane curing compound shall be applied.

END OF SECTION

SECTION 09900

PAINTING

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

Provide all labor and materials to complete the painting job and related work, as specified. The job consists of, but is not limited to, the following principal items:

A. Power tool cleaning and painting of all pipes, pipe fittings, pipe and valve supports (excluding concrete), nuts, bolts, etc.

B. Pumping units, motors and their steel bases, flowtube, and valves shall be factory painted by the Manufacturer.

C. Vacuum priming system (vacuum pumps, separation chamber assembly, and priming valves) shall be factory painted by the Manufacturer.

D. Touch up painting on adjacent appurtenances and piping.

1.02 GENERAL CONDITIONS

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 the United States Environmental Protection Agency (EPA).

1.03 SUBMITTALS

A. Provide product data on painting material.

B. Submit manufacturers' application instructions.

C. 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

PUMP, PIPE, FLOWTUBE, and VALVE INTERIOR SURFACES:
Primer:
TNEMEC Series 20 Pota-Pox II or equal
8 mils DFT
Color: Approved by City

Finish Coat:
TNEMEC Series 20 Pota-Pox II or equal
8 mils DFT
Color: Approved by City

PUMP, PIPE, FLOWTUBE and VALVE EXTERIOR SURFACES:
First Coat:
TNEMEC Self-Priming Epoxyline II Series or equal
4 mils DFT
Color: To match existing; approved by City

Second Coat:
TNEMEC Self-Priming Epoxyline II Series or equal
4 mils DFT
Color: To match existing; approved by City

PUMP MOTOR and ENTIRE PRIMING SYSTEM EXTERIOR:
First Coat:
TNEMEC Self-Priming Epoxyline II Series or equal
4 mils DFT
Color: To match existing; approved by City

Second Coat:
TNEMEC Self-Priming Epoxyline II Series or equal
4 mils DFT
Color: To match existing; 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 using hand held power tools to the extent of an SSPC-SP11 (Power tool cleaning to bare metal.).

B. 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.

C. 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 material which may constitute a fire hazard; place in closed metal container and remove daily from site.

END OF SECTION

SECTION 15050

MISCELLANEOUS PIPING

PART 1 GENERAL

1.01 SCOPE

This section covers the furnishing and installation of miscellaneous piping 6 inches in diameter and smaller. The work covered by this section of the specification shall include the following items of work:

A. Vacuum piping, including vacuum header, vacuum lines, and associated piping at pumping units.

B. Gauge piping at vacuum tank and vacuum pumps.

C. Gauge piping, including pressure switches and pressure gauges on Pump #5 discharge piping.

D. Drainage piping and equipment drains at Pumping Unit #5 plus associated piping up to point of local waste at south end of suction tunnel trench.

E. All hangers, supports and appurtenances required for the proper installation and support of piping.

F. All other miscellaneous piping on the plans not specified under other sections of these specifications.

PART 2 PRODUCTS

2.01 PIPING

The requirements which follow shall govern the manufacture and furnishing of materials and the installation of piping required as a part of this specification.

A. Steel: ASTM A120, standard weight (Schedule 40), or Fed. Spec. WW-P-406a, Weight A.

B. Iron-Pipe-Size Brass and Copper:
   1. Brass: ASTM B43, red brass, extra heavy weight, or Fed. Spec. WW-P-351, Grade A, extra heavy weight.
   2. Copper: ASTM B42, hard drawn, regular weight, or Fed. Spec. WW-P-377b, hard drawn, standard weight.

C. Nipples: Fed. Spec. WW-N-351a, "Short Pattern" unless otherwise required. The use of "Close Pattern" nipples will be permitted only by special authorization in each case. Nipple stock shall be of the same material as connecting pipe.

D. Copper Tubing: ASTM B88, or Fed. Spec. WW-T-799a Type L hard drawn.

2.02 FITTINGS

All fittings including couplings shall be of the types specified herein.

A. Screwed:
1. Brass Fittings: Fed. Spec. WW-P-460, Class A, for iron-pipe-size brass or copper pipe.
2. Bronze Unions: Fed. Spec. WW-U-516, Composition B for iron-pipe-size brass or copper pipe.
3. Cast Iron Drainage Fittings: Fed. Spec. WW-P-491a, Type III (galvanized) for all steel drainage piping.
4. Malleable Iron Fittings: Fed. Spec. WW-P-521d, Type II (galvanized) for use in steel pipe 2-1/2" and smaller.
5. Malleable Iron Unions: Fed. Spec. WW-U-531a, Type B (galvanized) for use in steel pipe 2-1/2" and smaller.

B. Flanged:
1. Flanges: A.S.A. B 16.1 – 1948 (Class 125) for screwed cast iron companion flanges, or A.S.A. B 16.5 – 1957 for welding steel flanges. All pressure piping 3 inches and larger shall be flanged. Flanges shall be flat faced.
2. Flange Bolts and Bolt Stud: Conform to Section SP-17 "Bolting for Flanged Joints" of this specification.
3. Gaskets: To be as specified under Section SP-18 "Gaskets for Flanged Joints" of this Specification.

C. Flareless Compression Fittings: Brass tube fittings shall be Crawford "Swagelok" for all 3/8 inch (1/2 inch O.D.) or smaller Type L, hard drawn copper tubing.

D. Solder: ASA B 16.22 for ½ inch (5/8 inch O.D.) or larger Type L, hard drawn copper tubing. Solder shall be 50-50 tin-lead solid wire solder of an approved type and brand.

E. Insulating: Insulating fittings which will prevent contact of dissimilar metals, W & K Manufacturing Company "Dielectric Unions", Ecoff Products Company "EPCO Dielectric Unions", American Sanitary Company "Dielectric Couplings", or approved equal. Wherever copper pipe or tubing is connected to iron or steel pipe, an insulating fitting shall be installed between the dissimilar metals.

2.03 SERVICE AND TYPE REQUIREMENTS

Except as otherwise specified or authorized, the kinds of pipe and tubing for the various services shall conform to the general requirements of this Section and the several sections hereunder. Kinds of pipe for service conditions not covered by this specification shall be as specified elsewhere in these documents or indicated by the plans or, in the absence of any definite requirement, as approved by the Commissioner.

A. Galvanized Wrought Steel Pipe:
   1. Pipe sleeves.
   2. All drain and vent piping for large steel pipe furnished under "Station Piping", 2" and smaller.
   3. All drainage piping and equipment drains from bell up's to point of local waste.
   4. Service water lines 2-1/2 inches and larger and return lines.

B. Copper Tubing: Type L hard drawn copper tubing shall be used for all exposed locations for all water supply piping 2" and smaller, all vacuum piping, equipment drains to bell up's, miscellaneous piping at pump including drains to bedplate, and all other piping not otherwise specified.

2.04 PIPE JOINTS

A. Screwed: Pipe threads shall conform to Fed. Spec. GGG-P-351a, and shall be full and cleanly cut with sharp dies. Not more than three threads at each pipe connection shall remain exposed after installation. Ends of pipe shall be reamed, after threading and before assembly, to remove all burrs and rough inner edges. Threaded joints shall be made up with a joint compound or thread lubricant suitable for the service in each case, as approved by the Commissioner. The material used in each case shall provide maximum protection to the threads, and shall be applied in such manner and quantity that all threads are coated but no jointing compound or lubricants is forced into the interior of the pipe.

B. Compression Joints in Copper Tubing: Fittings and adapters for copper tubing shall be installed by competent and experienced workers in accordance with the fitting manufacturer's instructions and recommendations.

   Tubing shall be cut square, and all burrs shall be removed. Joint contact surfaces of fittings and tubing shall be cleaned & burnished with "00" steel wool before assembly.

   C. Soldered: The steps to be followed in making up a soldered joint are as follows.
      1. Clean end of tube and interior of fitting socket.
      2. Apply flux to cleaned areas.
      3. Assemble pipe and fitting.
      4. Apply heat and solder.
      5. Remove residual solder and flux from exterior surfaces.

Tubes shall be accurately measured before cutting. It is essential that the tube enter the fitting all the way to the fitting socket. After soldering, and while the joint is still hot, surplus solder and all flux on the exterior of the joint shall be removed with a rag or brush.

2.05 ANCHORS, BOLTS AND SLEEVES

All anchors, inserts, bolts, nuts, washers, sleeves, supports, and other accessories which are required for any work under this contract shall be furnished and installed hereunder. Except where the use of other non-corroding materials is required, all anchor bolts, nuts, washers, and other hardware shall be hot-dip galvanized in conformity with the requirements of ASTM A135 and A385.

All anchor bolts which are cast in place in concrete shall be provided with sufficient threads to permit a nut to be installed on the concrete side of the form or supporting template. When the bolt is installed, a second nut shall be attached to the bolt on the outside of the form or supporting template, and the two nuts adjusted and tightened in such a manner that the bolt will be rigidly held in proper alignment.

Cinch anchors shall be Type 1 or Type 2 ring wedge cinch anchors as manufactured by the National Lead Company, or approved equal, and shall be furnished and installed only where permitted by the plans or specifically authorized by the Commissioner. Unless otherwise shown on the plans, all cinch anchors shall be of the three-unit type. The minimum distance between the center of any cinch anchor and an edge or exterior corner of concrete shall be not less than (a) 4-1/2 times the diameter of the hole in which the cinch anchor is installed, where the depth of the hole is 4 times its diameter; or (b) 3 times the diameter of the hole where the hole depth is at least 6 times the hole diameter, with a minimum edge distance of 3” in either case. Wherever cinch anchors are used in conjunction with concrete bases or pads, the cinch anchors shall extend into the structural concrete.

All cinch anchors bolts holes shall be thoroughly cleaned by means of (a) compressed air followed by swabbing with a wet rag; or (b) water applied as a jet from a hose nozzle.

Bolts, hole diameters, and installation methods for cinch anchors shall be in conformity with the manufacturer’s specifications except that in no case shall the depth of hole be less than 4 hole diameters.

If the anchorage is in shear, the annular space between the concrete and the bolt shall be filled with a suitable rigid material which will prevent the bolt from bending.

2.06 INSULATION

All cold water piping and appurtenances installed under this section of the contract shall be insulated with ½ inch thickness of Armstrong Armaflex Pipe Insulation, or an approved equal except as specifically excluded hereinafter. Excluded piping shall be air vent & drain piping for "Station Piping" and gauge & flow tube differential piping.

PART 3 EXECUTION

3.01 PIPE INSTALLATION

Installation of piping shall conform to the general requirements as hereinafter specified and to specific requirements as set forth in other specification sections for this Contract.

Flanges, compression fittings, or unions as specified shall be provided in piping at locations adjacent to devices or equipment which may require removal in the future and at such other locations as may be required by the plans or specifications.

All piping shall be concealed as much as possible and installed in such a manner that it will not obstruct openings or passageways, and shall be rigidly anchored to walls & ceilings by means of suitable pipe hangers or wall brackets. Concrete inserts shall be used for the support of piping hangers wherever practicable. Where it is necessary to install hangers or supports after the concrete has been poured or other masonry work is finished, anchor bolts with two unit cinch anchors shall be used. Unless otherwise specified, all hangers shall be of the adjustable screw pattern. Strap hangers will not be acceptable. All hangers & bolting located below floor at Elevation 0.00 (City Datum) shall be hot dip galvanized.

Except where specifically shown or specified otherwise, no pressure piping of any kind shall be installed in or beneath concrete walls, in concrete floors, or beneath floor slabs which rest on the ground, unless all joints are accessible and the pipes so installed in conduits, ducts, or otherwise, that they can be readily removed.

All piping passing through existing structure beams, walls, floors, etc. shall be provided with openings by core drilling as a part of this contract. All core drilling of existing structure shall be done only after the specific location for each hole has been approved to minimize structural damage and avoid damage to concealed conduits.

Pipe shall be cut from measurements taken at the building, and not from the plans, and all necessary provisions shall be taken in laying out piping to provide throughout for expansion and contraction. Piping shall be properly supported at intervals of not more than 10 feet, (closer where specified or required), with vertical runs securely braced and anchored. Pipes shall be held free from contact with the building construction.

All piping shall be installed free of strains which will cause stresses to be transmitted to equipment and appurtenances.

The location of items of equipment not specifically indicated by the drawings, and the location and arrangement of all small piping serving such equipment, shall be as directed or approved by the Commissioner.

All piping within the Station shall be arranged, and facilities provided, for complete drainage thereof. Drainage connections shall be made with "Y" fittings with a drop.

All pipes shall be thoroughly cleaned of all dirt and scale, and all burrs in the ends of pipe & nipples removed by reaming, prior to installation or assembly.

After installation is complete, piping shall present a clean surface suitable for painting.

3.02 CLEANING

The inside of all pipe, valves, and fittings shall be smooth, clean, and free from blisters, loose mill scale, sand and dirt when erected. All lines shall be thoroughly blown before placing in service.

3.03 TESTS

All piping that is connected to the large steel pipe shall be tested during the testing of the large steel pipe. All other piping shall be pressure or vacuum tested.

Leakage may be determined by loss of pressure or vacuum, soap solution, or other positive and accurate method acceptable to the Commissioner. All devices or other accessories which are to be connected to the various lines and which would be damaged if subjected to the test pressure shall be disconnected as required and the ends of the various branch lines plugged or copped as required during the testing procedures.

It is the intent that all joints in all piping to be furnished and installed under the provisions of these contract documents be tight and that all joints which are to be found by observation, or during any specified test to leak, shall be made tight by the Contractor hereunder.

END OF SECTION

SECTION 15100

PIPING, VALVES & FITTINGS

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

Furnish and install all piping, valves, couplings, fittings, and controls for Pump No. 5 as required.

Work for Pump No. 5 shall include the replacement in kind of one butterfly discharge valve, and the replacement of one existing ball discharge valve with a new cone type discharge valve.

Piping shall be complete with all fittings, specials, flanges, couplings, joint harnesses, pressure taps, cinch and thrust anchors, gaskets, bolts and nuts, pipe supports, restraints, and other appurtenances shown on the plans and/or as required for proper installation and operation of the pumping/piping system.

All work and materials required to install the anchoring plates for the discharge piping at the east wall shall be done hereunder. This includes chipping of the concrete wall, if necessary.

1.02 SUBMITTALS

The required submittals shall include drawings, design calculations, specifications, piping and valve layouts, and execution drawings. No pipe, fittings, valves, plates, nor specials shall be manufactured / fabricated until all submittals for that item have been approved by the City.

PART 2 PRODUCTS

2.01 PIPING

(For piping 6” or smaller see SECTION 15050, MISCELLANEOUS PIPING)

Steel piping shall be Schedule 40, with a minimum nominal wall thickness of 0.500 inches. Pipe shall be of the nominal diameter (size) as indicated on the drawings and conforming to all requirements of AWWA Standard C200-05 and ASTM A139 Grade B, and ANSI B16.5. Piping shall be carbon steel and be one of the following:

1. Fabricated from plate in conformance with AWWA C200, Sections 1 through 6.

2. Spiral butt weld pipe manufactured according to ASTM A-139 Grade B, ASTM A-252 Grade 2 or 3 and ASTM A-211.

All fabricated pipe shall be made from steel plates rolled into cylinders or sections thereof with 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.

A. Flanges

All flanges shall be AWWA Class D, hub type, steel slip-on flanges, conforming to the requirements of AWWA C207 Table 2. 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.

B. Bolts and Nuts

Flanges shall be bolted with bolt-stud and nuts. Bolts for AWWA flanges shall be of the diameters set forth in Table 2 of AWWA C207. 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.

C. Flange Gaskets

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.

D. Welded Joints

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. 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.

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.

Leaks in welds shall be repaired by removing the defective material that caused the leak in each case and re-welding. No leak shall be repaired by mechanical caulking.

E. Protective Coating

1. The interior surfaces of the steel pipes, specials and fittings shall be prepared, primed and coated. Surface preparation shall be done in accordance with paint manufacturer's recommendations.

2. Coating on exterior surfaces shall be applied in accordance with Section 09900 of the specifications.

3. Interior valve surfaces shall be painted in accordance with AWWA C504. Extreme care shall be taken to prevent damage to resilient seat material.

2.02 BUTTERFLY VALVES

A. General

The Contractor shall furnish and install one (1), butterfly valve (Isolation Valve 5C) with the size as indicated on the contract drawings. Valve shall be of the tight-closing, rubber-seat type that fully complies with the latest revision of AWWA Standard C504 class 150# and shall be bubble-tight at the rated pressure in either direction and shall be suitable for throttling service and frequent operation. Valve discs shall rotate 90 degrees from the full open position to the tight shut position. Angular misalignment of the disc with respect to the seat shall be one (1) degree off center without leakage. Valves shall meet the following requirements:

B. Valve Body and Flanges

All valve bodies shall be ductile iron, ASTM A-536, grade 65-45-12, flanged. Flanges shall be ANSI B16.1 with class 125# drilling, fully faced.

C. Valve Disc

All valve discs shall be constructed of ductile iron, ASTM A536 grade 65-45-12 with a stainless steel seating edge, Class B. 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 316 stainless steel pins.

D. Valve Shaft

Valve shaft shall be constructed of stainless steel, ASTM A276 type 304. All shafts shall be turned, ground and polished. Shafts shall be two-piece, stub-type keyed for operator connection.

E. Valve Seat

Seat shall be of a synthetic rubber compound and 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 degrees without interruption and have a plurality of grooves mating with a spherical disc edge seating surface.

F. Valve Bearings

All shaft bearings shall be of the self-lubricating, sleeve-type. Bearings shall be designed for horizontal and/or vertical shaft loading.

G. 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.

H. 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.

I. Proof of Design

The manufacturer, furnishing the valves, shall provide written certification that the valves proposed meet the design requirements of AWWA C504.

Valves shall be as manufactured by Milliken Co., Henry Pratt Co., or an approved equal.

J. Manual operator for the butterfly valves shall have all gearing totally enclosed. Each operator shall have a torque rating as hereby specified. All valves shall be equipped with a disc indicator. Operator mounting arrangement will be indicated on shop drawings. Operators shall be as manufactured by Philadelphia Gear Corp. or an approved equal. Valve operators shall be designed to produce the specified output torque with a hand wheel pull of 40 pounds. Each hand wheel shall rotate counterclockwise to open the valve. Hand wheels shall have diameter of not greater than 24” for valves 30” or smaller, and a diameter of not greater than 30” for valves 36” and larger. Hand wheels shall have cast thereon the word “OPEN” and an arrow indicating the direction to open. 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.

K. Limit Switches

Two limit switches shall be mounted in watertight enclosures and will be used for remote indication of valve position of the discharge, or “C” valve. Limit switches shall be securely mounted and shall be operated by the pointer of the valve position indicator. 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.

2.03 CONE VALVES

A. General

The contractor shall furnish and install one (1), cone valve (Discharge Valve 5B) with the size as indicated on the contract drawings. The pump will be started against the discharge cone 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.

Pump Unit No. 5, Discharge Valve 5B shall be a cone valve of the conical plug type with a torque unit, employing axial motion to unseat the plug, followed by a rotary motion to open or close the valve, and then followed once again by an axial motion to reseat the plug. Valve shall be of the metal-to-metal seated type, Class 150#. Valve designs employing a Teflon®-coated or other non-metallic material shall not be acceptable. Liberal safety design factors shall be used throughout, especially in the design of parts subject to intermittent or alternating stresses. In general, the working stresses shall not exceed one-third of the yield point or one-fifth of the ultimate strength of each material. Bearing pressure shall not exceed 3000 psi. The cone 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. Cone valve shall be as manufactured by APCO Williamette Valve & Primer Corp., Henry Pratt Co., or approved equal. The cone valve shall consist of five (5) main elements listed below and described herein:

1. A valve body having a waterway inlet and outlet diameters equal to the nominal size of the valve.

2. A conical plug having a clear waterway diameter equal to the nominal size of the valve.

3. A head cover to enclose the plug within the valve body.

4. An operating mechanism mounted on the head cover.

5. Electric motor, hydraulic or manual operator.

B. Body

The cone valve body shall be ductile iron, ASTM A536 65-45-12, with a housing having flanged inlet and outlet waterways and a head flange opening. The head flange opening shall allow removal of the plug. Waterway flanges shall conform to the dimensions and drilling of ANSI B16.1, Class 150# and shall be flat faced. Inside the body of the valve, two monel seat rings shall be provided to engage the seat rings on the plug when the plug is seated. The body seats shall be machined, ground and polished to provide for a matched and tapered fit with the plug seats, and to provide for a positive drop-tight upstream and downstream seal at the closed position of the plug. A bronze pivot bearing (ASTM B584-C93200) shall be provided for the plug trunnion.

The valve body shall be flanged to connect to the valve body closure head cover, which shall make a registered connection with the valve body and shall be of sufficient inside diameter to accept the entire plug sub-assembly. There shall be two (2) pipe connections, one for an air vent and another for a drain.

C. Plug

The ductile iron plug, ASTM A536 65-45-12, shall have the shape of a frustum of a cone with a clear waterway opening through it. The plug shall rotate on top and bottom trunnions which are integrally cast, large diameter, and bronze bushed (ASTM B584-C83600). The operating shaft shall be securely attached to the plug to transmit the lifting force and operating torque. The operating shaft shall be ASTM A564 17-4 PH stainless steel. The plug shall be provided with monel seats, MONEL-Weld Overlaid per AWS ERNICu-7, to engage the monel seat rings on the body when seated in both the open and closed positions.

D. Head Cover

The valve shall be provided with a cast iron head to close the body head flange opening. The head cover shall make a registered connection with the valve body. A bronze pivot bearing in an integrally cast trunnion shall be provided with the plug.

E. Operating Mechanism

The operating mechanism shall be mounted on the head cover and shall be provided with a removable cover which shall permit inspection, adjustment, and repair of the operating mechanism. The mechanism shall consist of a crosshead device which will lift, rotate, and lower the plug. The crosshead shall travel in a straight line and shall operate through an independent link and lever arrangement, so that lifting shall be accomplished by means of a lift nut and rotation by means of a rotator lever. The operating shaft shall be of sufficient strength to withstand any stresses to which it may be subjected under the design operating conditions. The valve shall be provided with a cast iron valve plug position indicator which will operate over large cast markings on the head cover.

F. Valve Operation

The pump shall start against the closed discharge valve. 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.

G. Warranty

The metal-seated cone valve and torque unit shall be warranted for a minimum of five (5) years from the date of installation.

H. Wiring

All electrical components shall be shop-wired to a terminal strip to facilitate a minimum of field wiring at the time of installation, including inter-wiring of space-heater, limit and torque switches, etc.

I. Selector Switch

The actuator shall be supplied with a 3-position LOCAL-REMOTE selector switch which is padlockable in any position.

2.04 MANUAL VALVE ACTUATOR

None

2.05 MOTORIZED VALVE ACTUATOR AND CONTROLS

A. Valve Drive Unit

All discharge valves shall be equipped with a single speed drive unit and controller for automatic operation. The motor operated drive unit shall be mounted on the valve shaft or on the reduction gearing. The new valve drive unit shall consist of the motor, gearing mechanism, handwheel mechanism, limit switches, torque switches, lubricants, heating elements, wiring, and terminal facilities enclosed in a cast iron, weatherproof housing.

The functional requirements, together with special requirements to interlock with the associated pump motor controls, are covered in the contract and reference drawings. Valves shall close with a clockwise rotation.

Valve actuators shall be tested according to the test requirements of AWWA Standard C540. 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 the job site.

The cone valve manufacturer shall provide the required sizing data to the actuator manufacturer. The contractor shall coordinate design with the valve manufacturer to ensure that actuators are installed in an upright position.

Electric motor actuators shall be as manufactured by EIM Controls, Limitorque, or approved equal.

B. Motor

The motor shall be a high torque (1.5 safety factor minimum), low starting current design, made expressly for valve control service and capable of operating the valve under full differential pressure 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 when voltage to the motor is +/-10% of the nominal voltage. The motor shall be totally enclosed, non-ventilated, compound wound, and rated 125 VDC with a minimum Class B insulation. The motor shall be factory lubricated for lifetime operation; motor enclosure rating shall be NEMA 4. The motor shall be capable of operating at any voltage +/-10% of its voltage rating. Motors shall be factory lubricated for lifetime operation. Overload relays or inherent motor heat sensors embedded in the windings shall be provided to protect the motor in the event of an overload.

C. Gearing Mechanism

Reduction shall be performed by a series of spur, helical, bevel, and/or worm gears. Worm gears shall be bronze, all others shall be steel. All gears 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 materials. The unit shall be constructed to permit changing of the gear ratio, if required.

D. Handwheel Mechanism

The actuator shall be equipped with a handwheel for manual operation. The handwheel shall not rotate during motor operation and during handwheel operation the motor shall not turn. The drive unit shall be responsive to electrical control at all times and shall instantly disengage the handwheel when the motor is energized. The handwheel shall rotate counterclockwise to open the valve. An arrow, indicating the direction of rotation, and the word “OPEN” or “CLOSE” shall be cast on the handwheel. The handwheel 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.

E. Lubrication

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 conditions.

F. Torque Switch

The actuator shall include an adjustable torque limit switch (and thrust switch where applicable) These switches shall be incorporated into the valve control circuit so as to interrupt the power supply when a valve requiring torque seating has reached the fully open or fully closed position, or when an obstruction has been encountered during travel. Open and close torque switches shall be adjustable by means of individually calibrated dials and marked “OPEN” or “CLOSE”.

The torque spring furnished with the unit shall allow adjustment of torque to be increased a minimum of 25 percent beyond that 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. Portions of the scale which are beyond the travel of a fully compressed torque spring shall be painted out or removed. The gear head, gearing and valve shall be designed to withstand the 25 percent over torque capability required by the maximum torque switch setting specified above.

G. Limit Switches

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 indicated below. Limit switches shall be rated 2 amperes at 125 VDC. See contract drawings.

GLS/1	Contact open only when the valve is fully open; used to de-energize "OPEN" contactor and turn off "GREEN" indicating light (Gear train No. 1).
GLS/2	Contact open only when the valve is fully closed; used to de-energize "CLOSE" contactor and turn off "RED" indicating light (Gear train No. 2).
GLS/3	Contact closed only when the valve port is 95 percent closed to fully closed. This switch adjustment must be independently adjustable (Gear train No. 3).
GLS/4	Contact open only when the valve is fully open, used for remote indication. (Gear train No. 1).
GLS/5	Contact open only when the valve is fully closed, used for remote indication. (Gear train No. 2).
GLS/6	Contact open only when the valve is fully open, used for valve status indication at drive. (Gear train No. 1).
GLS/7	Contact open only when the valve is fully closed, used for valve status indication at drive. (Gear train No. 2).
GLS/8	Contact closed only when the valve is fully closed; interlock with primary switchgear to prevent opening breaker when discharge valve is open (Gear train No. 2).

Terminal facilities for connection to motor leads, solenoid, heaters, and heaters shall be provided in the limit switch compartment. Threaded conduit hubs shall be provided for conduit connections.

H. Pressure Switches and Gauges

See Section 15101 – Flowtube, Instrumentation and Controls.

I. Heating Elements

Space heating elements shall be provided in both the motor housing and the geared limit switch compartment. The heating elements shall be rated 208 VAC, single phase.

2.06 ELECTRICAL CONTROLS

A. The valve actuator control panel shall be fabricated by IDAC Division of Pieper Electric Inc. , no substitutions, and 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 “LOCAL” and “REMOTE”.
B. 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 95 percent closed in approximately 48 seconds; the remainder of the closure shall be at normal closing speed.
C. 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

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.

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.

D. REMOTE MODE:

The VFD shall receive a PUMP START REQUEST command from SCADA so the pump begins to pump against the closed discharge and buildup pressure. The VFD shall include a N.O. contact to indicate to the valve controller that the VFD has reached minimum speed. The closure of the VFD minimum speed contact and the discharge pressure switch, shall initiate a NORMAL OPEN REQUEST of the valve, opening it at normal speed.

Upon receiving a NORMAL CLOSE REQUEST command from the SCADA, the discharge valve controller shall initiate a normal close of the discharge valve. The valve shall begin closing at normal speed; when the valve is 95% closed, the valve controller shall issue a PUMP STOP REQUEST command to the VFD, allowing the motor to coast to a stop.

In "REMOTE MODE" the front door located valve open/close push buttons shall be disabled.

E. LOCAL MODE**:**

In "LOCAL MODE" the operator will have full control of opening and closing the valve at normal speed by use of the front door located valve open/close push buttons. The valve open/close push buttons must be maintained by the operator 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.

When the valve controller and the VFD are both in LOCAL mode, the VFD must be manually started; once the operator has verified that the VFD is at minimum speed and the discharge pressure switch is closed, the operator may open the valve. Similarly, for pump shutdown, the operator must manually close the valve and then stop the VFD.

F. OVERTEMPERATURE AND EMERGENCY SHUTDOWN**:**

When the stator windings or pump or motor bearings have reached a temperature within 10% of their maximum allowable operating temperature, the VFD shall send a "HI TEMPERATURE" alarm to SCADA. Once the windings or bearings reach maximum operating temperature (HI HI TEMPERATURE), the motor protective realy shall activate a contact output to trip the 86M motor lockout relay. This shall automatically initiate a normal shutdown sequence of the discharge valve, pump and motor and prevent operation of the motor until the relay has been reset.

The 86(S) switchgear lockout relay shall trip in the event of a feeder or VFD fault or activation of an E-STOP pushbutton and immediately open the feeder circuit breaker thereby disconnecting power to the VFD. In this case, the 86S relay shall activate a contact output to the valve controller which shall initiate an emergency close of the discharge valve.

2.07 NAME PLATES

A. Each valve shall have its number suitably shown on both the valve operator and the valve controller. Numerals shall not be less than two (2) inches high and shall be black baked enamel on anodized aluminum plates. The location of the name plate and the method of fastening shall be subject to approval by 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 at 150% of normal operating pressure. 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

SECTION 15101

FLOWTUBE, INSTRUMENTATION AND CONTROLS

1.01 SCOPE

The contractor shall furnish and install one (1) 30” electromagnetic flowmeter and flow transmitter in the discharge line as shown on the plans.

The contractor shall furnish and install all controls and instrumentation in order to provide a complete and operational pumping unit as described in these specifications and indicated on the contract drawings.

The contractor shall furnish and install all new conduit and wiring necessary to complete the job and provide the required control and indication signals needed for the equipment to function properly and as intended.

1.02 FLOWTUBES

Each flowmetering device shall consist of a flanged magnetic flowtube and flow transmitter, which are products of a manufacturer who is regularly engaged in the production of metering equipment of this type. The flowmeter shall be OIML R49-1 compliant and shall be self-calibrating and self-checking. The magnetic flowmeter shall be ABB WaterMaster Series, or approved equal.

The flowtube shall have the required characteristics as specified below:

Nominal line size	30 inch
Flow Range	70,446 U.S. gpm (suitable for flow measurement 15 to 25MGD)
Accuracy	0.4% of rate to 7,045 U.S. gpm
Tube Construction	AISI Type 304 ss, 0.125 in. wall thickness
End Connections	ANSI Class 150 Flange, cs
Lining	NSF-61 approved; polypropylene
Electrodes	AISI Type 316L ss
Coil Drive/Supply	Pulsed dc supplied by flow transmitter
Housing	General Purpose, NEMA 4X

1.03 FLOW TRANSMITTERS

The contractor shall furnish and install a remote-mounted flow transmitter for the flowtube. The flow transmitter shall be ABB WaterMaster Remote Electronic Display unit Transmitter, or approved equal.

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 supply a pulsed dc output to the flowtube to power the flowtube coil.

Transmitter shall output a 4-20mA signal proportional to flow rate. The flow transmitter output shall be calibrated 13-27 MGD.

1.04 PRESSURE GAUGES

The contractor shall furnish and install one pressure gauge on the discharge piping for Pump #5. Pressure gauge shall be liquid-filled, stainless steel, with 50mm dial, Ashcroft Type 1008, or approved equal. Pressure gauge range and scale shall be 0-150 psi.

1.05 DISCHARGE PRESSURE SWITCHES

Contractor shall furnish and install a N.O. pressure switch on the discharge piping as shown on the contract drawings. When the pressure switch closes on pressure buildup and the VFD reaches minimum speed, the discharge valve shall open. Pressure switch shall be Ashcroft B-Series rated 200 psig, contact rating 125Vdc or ac, 10A, SPDT, or approved equal. Contractor shall also furnish and install new surge suppressors, Ray Pressure Snubbers, or approved equal.

1.06 PUMP PRIMING SENSORS AND RELAYS

Contractor shall replace the existing Warrick Co. pump priming electrodes and relay with a new electrode assembly and magnetic control relay.

The electrode assembly shall consist of two electrodes of the same length, mounted in an electrode holder and separated and insulated as required to cause a short circuit across the electrodes when the water level is at or above, the minimum priming level. A control relay output contact shall interlock with the pump starting circuit, in the VFD, to enable starting the pump. In the event of loss of prime, the control relay shall lock out the pump and sound an alarm. The electrode assembly shall be provided with two new electrodes and a 1/4 inch tapped connection on top for vent piping, which shall be installed as shown on the reference drawings.

The liquid level control system shall be designed for use on 120VAC, 60 Hz electrical power; with output contacts rated 2 amperes, 125 VDC nominal. Pump electrode assembly and control relay shall be as manufactured by B/W Controls, Warrick, or approved equal.

1.07 TEMPERATURE SENSORS

Sensing elements for the pump and motor bearings and motor stator windings shall be platinum RTDs, 100Ω @ 0°C, 3-wire type. The RTD probes shall be allocated as follows: two (2) for pump bearings, two (2) for motor bearings, six (6) for motor internal windings.

1.08 E-STOP AND RTD WIRING

The contractor shall wire all RTD inputs, directly into the VFD. The VFD shall send a “HI TEMPERATURE” alarm to SCADA when the pump or motor windings or bearings have reached a temperature within 10% of their maximum operating temperature. Once the windings or bearings reach maximum operating temperature, the VFD shall activate a contact output to trip the 86M motor lockout relay and cause the discharge valve to close at normal speed.

The new Emergency Stop push button, which shall be mounted on VFD enclosure, and the E-Stop push button, which shall be mounted in the switchgear cubicle, are to be wired into the 86S switchgear lockout relay. The VFD “DRIVE FAULT” and “BYPASS FAULT” contacts shall also be wired into the 86S relay lockout circuit to cut power to the drive in an emergency or critical fault situation. An 86S relay trip shall cause the discharge valve to close at high speed.

Lockout relays shall be Electroswitch WL-2, rated 125VDC. Lockout relays shall include pistol grip, target indicator, and two (2) normally open and two (2) normally closed contacts rated 125VDC, 5A.

END OF SECTION

SECTION 15400

PUMP PRIMING EQUIPMENT

PART 1: GENERAL

This contract shall include the furnishing of all equipment, labor, supervision, materials, and appurtenances for and in connection with the following project as shown on the contract drawings and further specified herein.

1.01 SCOPE

Priming of the pumping units shall be provided by means of vacuum type priming equipment installed at the locations shown on the plans, complete with all vacuum and interconnecting piping, control valves, vacuum priming valves on the pumping units, fittings, pipe hangers, pipe sleeves, gauges, bases, anchor bolts, floor and ceiling plates or flanges, and other accessories and appurtenances.

The vacuum type priming equipment to be furnished and installed hereunder is to be used for priming the pumping units and shall be so designed and arranged so that the pumps will be automatically primed at all times.

Vacuum priming system shop drawing submittals shall include detailed data on equipment construction, operation, wiring, and control.

Principal items of equipment, accessories and appurtenances to be furnished and installed hereunder shall include the following:

For Installation of Vacuum Priming System

A. Furnish and install vacuum tank complete with gauge glass and specified tapped connections.

B. Furnish and install a duplex, multi-jet vacuum pump assembly with a separation chamber.

C. Furnish and install two (2) vacuum check valves (one for each vacuum pump inlet line).

D. Furnish and install a complete set of motor starters and controls, including pressure and selector switches, electrically operated valves, vacuum system alarm contact output for remote indication to SCADA, and other apparatus. The contractor shall be responsible for the wiring of this equipment and all apparatus necessary to furnish a complete and operating system as outlined in these specifications and as shown in the shop drawing submittals.

E. Furnish and install two (2) vacuum gauges (one for each vacuum pump inlet line).

F. Furnish and install one (1) vacuum gauge for vacuum tank.

G. Furnish and install one (1) vacuum switch for low vacuum alarm.

H. Furnish and install two (2) vacuum control switches.

For Installation on Pumping Units 1A, 1B, 2, 3A, 3B, 4, 5, 6A & 6B

A. Furnish and install nine (9) vacuum priming valves (and associated piping), one for each pumping unit.

B. Furnish and install nine (9) electrode assemblies, including magnetic control relay, Motor Low Voltage Compartment door-mounted, priming indication lights(and associated piping), one for each pumping unit.

For Installation of Piping Between Vacuum Priming System and Water Pumping Units

A. Furnish and install all vacuum and interconnecting piping, valves, air vents, fittings, pipe hangers and sleeves as required for a complete installation, including valve connections for all nine (9) pumps.

Vacuum priming system shall be manufactured by Domestic Pump (ITT Industries) or an approved equal.

The existing vacuum priming system must be available for service while the new system is being installed.

Vacuum priming valves and accessories shall be either as manufactured, or as recommended by the Nash Engineering Company, or an approved equal.

PART 2: PRODUCTS

2.01 VACUUM TANK

The vacuum tank shall be 36 inches in diameter and 72 inches in length and shall be designed for mounting in a horizontal position on a wall bracket. The tank shall be fabricated from steel plates, designed for a vacuum of 20 inches Hg, and heavily galvanized inside and outside using the hot-dip process. In addition to any connections that may be required for the equipment furnished, the tank shall be provided with the appropriate taps or connections to fit the piping layout:

A. One (1) 2-1/2 inch connection for the vacuum header piping from the vacuum priming valves at the pumping units.

B. Connection of the size required for the vacuum gauge, vacuum alarm switch, and two vacuum control switches.

C. Connections as required for a 24 inch gauge glass.

D. Gauge panel with supports.

2.02 VACUUM PUMPS

The two vacuum pumps to be furnished and installed shall be of the horizontal, electric motor driven type, and shall be Domestic ITT Duplex, Type MJS or approved equal. Each vacuum pump shall be driven by a nominal 460 volt, 3 phase, 60 cycle, 15 hp, 1750 rpm electric motor. Motors shall be furnished with Class "B" insulation with full epoxy encapsulated windings including end turns and slots. The insulating material shall be non-hydroscopic, designed for high humidity service, and shall be a material that is free of cracking due to age or differential expansion. The motor nameplate rating shall not be exceeded at any point on the vacuum pump curve with a service factor of 1.0. The motor shall be direct connected to the pump through a flexible coupling of approved design and construction, and shall have a capacity of not less than 126 cfm measured at 15 inches Hg vacuum referred to 30 inch barometer with 60° F water seal. Each pump and motor shall be assembled on a suitable base plate. All concrete bases, grouting, and anchor bolts as required shall be furnished and installed hereunder.

Automatic operation of the vacuum pumps will be controlled by the vacuum switch. Magnetic starters and a selector switch shall be furnished and handled under this contract, and will be installed by the electrical contractor for control and automatic alternation of the vacuum pump to be used.

2.03 VACUUM PRIMING VALVES

Each of the nine pumping units shall be provided with one vacuum priming valve for connection to the suction and discharge volutes of the pumps. Each priming valve shall have a 1-1/2 inch side tap for piping connection to the vacuum header, a 2 inch bottom tap for piping connection to the suction volutes, a ½ inch side tap for piping connection to the discharge volute, a 1 inch plugged tap opposite the ½ inch tap, and a ¼ inch side tap (near the top) for vent connection from the electrode holder. An inverted check valve shall be installed in a vertical position in the ½ inch piping connection from the discharge volute of the pump and an orifice shall be placed in the ½ inch tap at the priming valve. Priming valves shall be Nash, Model Size 1-1/4 inch x 9/16 inch vacuum priming valves, designed for suction pressure of 20 psi, or approved equal. Each pumping unit will be furnished with two (2) taps in each suction volute and one (1) tap in the discharge volute. The contractor hereunder shall furnish and install connecting piping to the pump casing as shown on the plans.

2.04 MOTOR STARTERS AND CONTROLS

Each vacuum pump shall be provided with a NEMA Type 12 combination (circuit breaker disconnect type) magnetic motor starter with electric alternator to provide automatic sequencing of lead pump. A vacuum pump controller shall have a three-deck, "Off-Automatic-Continuous" selector switch mounted on the cover for each pump to allow turning off pumps, alternating sequencing, or testing of the pumping units. Each starter shall be provided with suitable heaters and three overload relays selected to protect its motor. A fused, 480/120 volt control power transformer, sufficiently sized to provide power for all controls and pilot devices in the controller cabinet; all controls shall be rated 120 volts. Controls for each pump shall include a control power switching relay that shall maintain control power to the water makeup system in the event that Pump No. 1 fails or is disconnected for maintenance, by automatically switching control power over to Pump No. 2. Circuit breaker disconnect shall be rated for 600 volt A.C. service and have a minimum interrupting capacity of 20,000 amperes symmetrical at 480 volts.

A pressure switch shall be provided and installed on the vacuum tank for each vacuum pump. They will be connected to cause the pump selected for automatic operation to start when the vacuum in the tank reaches 15 inches Hg and to stop when the vacuum in the tank reaches 20 inches Hg. One additional vacuum switch shall be provided and installed on the vacuum tank. Its contacts will close at 9 inches Hg for low vacuum alarm. Switches shall each be provided with 2 N.O. isolated contacts, as manufactured by Ashcroft or approved equal. Starter, solenoid valve, pressure switches and other system electrical wiring shall be furnished and installed as indicated on the shop drawings.

2.05 VACUUM INDICATING GAUGES

Vacuum indicating gauges to be provided shall include one to be mounted on the vacuum tank and one to be installed on each of the two vacuum pump inlet lines. Each vacuum indicating gauge shall be graduated from 0 to 30 inches Hg, shall have a dial size of 4 inches, a nickel plated case, and shall be Kunkle, or approved equal, complete with shut off valve.

2.06 VACUUM CHECK VALVES

All check valves shall be suitable for, and of a design and construction which will close and remain tight in, vacuum service. Check valves for installation in the inlet lines to the vacuum pumps shall be horizontal swing check valves, having vertical or 15 degree seats, selected for minimum pressure drop. Check valves installed in the ½ inch lines between the pump discharge volutes and vacuum priming valves shall be Crane Figure 29, or approved equal.

2.07 ELECTRODE ASSEMBLIES

Each of the nine pumps shall be provided with an electrode assembly rated 120VAC. Each electrode assembly shall consist of two electrodes of the same length mounted in an electrode holder, and separated and insulated as required to cause a short circuit across the electrodes when the water is at a level insuring that the pump is suitably primed. The electrodes of each assembly will actuate a magnetic control relay with DPDT contact outputs. The DPDT control relay output contact shall interlock with the pump starting circuit in the valve controller, to enable starting the pump; contact outputs shall be rated 125 VDC, 5 A. The Contractor shall furnish and install one (1), amber LED light rated 120VAC on the front of the Motor Low Voltage compartment so that in the event of loss of prime, the normally open control relay output shall disable the pump and the normally closed output contact shall illuminate the light indicating the loss of prime. Each electrode holder shall be a Charles F. Warrick Company, Type C-2, or approved equal. Each electrode assembly shall be provided with two electrodes and ¼ inch tapped connection on top for the vent piping which is to be installed as shown on the plans. The relays will be mounted in the respective motor terminal compartments and the connecting electrical conduit furnished and installed by others.

2.08 PIPING

All piping required to complete the installation of the vacuum pump assemblies, vacuum tank, vacuum priming valves, alternating receiver, and accessories and appurtenances shall be furnished and installed complete including all pipe, fittings, valves, pipe hangers and sleeves, and other accessories and appurtenances required to provide a workable and satisfactory installation in accordance with the plan details as a part of this contract (See SECTION 15050, MISCELLANEOUS PIPING).

PART 3 EXECUTION:

3.01 INSTALLATION CHECK

Immediately prior to the operation of the pump priming equipment, such equipment together with the installation thereof, shall be carefully inspected and checked to ensure that it is in proper operating condition and order. Such check shall be made by an authorized representative of the manufacturer of the pump priming equipment, who is a competent and experienced erector and operator of such equipment. He shall inspect, approve, and adjust if necessary, the equipment installation and shall be present when the equipment is first placed in operation. If any trouble develops in the operation of the equipment, he shall remain on the job until the issue is corrected or, if repairs are needed, return after the repairs have been made and remain until, in the opinion of the Commissioner, the equipment installation and operation thereof is satisfactory. All costs in connection with such installation check shall be included in the unit bid for the work under this contract.

END OF SECTION

SECTION 15500

PUMPING UNITS - GENERAL

PART 1 GENERAL

1.01 SUMMARY OF WORK

A. The contractor shall furnish, test, and place in satisfactory operating condition one (1), double suction, bottom-suction, side-discharge, horizontal split-case centrifugal pumping unit in strict accordance with the plans and specifications. Requirements for the variable frequency drive, induction motor, and priming valve for Pump No. 5 are covered elsewhere in these documents.

B. The contractor shall furnish and install pump priming equipment. This should include a vacuum priming valve, electrode assemblies, all interconnecting piping, vents, and fittings as required.

C. 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 AND INSTALLATION CONDITIONS

A. The pumping unit will be used to pump filtered Lake Michigan water. Water temperature will vary from 32°F to 80°F. Pump performance shall be based on a water temperature of 68°F.

B. The pumping unit will 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. The pump is to be installed in the Riverside Pumping Station at an elevation of approximately 585 feet above sea level.

C. All equipment furnished shall conform to OSHA, NEC, the “Wisconsin Electrical Code” and “City of Milwaukee Code of Ordinances” where applicable.

D. All equipment shall be designed and arranged for use in conjunction with the existing supervisory control.

E. The pumping unit shall be designed so that it may run simultaneously with the other high service pumping units. The 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.

F. Pumping unit shall be equipped with operating accessories that meet the appropriate operating requirements specified hereafter.

1.03 QUALITY ASSURANCE

A. The complete pumping 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 five (5) 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. Each 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 unit shall be manufactured by Patterson Pumps, ITT Bell & Gossett, or an approved equal.

PART 2 PERFORMANCE AND DESIGN REQUIREMENTS

The head, capacity, and related performance & design requirements for the pumping unit are as follows:

PUMP NO. 5

Rated Capacity @ rated head	17360 gpm (25 MGD)
Rated total head (TDH), feet	295

Shutoff head, feet	328
Normal operating head range, feet	265 to 328
Minimum head for Continuous operation, feet	265
Minimum pump efficiency:	87%
Minimum overall efficiency (Wire to Water) at rated head	81%
Pump discharge nozzle diameter, inches	24
Pump suction nozzle diameter, inches	30
Motor voltage	4160/3/60
Motor service factor (S.F.)	1.15
Maximum brake horsepower, BHP	Supplied by Manufacturer
Motor horse power, HP	2000 HP
Minimum motor efficiency at full load	Supplied by Manufacturer
Motor and Pump Bearing Temperature Detectors (RTDs)	Required
Motor thermal cut-off	Required
Motor Stator Resistance Temperature Detectors (RTDs)	Required
Maximum distance from suction Inlet centerline to discharge Flange face, inches	See attached drawing
Minimum Design Pressure	Shutoff Head
Minimum Shop Test Pressure	1.75 times Rated Head or 1.5 times Shutoff Head, whichever is greater

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.

G. Combination pump curves

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 PUMPS

PART 1 PUMP CONSTRUCTION AND ASSEMBLY

1.01 PUMP TYPE

Pump shall be the single stage, bottom-suction, side-discharge, double suction, horizontal split case, centrifugal type. Pump shall be induction motor driven with rated capacities as indicated in PART 2, PERFORMANCE AND DESIGN REQUIREMENTS of Section 15500, PUMPING UNITS - GENERAL.

1.02 PUMP CASING

Pump casing shall be made of high grade cast iron conforming to the requirements of ASTM A48, Class 30 minimum thickness suitable for the maximum 250 psi working pressure. The casing shall be subject to hydrostatic pressure testing in the shop of the manufacturer in accordance with the pressure limits indicated in PART 2, PERFORMANCE & DESIGN REQUIREMENTS of Section 15500, PUMPING UNITS. The casing shall be of the single-volute, axially split type with the suction and discharge nozzles in the lower half casing so that the upper half of the casing may be removed without disturbing the suction or discharge piping. The upper and lower half casings shall be furnished with heavy flanges, faced, drilled, and bolted together. Jack screws or other means shall be provided for breaking the joint, and taper dowel pins with nuts shall be provided, integral with the flanges, to ensure accurate alignment. The upper half casing shall be provided with eye bolts or lifting lugs to facilitate removal. The lower half casing shall be provided with feet for bolting and dowelling to the base plate. Flanged nozzles shall be provided for the suction and discharge piping. All nozzle flanges shall be sized for 250 lb. and drilled for 125lb. The pump casings shall be provided with tapped openings for drains, priming connections, gages, and vents.

1.03 IMPELLER

Pump impeller shall be of the double-suction, enclosed type and shall be carefully designed to give the specified characteristics and consist of a single bronze casting. All impeller surfaces shall be polished smooth and be free from burrs. Vanes shall be formed by accurately set cores to obtain even thickness and spacing, and shall be cast in one piece. The impeller shall be keyed to the shaft and securely held in axial position by bronze shaft sleeves, and lock nuts designed to tighten with normal shaft rotation. The impeller shall be dynamically balanced to prevent vibration and hydraulically balanced to prevent thrust. The rotating assembly shall be designed to withstand reverse rotation without damage. The contractor shall provide manufacturer’s certified balance tests.

1.04 WEAR RINGS

Wear rings shall be provided on the casing and impeller at the joint running between the suction and discharge chambers to minimize water leakage between the impeller and casing.

Impeller rings shall be ASTM A 743CF8M stainless steel, fastened that they cannot rotate or become loose when the pump is subjected to reverse rotation. Impeller rings shall be securely fastened to the impeller hubs and shall have a close running fit with the casing rings.

Casing rings shall be 316 stainless steel, positioned in the casing by tongue and groove fit and locked against rotation by the lower half of the casing.

1.05 BEARINGS

Bearings shall be of the heavy duty, 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.

All pump bearings shall be of 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.

Pump bearings shall be oil lubricated by design and be provided with suitable large capacity oil reservoirs equipped with sight glasses to determine oil levels regardless of whether or not pump is running. Pump lubrication system shall be designed for a minimum of two weeks unattended service with remote or automatic control of operation.

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.

Both the inboard and outboard ball bearings shall be 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 shall be of extra large capacity for both radial and thrust loads with the outboard bearing confined rigidly in the bearing housing to take end thrust and the inboard bearing set with sufficient clearance to allow for shaft expansion. Inboard and outboard bearings shall be provided with 100Ω platinum RTDs to monitor bearing temperature.

Both bearings shall be able to be removed and replaced without the need to remove the rotation assembly from the pump.

1.06 STUFFING BOXES

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.

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 shut-off, control, and check valves shall be furnished. Each stuffing box shall be equipped with a bronze of Teflon lantern ring as required by pump suction pressures.

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, 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.

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.

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.

The stuffing boxes/seal chambers shall be extra deep, designed for packing and lantern rings or mechanical seals. Under each stuffing box is a drip pocket with tapped drain outlet. The stuffing boxes/seals chambers are completely removable and replaceable.

1.07 PUMP SHAFT

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.

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.

1.08 CARTRIDGE MECHANICAL SEAL ASSEMBLY

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 a 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.

1.09 FOUNDATION PLATE

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 pump and motor. Motor 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 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 LABELS

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.

1.11 VACUUM PRIMING VALVE

(See SECTION 15400, VACUUM PRIMING SYSTEM).

1.12 VACUUM CHECK VALVE

All check valves shall be suitable for, and of a design and construction which will close and remain tight in, vacuum service. Check valves installed in the ½ inch lines between the pump discharge volutes and vacuum priming valves shall be Crane Figure 24, or approved equal.

1.13 VACUUM RELIEF VALVES

Vacuum relief valves shall be Nash Vacuum Relief Valves of a type and size (not smaller than ½ inch) recommended by the Nash Engineering Company for the existing vacuum pumps, or an approved equal.

1.14 ELECTRODE ASSEMBLIES

(See SECTION 15400, VACUUM PRIMING SYSTEM).

1.15 PIPING

All piping required to complete the installation of the vacuum priming valves, accessories and appurtenances shall be furnished and installed complete including all pipe, fittings, valves, pipe hangers and sleeves, and other accessories and appurtenances required to provide a workable and satisfactory installation in accordance with the plan details as a part of this contract.

PART 2 PERFORMANCE

2.01 FACTORY TESTING

Pump shall be hydraulically Performance and hydrostatically Pressure tested and certified by the pump manufacturer according to the procedures of the Hydraulic Institute Standards. The completed pump shall be witness tested at the factory with calibrated motors according to the procedures of the Hydraulic Institute, Level A. The test shall include gallons per minute versus total head, horsepower and efficiency. A minimum of seven test points, including shut-off and design points, shall be included. Certified Test curves showing capacity, head, efficiency, and brake horsepower, shall be submitted to the City.

2.02 ROTATIONAL BALANCE

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 per the Hydraulic Institute standard vibration limits.

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 places. Protect from weather, dirt, fumes, water, construction debris and physical damage.

3.02 ELECTRIC WORK

A. All electrical work shall be performed by the Contractor with the exception of wiring terminations at the City SCADA cabinet. SCADA cabinet terminations and all associated SCADA programming and modifications necessary to accommodate the new equipment shall be performed by City forces. The contractor shall size and install all conduit and conductors according to equipment requirements and all local and national codes governing this type of work. The contractor shall submit complete point-to-point wiring diagrams prior to pulling wire for review.

B. 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 installation again after corrections have been made.

3.03 INSTALLATION

A. Install new pumping unit at the original location of the old pumping unit as shown on the attached contract drawings. Contractor shall set the pumping unit, grout the baseplate, install suction and discharge piping, and perform all other work required for a complete and operational installation.

B. Construct concrete pad to accommodate new Pumping Unit No.5. All concrete work shall be in accordance with Section 03300, CONCRETE WORK.

C. 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 this contractor.

D. Start-up the pumping unit in accordance with the manufacturer's start-up instructions and in presence of manufacturer's representative.

E. 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 unit in service.

3.04 STARTING SERVICE

After installation of the pumping unit is complete, the manufacturer shall provide three (3) days (24 hours) service for training City employees. At least a seven (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 will involve multiple sessions to accommodate three (3) shifts of personnel.

END OF SECTION

SECTION 15700

ELECTRIC MOTORS

PART 1 GENERAL

1.01 MOTOR TYPE AND RATING

A. Pump No. 5 motor shall be horizontal, continuous duty, squirrel cage induction, open drip-proof, premium efficiency, speed as required by the pumping unit and operate on a 4160 volt AC, 3 phase, 60 Hz supply. Pump No. 5 motor shall be inverter duty rated.

B. Motors 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. Motors shall be sized to operate pump continuously at all heads within the specified operating range without exceeding its specified rating.

D. Motors shall be rated for a 1.15 service factor in a 40°C ambient temperature.

1.02 CODES AND STANDARDS

All equipment shall be designed, fabricated, assembled and tested in accordance with the most current applicable standards as defined by the following institutions:

A. American National Standards Institute (ANSI)

B. Institute of Electrical and Electronic Engineers (IEEE)

C. National Electric Manufacturers' Association

D. Anti-Friction Bearing Manufacturers' Association (AFBMA)

Equipment shall be labeled or listed as being approved by the Underwriters Laboratories (U.L.), whenever applicable.

1.03 SERVICE CONDITIONS

A. Motors 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. Motors shall be capable of continuous operation at full load and rated frequency with a voltage variation of +/- 10% and a frequency variation of +/- 5.0 %.

C. Motors shall be suitable for 25% over speed in reverse direction without damage to bearings or from centrifugal forces.

D. Motors 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.

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

1.04 OPERATING CHARACTERISTICS

With rated voltage and frequency applied, motor performance shall be as follows for critical operating characteristics:

A. Torques:

   Motors shall meet or exceed the minimum locked rotor (starting) and breakdown torque specified in NEMA standard MG1 for design B for the ratings specified.

B. Currents:

   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.

C. Temperature Rise:

   The temperature rise, by resistance, shall be 80 degrees C or less when measured at rated load.

1.05 SUBMITTALS

The following specific information shall be provided with proposal:

A. Complete motor nameplate data in accordance with NEMA standards.

B. Approximate motor weight.

C. Preliminary dimensions and size of motor and frame.

D. Motor performance data to include the following:

1. Guaranteed minimum efficiencies at 100%, 75%, and 50% of full load. Guaranteed minimum power factor at 100%, 75% and 50% of full load.

2. Locked rotor current.

3. Full load current.

4. Starting Torque.

5. Full load torque.

6. Breakdown torque.

7. Full load power factor and maximum correction capacitor kVa.

8. Nominal efficiency in accordance with IEEE 112.

E. Manufacturer's printed data on each motor type being provided to indicate compliance with specified performance and construction.

F. Complete description of testing facilities.

G. Job site storage requirements.

The following information is required within six (6) weeks after order:

A. Certified dimensional drawings of motor and frame.

B. Recommended spare parts list with pricing.

The following is required upon shipment of the units:

A. Operations & Maintenance Manuals.

B. Connection diagrams.

C. Test reports as Specified.

PART 2 MOTOR CONSTRUCTION AND ASSEMBLY

2.01 MOTOR ENCLOSURE

Motor enclosure shall be open drip-proof, made of heavy-duty rugged cast iron.

2.02 STATOR

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 adjustable speed drive service shall meet NEMA MG-1, Part 31, dated 1993 and shall have an insulation system rated for such service.

2.03 ROTOR

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

Motors shall have a minimum of two (2) Remote Temperature Detectors (RTDs) per phase for a total of six (6) in the stator windings located in the slots between the coil sides of different phases. Motors shall have two (2) RTDs for the motor bearings; mounted as closely as possible to the outer surface of each bearing. Similarly, the pumps shall also have two (2) RTDs for the pump bearings; mounted as closely as possible to the outer surface of each bearing. RTDs shall be platinum100 Ω @ 0°C, 3-wire type. Wiring shall be stranded copper not less than 16 gauge with approved moisture and heat resistant insulation, laid up in a multiple triad cable with overall shield. One conductor from each element shall be grounded to the stator at the terminal box.

RTD inputs shall be run to the VFD. The VFD shall send a “HI TEMPERATURE” alarm to SCADA when the stator windings or bearings have reached a temperature within 10% of their maximum operating temperature. Once the windings or bearings reach maximum (HI HI TEMPERATURE) operating temperature, the VFD shall activate a contact output to trip the 86M motor lockout relay and automatically initiate a normal shutdown sequence of the pump and motor.

2.05 SPACE HEATERS

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 208 volt AC, three phase, 60 hertz service.

2.06 MOTOR BEARINGS

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.

All 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.

2.07 TERMINAL BOX

The motor shall be provided with a sheet steel enclosed terminal cabinet mounted integrally on the motor. It is the intent of this specification that the terminal cabinet be approximately the same height as the motor frame and shall have two separate compartments, one for the high voltage leads, and one for low voltage accessories and terminal connections. Hinged front doors shall provide access to the high and low voltage compartments. 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, that are not suitable for rotation, must be capable of top-entry. Box must 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.

The high voltage compartment shall contain:

1. One (1) set of cable lugs/clamps for termination of phase conductors.

2. Ground lug for connection of bare ground wire; this conductor shall be carried in the same conduit that carries the incoming feeder cables.

3. One (1) hinged cover with suitable latching provisions.

The low voltage section shall contain:

1. One (1) pump prime relay with door-mounted pilot light, Warrick or approved equal, for use in pump start circuit to prevent closure of the motor contactor unless the pump is primed; to be wired to terminal strip for external connections.

2. One (1) complete set of terminal blocks for all external low voltage wiring connections to control devices and space heaters.

3. One (1) hinged cover with suitable latching provisions.

4. One (1) manual reset motor lockout relay, Electroswitch WL-2 or approved equal, with pistol grip, target indicator and two(2) normally open contacts and two(2) normally closed contacts rated 125 VDC, 5A. minimum; coil voltage 125VDC.

2.08 ACCESSORIES

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

The following standard tests shall be performed for motors in accordance with IEEE 112 method B.

A. Current Balance

B. High Potential Test per MG 1-20.47

C. Vibration Test

D. Winding Resistance per IEEE Standard 112.4.1

E. Locked Rotor Current

F. No Load Running Current measurements at 60 Hz in accordance with IEEE Standard 112.4.6

G. Full Load Heat Run

H. Full Load Percent Slip

I. Efficiency at 100%, 75%, and 50% Load

J. Noise test per IEEE standard 85 decibel

K. Water immersion test per NEMA MG 1-20.48

3.02 VIBRATION

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 contractor shall furnish and install all electrical materials, labor, equipment, and appurtenances necessary to manufacture, deliver, test, install, and bring into full operation, as described in the contract drawings and specifications, the following new electrical equipment and systems at the Milwaukee Water Works' Riverside Pumping Station:

1. Variable Frequency Drive (VFD) System for Pumping Unit No. 5, (which for reference purposes shall include pump, motor, VFD with bypass, manual suction and motorized discharge valves, and all associated control and monitoring instrumentation, relays, and accessories needed to start and operate Pump No. 5 in accordance with the specifications).

2. Pump Priming System for station distribution pumps including valves, priming relays, electrodes, two motor compressors, motor controllers, and accessories.

3. 30" magnetic flow meter.

1.02 SCOPE

A. The contractor shall fulfill all Basic Electrical Requirements as set forth in the specifications and detailed on the contract drawings. This work shall include the following:

1. Disconnection and demolition of the existing systems being replaced and all associated electrical power, indication and control wiring back to the source and all conduit as is practical.

2. Contractor shall size, furnish, and install all electrical conduit, boxes, wire, and fittings as required to provide all electrical power, control and indication for the new electrical equipment and systems included in SECTION 1.01 PROJECT OVERVIEW. All wire and conduit shall be sized in accordance with NEC requirements and best practices in the electrical trade. Wiring requirements shall be determined from the contract drawings, specifications and the functional control diagrams and descriptions.

3. Contractor shall be responsible for the development of master electrical power and control interconnect wiring diagrams, necessary for construction that shall include coordination of electrical control devices and new and existing equipment. Wiring requirements shall be determined from the contract drawings, specifications and shop drawings. These drawings shall be included with the other submittals sent to the City for review prior to pulling new wire and cable.

The City shall provide termination points, inside the SCADA cabinet, for the Contractor to terminate the control and indication wiring. The City shall be responsible for all associated SCADA system control and monitoring programming.

4. Contractor shall make modifications to the switchgear section for Pump No. 5 as indicated in the contract drawings and shall remove the existing motor management relay and obsolete synchronous motor field control equipment from the Pump No. 5 switchgear section. The contractor shall install one (1), new feeder management and protection; cover plates shall be furnished for and installed over all unused openings. The contractor shall reconnect the relay to the Modbus network in the 5kV switchgear and make all necessary relay and PLC programming changes for SCADA to bring in power quality monitoring data from the new relay. All relay and equipment startup and operation settings shall be established and programmed by the contractor. The contractor shall conduct a relay coordination study to determine these parameters and provide one copy to the City. The study shall also incorporate the manufacturer's recommended fuse size for the VFD.

5. 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.

6. Work included in all other divisions is the responsibility of the contractor performing the Division 16 work unless noted otherwise.

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 Underwriters' Laboratories UL label of approval or other 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 (MWW), 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 MWW. 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 MWW's intent (as determined by the MWW 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 MWW 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 MWW 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 MWW, 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 MWW before proceeding.

C. Tools, materials and equipment shall be confined to areas designated by the MWW.

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 MWW'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 MWW 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 forty (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 ten (10) MWW employees.

1.17 RECORD DRAWINGS

A. The contractor shall maintain at least one (1) copy each of the specifications and drawings on the job site at all times.

B. MWW 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 MWW 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 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.

3.02 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.

3.03 COORDINATION

A. The contractor shall cooperate with other trades and MWW 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 MWW, 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.

3.04 SLEEVES

A. Pipe sleeves for conduits 6 inches 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.

3.05 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.

3.06 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 INTERMEDIATE METAL CONDUIT (IMC) AND FITTINGS

A. Conduit: Galvanized steel, threaded.

B. Fittings and Conduit Bodies: Use all steel threaded fittings and conduit bodies.

2.03 FLEXIBLE METAL CONDUIT AND FITTINGS

A. Conduit: steel, galvanized, spiral strip.

B. Fittings and Conduit Bodies: All steel, galvanized, or malleable iron.

2.04 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.

2.05 CONDUIT SUPPORTS - See Section 16190.

2.06 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 condulet covers must be fastened to the condulet 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 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 and number of conductors to be installed. Conduit size shall be 3/4 inch 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 the 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. Changes in direction shall be made with symmetrical bends, cast steel boxes, stamped metal boxes or cast steel conduit bodies.

M. 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 manufacturer's 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 UL 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 manufacturer’s recommendations.

3.03 CONDUIT INSTALLATION SCHEDULE

A. Conduit other than that specified below for specific applications shall not be used.

B. All Locations: Rigid steel conduit. Intermediate metal conduit.

C. Medium Voltage Applications (Interior Locations): Rigid steel conduit.

D. Motor and equipment connections: Flexible metal conduit. 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.

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 (5) 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 (5) 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°F, the cable shall be moved to a heated (50°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 (2) 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 underground 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°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°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°F to 150°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°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 non-injurious 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 eight (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 manufacturers' 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°C. Other areas shall use insulation rated 75°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.

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.

4-20mA analog signal cable shall be 16 AWG shielded, twisted pair, Belden 8719, or approved equal.

RTD wiring shall be 12 multiple triad cable, 18 AWG with overall shield; Belden 1095A or approved equal.

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 unless otherwise noted, 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 bed 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 two (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% 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

Applicable provisions of Division 1 shall apply to all work under this Section.

1.01 SCOPE

Pull and junction boxes for power, low voltage, and fiber optic installations. Included are the following topics:

PART 1 - GENERAL
- Scope
- Submittals

PART 2 - PRODUCTS
- General
- Pull and Junction Boxes

PART 3 - EXECUTION
- Coordination of Box Locations
- Pull and Junction Box Installation

1.02 SUBMITTALS

Submit product data under provisions of Division 1 and Section 16010. Provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.

PART 2 - PRODUCTS

2.01 GENERAL

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 PULL AND JUNCTION BOXES

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).

For fiber optic and other low voltage cable installations the NEC box size requirements shall apply. All boxes, used on 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.

Sheet Metal Boxes: code gauge galvanized steel, screw covers, flanged and spot welded joints and corners.

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.

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.

Box extensions and adjacent boxes within 48” of each other are not allowed for the purpose of creating more wire capacity.

Junction boxes 6" x 6" or larger size shall be without stamped knock-outs.

Wireways shall not be used in lieu of junction boxes.

PART 3 EXECUTION

3.01 COORDINATION OF BOX LOCATIONS

Provide electrical boxes as required for splices, taps, wire pulling, equipment connections, and code compliance.

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.

Locate and install to maintain headroom and to present a neat appearance.

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

3.02 PULL AND JUNCTION BOX INSTALLATION

Support pull and junction boxes independent of conduit.

END OF SECTION

SECTION 16190

SUPPORTING DEVICES

PART 1 GENERAL

Applicable provisions of Division 1 shall apply to all work under this Section.

1.01 SCOPE

The work under this section includes conduit and equipment supports, straps, clamps, steel channel, etc. and fastening hardware for supporting electrical work. Included are the following topics:

PART 1 - GENERAL
- Scope
- Submittals

PART 2 - PRODUCTS
- Material

PART 3 - EXECUTION
- Installation

1.02 SUBMITTALS

Submit data for support channel under provisions of Division 1 and Section 16010.

PART 2 PRODUCTS

2.01 MATERIAL

Support Channel: Steel, galvanized, enameled or other corrosion resistant approved equal.

Hardware: Corrosion resistant.

Minimum size threaded rod for supports shall be 3/8” for trapezes and single conduits 1-1/4” and larger, and ¼” for single conduits 1” and smaller.

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 iron backing plates when rigid steel conduit is installed on interior or exterior surface of any exterior building wall.

PART 3 EXECUTION

3.01 INSTALLATION

Fasten hanger rods, conduit clamps, outlet, junction and pull boxes to building structure using pre-cast insert system, preset inserts, beam clamps, or expansion anchors.

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 on concrete surfaces; sheet metal screw in sheet metal studs and wood screws in sheet metal studs and wood screws in wood construction. If nail-in anchors are used, they must be removable.

Power-actuated fasteners and plastic wall anchors are not permitted.

File and de-bur cut ends of support channel and spray paint with cold galvanized paint to prevent rusting.

Do not fasten supports to piping, ductwork, mechanical equipment, cable tray or conduit.

Fabricate supports from galvanized structural steel or steel channel, rigidly welded or bolted to present a neat and workmanlike appearance. Use hexagon head bolts with spring locks under all nuts.

In wet locations, mechanical and electrical rooms, install free-standing electrical equipment on 3-1/2” concrete pads unless specified otherwise.

Install surface-mounted cabinets and panelboards with a minimum of four anchors. Provide steel channel supports to stand cabinet one inch off wall.

Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.

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

Applicable provisions of Division 1 shall apply to all work under this Section.

1.01 SCOPE

This section describes the products and execution requirements relating to labeling of power, lighting, general wiring, and signal 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 equipment and labeling of inner duct (fiber optic). Included are the following topics:

PART 1 - GENERAL
- Scope
- Related Work
- Submittals

PART 2 - PRODUCTS
- Materials

PART 3 - EXECUTION
- General
- Junction and Pullbox Identification
- Innerduct Labeling
- Power and Control Wire Identification
- Nameplate Engraving
- Panelboard Directories

1.02 RELATED WORK

Section 16123 - Building Wire and Cable (Below 600 Volts)

1.03 SUBMITTALS

Submit shop drawings under provisions of Division 1, General Conditions of the Contract, and Section 16010.

Include schedule for nameplates and stenciling.

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 PRODUCT

2.01 MATERIALS

Labels: All labels shall be permanent, and machine generated. NO HANDWRITTEN OR NON-PERMANENT LABELS ARE ALLOWED.

Label size shall be appropriate for the conductor or cable size(s). 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.

Nameplates: Engraved three-layer laminated plastic, black letters on a white background. Emergency system shall use white letters on red background.

Tape (phase identification only): Scotch #35 tape in appropriate colors for system voltage and phase.

Adhesive type labels not permitted except for phase and wire identification.

PART 3 EXECUTION

3.01 GENERAL

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.

All branch circuit and power panels must be identified with the same symbol used in circuit directory in main distribution center.

Clean all surfaces before attaching labels with the label manufacturer’s recommended cleaning agent.

Install all labels firmly as recommended by the label manufacturer.

Labels shall be installed plumb and neatly on all equipment.

Install nameplates parallel to equipment lines.

Secure nameplates to equipment fronts using screws, or rivets. Secure nameplate to inside of recessed panelboards in finished locations.

Embossed tape will not be permitted for any application.

3.02 JUNCTION AND PULLBOX IDENTIFICATION

The following junction and pullboxes shall be identified utilizing spray painted covers:

System	Color(s)
Secondary Power – 480Y/277V	Brown
Secondary Power – 208Y/120V, 240/120V	White

3.03 INNERDUCT LABELING

All innerduct containing fiber optic cable installed under this project shall be labeled where exposed.

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.

The tag shall be secured to the innerduct(s) using self-locking ties.

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

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.

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

Provide nameplates of minimum letter height as scheduled below.

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.

Equipment Enclosures: 1 inch (25 mm); identify equipment designation.

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.

Individual Circuit Breakers, Disconnect Switches, Enclosed Switches, and Motor Starters: ½ inch (13 mm); identify source and load served.

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.

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

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

END OF SECTION

SECTION 16260

MEDIUM VOLTAGE VARIABLE FREQUENCY DRIVES RATED 300-10,000 HP

PART 1 GENERAL

1.01 SUMMARY

Section Includes:

A. This specification covers materials, labor, equipment and start-up services required to manufacture, assemble, shop test, deliver, and install a new integrated medium voltage variable frequency drive (VFD) system for the new Pumping Unit No. 5.

B. Every VFD system shall consist of all components required to meet the performance, protection, safety, and certification criteria of this specification.

C. The VFD shall be following components must be integrated into the VFD System:
Integral line reactor
Active Front End [PWM converter]
PWM inverter
DC Link with common mode voltage protection
Input and output filters if applicable

1.02 QUALIFICATIONS

A. Manufacturer
1. The manufacturer shall have a minimum of 10 years experience in the manufacturer of medium voltage variable frequency drives for use in similar applications at the specified voltage and power ratings. A user list, complete with contact names and telephone numbers, shall be furnished upon request. All equipment furnished shall be designed and constructed in accordance with the industry's best practices and methods and shall operate satisfactorily and in keeping with the City's intent as set forth in the contact documents.
2. The approved manufacturers are:
a. Rockwell Automation Allen-Bradley (no substitutions)

B. Support
1. The manufacturer shall maintain factory trained and authorized service facilities within 100 miles of the project and shall have a demonstrated record of service for at least the previous ten years owned and operated by the VFD drive manufacturer.
2. Support personnel are to be direct employees of the manufacturer.
3. The manufacturer shall provide all required start-up and training services.

C. Certification
1. The VFD shall be factory pre-wired, assembled, and tested, as a complete package by the VFD supplier. Pump No. 5 specific drive, motor and application data shall be preloaded into the operator interface and tested prior to shipment.
2. All inspection and testing procedures shall be developed and controlled under the guidelines of the Supplier's quality system. This system must be registered to ISO 9001 and regularly reviewed and audited by a third party registrar.
3. All incoming material shall be inspected and/or tested for conformance to quality assurance specifications.
4. All sub-assembles shall be inspected and/or tested for conformance to Supplier's engineering and quality assurance specifications.
5. All printed circuit boards with active components shall be burned-in per the manufacturer's standards.
6. Third party manufacturers and brand labeling shall not be allowed.

1.03 REFERENCES

A. Variable Frequency Drive
1. Canadian Standards Association (CSA) "Industrial Control Equipment C22.2 No. 14"
2. American National Standards Institute (ANSI) "Instrument Transformers C57.13"
3. Institute of Electrical & Electronic Engineers (IEEE)
4. Electrical & Electronic Manufacturers Assoc. of Canada (EEMAC)
5. Guide for Harmonic Control and Reactive Compensation of Static Power Converters (IEEE 519-1992)
6. National Electrical Manufacturers Association (NEMA) "Medium Voltage Controllers Rated 1501 to 7200V AC ICS 3-2 (formerly ICS 2-324)"
7. Underwriters Laboratories, Inc. (UL) (High Voltage Industrial Control Equipment 347)
8. UL 347A Medium Voltage Power Conversion Equipment Preliminary Standard
9. International Electrotechnical Commission (IEC) 61800-5 AC Drives Standard
10. European Directives for Safety and EMC
11. National Electrical Code (NEC)
12. Occupational Safety & Health Act (OSHA)

1.04 ENVIRONMENTAL REQUIREMENTS

A. Conform to specified service conditions during and after installation of products.

B. Maintain area free of dirt and dust during and after installation of products.

1.05 PRE-MANUFACTURE SUBMITTALS

A. Refer to Section 01010 for submittal procedures.
B. Shop Drawings.
1. Elevation drawings showing dimensional information.

2. Structure Descriptions showing:
   a. Enclosure ratings
   b. Fault ratings
   c. Other information as required for approval
3. Conduit locations.
4. Unit Descriptions including amperage ratings, frame sizes, trip settings, pilot devices, etc.
5. Nameplate Information.
6. Schematic wiring diagrams.

C. Product Data
1. Publications on variable frequency drive.
2. Data Sheets and Publications on all major components.
   a. Contactors
   b. Circuit breaker and fuse information including time current characteristics
   c. Control Power Transformers
   d. Pilot devices
   e. Relays
   f. Operator Interface

D. Spares
1. Recommend spare parts list and list prices shall be supplied.
2. Critical Spares – Spare parts that are identified as being associated with long lead times and/or critical to the unit's operation.
3. Maintenance Spares – Spare parts that are identified as being required to regularly perform scheduled maintenance on their equipment. These spares include, but are not limited to, consumable spares that are required to be exchanged during scheduled maintenance periods.

E. Specification Response
1. Detailed response to this specification showing where in the literature and drawings each requirement is satisfied.
2. All clarifications and exceptions must be clearly identified.

F. Testing and Test Reports
1. Testing shall be per manufacturer's standard.
2. A copy of the test reports shall be provided as part of the Closeout documentation.

1.06 CLOSEOUT SUBMITTALS

A. Refer to Section 010010 SUMMARY OF WORK, for procedure on submittal of closeout documentation.

B. Contractor shall provide certification that the variable frequency drive has been installed in accordance with the manufacturer's instructions.

C. The Contractor shall provide certification that the Contractor has properly adjusted any timing devices required in the starting circuitry.

D. Final Drawings. The manufacturer shall provide final drawings reflecting the "As-Shipped" status of the motor control center. The contractor shall be responsible for making any changes to the "As-Shipped" drawings from the manufacturer to reflect any field modifications.

E. Maintenance Data
1. Variable frequency drive installation instructions and User Manual.
2. Installation / Operation instructions for major components such as circuit breakers, contractors, isolation transformers, etc.
3. Drive Parameter Listing.
4. Field Service report from drive start-up service.
5. Variable Frequency spare parts listing and pricing.
6. Include name and phone number for a local distributor for the spare parts.

1.07 DELIVERY, STORAGE AND HANDLING

A. Contractor shall coordinate the shipping of equipment with the manufacturer.

B. Contractor shall store the equipment indoors in a clean and dry space.

C. Contractor shall protect the units from dirt, water, construction debris and traffic.

1.08 FIELD MEASUREMENTS

A. The Contractor shall verify all field measurements prior to the fabrication of the VFD.

1.09 SPARE MATERIALS

A. The following spare parts shall be furnished for each size drive:

B. Three of each type power and control fuse.

C. Two power modules (SGCT) or 20%, whichever is greater.

D. Two spare LEDs of each type used.

E. Two spare control relays of each type used.

F. Two sets of all replacement air filters.

G. One hoisting mechanism for removal and replacement of power cells, if required.

H. One set of all control printed circuit boards.

1.10 WARRANTY

A. The manufacturer shall provide their standard parts warranty for eighteen (18) months from the date of shipment or twelve (12) months from the date of being energized, whichever occurs first.

B. The manufacturer shall confirm this warranty as part of the submittal.

C. This warranty applies to variable frequency drive systems.

PART 2 PRODUCTS

2.01 RATINGS

A. Voltage
1. The VFD shall accept nominal plant power of 4160V ± 10% at 60Hz.
2. The VFD-Bypass unit shall include a single phase control power transformer to power the VFD cooling system and VFD system control circuits. The control power transformer shall be sized to accommodate the power requirements of these items and shall be a minimum of 2000VA.

B. Displacement power factor
1. The VFD shall be capable of maintaining a minimum true power factor (Displacement P.F. X Distortion P.F.) of .98 from 60-100% (15-25 MGD) load.
2. If necessary, a power factor correction unit shall be included in the lump sum bid to meet the true power factor requirement.
3. The true power factor that can be met shall be stated clearly in the submittals.

C Efficiency
1. VFD system efficiency shall be minimum of 96% at 100% speed & 100% load. System efficiency shall include VFD and line reactor. (Assuming a minimum motor PF of 0.86).
2. Control power supplies, control circuits, and cooling fans shall be included in all loss calculations.

D. Environmental Ratings
1. Storage ambient temperature range: -40 degrees C to 70 degrees C.
2. Operating A. ambient temperature range: 0 degrees C to 40 degrees C without derating.
3. The relative humidity range is 0% to 95% non-condensing.
4. Operating elevation: up to 1000 Meters (3,300ft) without derating.

E. Audible Noise Level
1. The maximum audible noise from the variable frequency drive shall comply with OSHA standard 3074, Hearing Conservation, which limits noise level to 85 dB(A).
2. The variable frequency drive shall comply with the OSHA standard at a distance of one meter from the front of the equipment (with doors closed at any speed or load condition).
3. Variable frequency drives with audible noise in excess of this limit must be provided with sufficient noise abatement measures to reduce the sound pressure level below 85 dB(A). Noise abatement treatment, if warranted, shall be included in the lump sum bid.

F. Motor Compatibility

1. The variable frequency drive shall be capable of operating a standard AC squirrel cage induction motor of equivalent power and speed rating over a speed range of 60-100% specified. Drives which require motors with higher insulation values will not be acceptable.
2. The variable frequency drive shall provide near sinusoidal voltage and current waveforms to the motor at all speeds and loads. Output current THD shall be less than 5%. Standard induction or synchronous motors shall not require de-rating or upgraded turn-to-turn insulation and shall not require additional service factor.
3. The motor insulation system shall not be compromised thermally or due to dv/dt stress. Dv/dt at the motor terminals (line-to-line) shall be limited to 10 volts per microsecond. The variable frequency drive shall provide stable operation of the motor without compromising the motor insulation system, regardless of motor cable distance. The vendor shall clearly state the limitations in motor cable distance with the proposal. If an output filter is required to mitigate reflected waves, or to meet any special requirements of the application, it must be integral to the VFD controller.
4. If output filters are used in the variable frequency drive, a Selective Harmonic Elimination (SHE) switching technique must be available to eliminate a potential harmonic resonance in the operating speed range.
5. Variable frequency drive induced torque pulsations to the output shaft of the mechanical system shall be less than 1% to minimize the possibility of exciting a resonance.

G. Sizing

1. Loads shall be as shown on the drawings.

H. Definitions

1. The Drive Unit shall refer to the actual drive that will be mounted within the specified enclosure.
2. The Drive System shall refer to the drive unit and all items specified under Drive System Options.

2.02 DRIVE UNIT DESIGN

A. General

1. The VFD shall be PowerFlex 7000, as manufactured by Rockwell Allen-Bradley and shall comply with the latest standards of ANSI, NEMA, IEEE, and the NEC. The drive shall be rated normal duty and shall be used to control the speed of the new 4160V, 2000 HP, 880 rpm, squirrel cage induction motor for Pump No.5. The VFD shall be capable of providing breakaway torque for the pump and adequate torque and horsepower to produce rated flow and head.
2. The input line converter section shall include and AC input line reactor PWM (Pulse Width-Modulated) active front-end rectifier that uses SGCT switching technology and Selective Harmonic Elimination (SHE), to eliminate the need for an isolation transformer to meet IEEE-519 requirements.

3. The machine side converter shall use a Pulse Width-Modulated Current source Inverter that employs SGCT technology to convert the rectified input back to AC for use by the motor.
4. Sensorless direct vector control strategy shall be used by the drive to control motor torque and speed independent of flux

B. Hardware
1. The VFD shall be designed for a minimum availability of 99.9%.
2. The VFD shall be designed for a Mean Time Between Failures (MTBF) of 100,000 hours.
3. The VFD shall be designed for a minimum life expectancy of 20 years.
4. In order to optimize reliability and minimum complexity, inverter switch component count shall be minimized by utilizing high peak inverse voltage (PIV) rated devices.
5. The VFD shall have a control power monitoring system that monitors all power supply voltages and signals.
6. Fiber optic interface boards shall be used to provide gating and diagnostic feedback signals for power semiconductor devices. The diagnostic feedback system shall allow constant control of the device as well as constant monitoring of device health and temperature feedback.
7. Field Programmable Gate Arrays (FPGA) shall be utilized on drive control boards to provide high speed handling of diagnostics and fault handling routines. High speed digital control systems shall continuously monitor all hardware and software faults including sensing of all power circuit voltage and currents as well as any internal equipment faults.
8. Power switch device diagnostics shall detect and protect against device short, over or under gate voltage, loss of gating, loss of diagnostic feedback, heat sink temperature feedback as well as overload monitoring and protection.
9. Failed power switch components shall be replaceable without removal of the entire power module. Special tools or force measuring transducers shall not be required. Failed power switch components shall be replaceable in less than 5 minutes.
10. Converter power modules shall be repairable in 5 minutes or less. If entire power module is replaced, vendor to specify mean time to repair failed power modules.

C. Control Logic
1. The VFD shall produce a variable voltage and variable frequency output to provide continuous operation over the application speed range to produce a pump flow of 15-25 MGD (60-100%).
2. The VFD shall be capable of operating with the output short circuited at full current.
3. The drive system shall provide controlled speed over the range specified. Speed accuracy within this range, expressed as a percent of top speed, shall be within 0.1% of base speed without encoder or pulse tachometer feedback.
4. The VFD shall have a “normal day” rating of 100% continuous current with a short-time duty rating of 110% overload for one minute, once every 10 minutes (suitable for variable torque loads).
5. The variable frequency drive shall be capable of 100% breakaway torque without tachometer feedback.
6. For high inertia loads, a preference shall be given to variable frequency drives capable to regenerative motor braking.

2.03 DRIVE UNIT FEATURES

A. Control Mode
1. The variable frequency drive shall utilize sensorless direct vector control, for optimum performance.

B. Auto Tuning
1. The variable frequency drive shall have a programmable auto tuning function.
2. The function shall be capable of being disabled.
3. The function shall be programmable for the following tuning options.
   a. Commutation inductance
   b. DC link time constant
   c. Motor stator resistance
   d. Motor leakage inductance
   e. Flux regulator
   f. Total Inertia

C. Starting Mode
1. The variable frequency drive shall offer two starting modes.
2. The S-Curve profile shall consist of both nonlinear and linear portions.
   a. A parameter shall exist that specifies the duration that the drive is ramping in the non-linear portion.
   b. A parameter shall define the total line to accelerate to rated speed in S-Curve.
3. The Ramp Mode shall be programmable with four ramp speed break points.
   a. The Ramp Mode shall have programmable acceleration and deceleration times.
   b. The Ramp Mode shall have a parameter for Ramp Start Delay that specifies the time the speed reference remains at zero after the drive is started.

D. Stopping Mode
1. The variable frequency drive shall have three stop modes.
2. The Ramp Mode shall be programmable with four deceleration times.
3. In the Coast Mode, a programmable parameter shall be set to specify the speed at which the drive shuts off and coasts when stopping.
4. Regen Mode

E. Auto-Restart Capability
1. The VFD shall be capable of automatically restarting in the event of a momentary loss of power.
2. An automatic restart delay parameter shall be available in the drive with an adjustment range of 0-10 seconds.

F. Flying Re-Start
1. The VFD shall be capable of restarting and taking control of a motor attached to a spinning load in the forward or reverse direction.

G. Preset Speeds
1. The variable frequency drive shall have three (3) preset speeds.
2. The preset speeds shall be programmable between 0.5 and 75.0 Hz.

H. Skip Speeds
1. The variable frequency drive shall have three (3) skip speeds.
2. The skip speeds shall be programmable between 1.0 and 75.0 Hz.
3. The skip speeds shall have a programmable band width between 0.0 and 5.0 Hz.

I. Ride Through
1. The VFD shall be capable of riding through a loss of power of 5 cycles.
2. The VFD system shall be capable of operating with a 30% voltage sag on the input power line. The motor shall not be allowed to reach a pull out condition.

J. Load Loss Detection
1. The drive shall have a parameter to specify the response of the drive to a loss of load condition.
2. The parameter shall have the following configuration options: disabled, warning or fault.

K. Digital I/O
1. Sixteen (16) isolated digital inputs shall be available as standard on the drive.
2. Sixteen (16) isolated digital outputs shall be available as standard on the drive.
3. Digital I/O shall be rated 12V to 260V AC or DC.

L. Fault Configuration
1. The VFD shall have fault classes that define the following:
   a. Class of drive input protection.
   b. Class of rectifier magnetic protection.
   c. Class of dc link protection.
   d. Class of motor protection (Class 10).
   e. Class of isolation transformer protection.
   f. Auxiliary trip class.
   g. External fault class.

2. Each fault class shall have the following configurations.
   a. Disable the fault input.
   b. The drive will shut down immediately.
   c. The drive will perform a controlled shutdown.
   d. The drive will not shutdown but a warning will be displayed.

3. The variable frequency drive shall have fault and warning masks.

M. Protection Features
1. Fault information shall be accessible through the Human Interface

2. The variable frequency drive shall have the following minimum line side protective features:
   a. Line current unbalance trip with programmable delay.
   b. Line overcurrent trip with programmable delay.
   c. Line overload warning and trip with programmable delay.
   d. Line overvoltage trip with programmable delay.
   e. Line undervoltage trip with programmable delay.
   f. Line voltage unbalance trip with programmable delay.
   g. Ground fault overvoltage trip with programmable delay.
   h. Ground fault overcurrent trip with programmable delay.

3. The variable frequency drive shall have the following minimum system level protective features.
   a. DC overcurrent trip with programmable delay.
   b. DC overvoltage trip with programmable delay.
   c. Rectifier heat sink temperature warning and trip.
   d. Cabinet temperature warning and trip.
   e. Inverter heat sink temperature warning and trip.
   f. Control Power warning and fault.
   g. Adapter (communication port) less warning and fault.
   h. XIO adapter loss.

4. The variable frequency drive shall have the following minimum load side protective features.
   a. Ground fault overvoltage trip with programmable delay.
   b. Ground fault overcurrent trip with programmable delay.
   c. Machine side dc link overvoltage trip with programmable delay.
   d. Motor overcurrent trip with programmable delay.
   e. Motor overload warning and trip with programmable delay.
   f. Motor overvoltage trip with programmable delay.
   g. Motor stall delay.
   h. Motor overspeed trip with programmable delay.
   i. Motor flux unbalance trip programmable delay.
   j. Motor current unbalance trip with programmable delay.
   k. Load loss level, speed and programmable delay.

N. Metering

1. The variable frequency drive shall display metered parameters through the operator interface.

2. The variable frequency drive shall meter the following:
   a. Value of RMS motor current
   b. Value of RMS motor terminal voltage
   c. Motor output current in Kilowatts
   d. Motor speed in RPMs

3. The metered values shall be capable of being assigned to an analog output to drive an optional output meter.

O. Contactor Configuration

1. The variable frequency drive shall have parameters for specifying input and output contactor configurations.
   a. The input contactor configuration parameter shall specify under what conditions the input contactor shall be commanded to open the drive. The parameter options shall be: open when not running, open for all faults or open for critical faults.
   b. The output contactor configuration parameter shall specify under what conditions the output contactor shall be open. The parameter options shall be: open when not running or open for all faults.
   c. An output contactor shall safely isolate the motor from the VFD when the pump is operating in the reverse direction.

2.04 DRIVE SYSTEM OPTIONS

A. Structure

1. Enclosure
   a. Air-cooled VFD enclosures shall be NEMA 1. Door vents shall consist of louver-panel assemblies that can be removed from the front in order to replace air filters. Safety screens shall be located behind each louver panel. Cabinets and doors shall be fabricated using minimum 12 gauge steel for sturdy construction. All doors shall be gasketed to provide environmental protection and secure fits.
   b. Door latches shall be heavy-duty ¼-turn type units which are operated with an Allen wrench. The converter cabinet door and cabling cabinet door shall be interlocked with up-stream isolators or breakers with a key lock. Interlocking shall be fully coordinated to prevent access to all medium voltage compartments.
   c. The VFD shall be designed for front access to allow for installations with no rear access. Equipment that requires rear or side access shall not be accepted.

2. Structure Finish
   a. Variable frequency drive enclosure shall be painted with hybrid epoxy powder paint per manufacturer's standard color.
   b. Metal back plates in the power cell and low voltage compartments shall be painted high gloss white for high visibility.
   c. Touch-up spray can(s), matching the enclosure color, shall be supplied.
   d. Painting shall be done on a continuous paint line through air-atomized electrostatic spray. All parts shall be painted before assembly.
   e. The preparation shall be Alkaline wash/rinse; iron phosphate rinse; iron-chrome sealer rinse; re-circulated de-ionized water rinse and virgin de-ionized water rinse.
   f. Total paint thickness – 0.002" (0.051 mm) minimum.
   g. Baking process shall be in gas over at 179ºC (355ºF) minimum.
   h. All unpainted steel parts shall be plated with a zinc plate/bronze chromate process for corrosion resistance.

3. Cooling System

   a. The VFD system shall be air-cooled.

b. The air-cooled VFD shall be provided with a single, mixed flow cooling fan, mounted integral to the VFD enclosure. Air flow pressure switch and temperature detectors shall be included to monitor air cooling system performance. In the event of a fan failure, the VFD shall issue an alarm indicating fan failure.

4. Cabling
   a. The VFD shall contain a power cable termination assembly designed for easy termination and access to line and load cables. The termination assembly cabinet shall allow for top and bottom entry and exit of line and load cables.
   b. A low voltage wire way shall be provided at the top front of the VFD and shall be available with a removable cover.
   c. All power and control terminations and termination strips shall be identified in accordance with all schematics and wiring diagrams.
   d. Low voltage control wire shall be TEW tinned, 600 volt AC rated.
   e. All VFD internal power connections shall be made with tin-plated copper bus or 8KV, minimum, insulated cable.

B. Harmonic Mitigation Techniques
   1. VFDs shall comply with the latest edition of IEEE 519 Harmonic Guidelines.
   2. Preference shall be given to drive systems that meet IEEE 519 harmonic guidelines with the lowest possible design complexity. The VFD supplier shall detail the number of main power components supplied in the VFD.
   3. The VFD design shall incorporate a PWM rectifier (Active Front End)

C. Auxiliary Relays
   1. Provide relays for Drive Warning, Drive Ready and two (2) additional relays to be wired custom requirements with relay outputs shall be dry, form C contacts, 2 N.O. & 2 N.C. and shall be rated for 115V AC/30V DC, 5.0 Amp resistive, 5.0 Amp inductive.
   2. Provide six (6) additional relays shall be provided for Drive Fault, Drive Run, Drive Minimum Speed, Bypass Run, Bypass Fault, and Winding/Bearing Overtemperature, with dry relay output form C contacts, 2 N.O. & 2 N.C., rated 125VDC, 5.0 Amp.

D. Communications
   1. The VFD shall be furnished with and Ethernet IP module to provide for direct control and status communication via Ethernet with the City's SCADA system.
   2. Provide a ControlNet (DeviceNet) adapter mounted on the customer interface board.

E. Isolated Analog Input and Output
   1. The analog interfaces shall be isolated.

   2. The analog signal interfaces (maximum of four (4)) shall be configurable for:
      a. Speed reference input (4-20 mA input signal).
      b. Speed output (4-20 mA output signal).
      c. Voltage output (4-20 mA output signal).
      d. Current output (4-20 mA output signal).
      e. Load (kW) output (4-20 mA output signal).
      f. Torque output (4-20 mA output signal).

F. RTD Inputs

1. The VFD shall be furnished with ten (10) 3-wire RTD inputs for monitoring and alarming of the motor and pump winding and bearing temperatures.
2. Motor Heater Control
3. Provide drive control circuitry to interface with a remote 208VAC/2700W, three-phase power source to energize the motor heater whenever the motor is not running.
4. The heater shall be interlocked with the drive run relay and shall be energized whenever the motor is not running.
5. Provide a RED pilot light mounted on the VFD enclosure to indicate Motor Heater On Status.

G. Pilot Devices

1. Pilot devices shall be NEMA Type 4 and shall be mounted on the drive system enclosure door.
2. Provide a Auto/Manual selector switch for Speed Reference.
3. Provide a "Hand/Off/Auto" selector switch for start-stop control and pilot lights for indication of the "Hand" and "Auto" modes.
4. Provide Start and Stop pushbuttons.
5. Provide the following colored pilot lights, mounted on the enclosure door. GREEN for indication of Ready, RED for Run, WHITE for Fault and AMBER for Warning. Pilot lights shall be transformer type.
6. Provide a NEMA Type ¼/12, single turn speed pot mounted on the drive system enclosure door.
7. One (1) emergency stop push button, normally open, red, momentary, mushroom head, SquareD or approved equal, contacts rated 125VDC 5A. minimum; pushbutton wired to energize lockout relay in Pump No. 5 switchgear cubicle.

H. Motor Run Time Meter

1. Provide a digital, non-resettable, door-mounted elapsed time meter.
2. The meter shall be electrically interlocked with the Drive Run relay on Bypass contactor to indicate actual motor operating hours.

I. Operator Interface Module

1. The VFD shall have a user-friendly operator interface terminal.
2. The interface terminal shall have the following minimum features:
   a. Large LCD display screens (minimum 16 lines – 40 characters) that are easy to read and provide 'at a glance' indication of drive operating status.
   b. User configurable bar type LCD metering for motor speed, load, torque, and voltage
   c. Elapsed time indication
   d. Extensive diagnostic functions that provide separate fault and warning queues in non-volatile memory that retain information under all conditions.
   e. On-line help that provides enhanced fault text messages.
   f. Trend buffers for at least 8 variables that allow one-shot or multi-shot trending.
   g. Multi-level (minimum of four levels) password access to ensure that only qualified personnel have access to critical parameters but still allow easy access to other levels of personnel.

h. Extended use of plain language messages to eliminate need to look up error codes or decipher the meaning of error messages.
i. Start-up wizard, including auto tuning, that is interactive and user-friendly.

J. Monitoring and Editing Software
Provide a Windows based application software to monitor and edit drive parameters, upload and save parameters to a file, download parameters to the drive, print parameters, and view and clear faults/alarms in the drive.

K. Motor Protection Options
Interfaces shall be provided to interface with the motor protection specified in the motor specification.

2.05 AC LINE REACTORS

A. An AC line reactor and Active Front End (AFE) shall be supplied with the VFD, instead of an isolation transformer. The VFD system with line reactor shall include common mode voltage protection for the motor.

1. Line reactors shall be integral to the VFD line-up.
2. The line reactor K-factor shall be designed for rectifier service (AFE rectifier).
3. The line reactor shall be convection cooled with Class H insulation.
4. The line reactor shall include thermal protection.

2.06 INPUT CONTRACTOR WITH ISOLATION UNITS

A. The medium voltage contractor and isolation unit shall be Allen-Bradley 1512 DM with the following features:
1. Fixed mounted vacuum contactor.
2. The 400A units shall include two (2) three-pole, gang-operated, non-load break isolating switches with one (1) single external operating handle. Both switches are mechanically interlocked with each other, the contactor and power cell doors.
3. Three (3) R-rated current-limiting power fuses.
4. Three (3) bar type current transformers
5. Low voltage control panel complete with pilot control relays; control circuit fusing; DC economizing circuits; “Normal-Off-Test” circuit; receptacle for remote test supply; set of control circuit terminal blocks.
6. Low voltage and power cell doors with viewing windows in both power cell doors to view the position of the isolating switches.

2.07 FULL VOLTAGE NON-REVERSING, OUTPUT BY-PASS STARTER UNIT WITH VACCUM CONTACTORS [TWO (2) PER DRIVE SYSTEM]

A. Fixed mounted “Output” and “By-pass” vacuum contactors shall be Allen-Bradley Bulletin 1512M or equivalent with the following features:
1. Fixed mounted vacuum contactor
2. The 400A units shall include two (2) three-pole, gang-operated, non-load break isolating switches with one (1) single external operating handle. Both switches are mechanically interlocked with each other, the contactor and power cell doors.
3. Three (3) R-rated current-limiting power fuses.
4. Three (3) bar type current transformers.

5. Low voltage control panel complete with pilot control relays; control circuit fusing; DC economizing circuits; “Normal-Off-Test” circuit; receptacle for remote test supply; set of control circuit terminal blocks.
6. Low voltage and power cell doors with viewing windows in both power cell doors to view the position of the isolating switches.

PART 3 EXECUTION

3.01 MANUFACTURE TESTING AND INSPECTION

A. Standard Testing
1. The following tests shall be carried out in accordance with applicable requirements and/or specifications of Canadian Standards Association (CSA), Underwriters Laboratories (cULus), National Electrical Manufacturers Association (NEMA), European Standard (EN), and International Electrotechnical Commission (IEC).
2. Functional checks shall be performed wherever possible; otherwise, inspection and continuity checks shall be made.
3. A “HI-POT” dielectric withstand test shall be performed on all buswork and cables from phase-to-phase and phase-to-ground (except solid-state components, low voltage controls and instrument transformers.) The voltage level used for this test depends on the product’s nominal AC voltage.
4. Component devices shall be functionally operated in circuits as shown on electrical diagrams or as called for by specific test instructions.
5. Instruments, meters, protective devices and associated controls shall be functionally tested by applying the specified control signals, current and/or voltages.
6. Medium Voltage Drives shall be inspected for the following:
   a. Control Power Failure Test
   b. Rectifier Gating Checks
   c. Inverter Gating Checks
   d. Line Converter Tests
   e. Machine Converter Tests
   f. Load tests

B. Cycle Testing
1. Drives shall be accelerated, under load on a dynamometer, to test the motor’s nominal frequency.
2. Drives shall be decelerated to 10 Hz and then accelerated up to test the motor’s nominal frequency; ramp time shall be approximately 10 seconds.
3. This cycle shall be repeated continuously for up to one hour.

C. Load Testing
1. Drives shall be tested under load at the test’s motor’s nominal frequency on a dynamometer.
2. Physical inspection.
3. The product must meet all applicable engineering and workmanship standards and specifications. All components shall be verified against engineering documentation to be present and correctly installed.

4. All bus and bus connections shall be checked for proper clearance, creepage, phasing, and torque.
5. Warning plates, isolation barriers, and mechanical interlocks must provide sufficient safety/isolation for personnel and equipment.
6. Warning labels and nameplates must be present and in their specified positions to advise personnel of possible hazards.
7. Isolation barriers must be in place within the cabinet. Such barriers protect personnel from touching live medium voltage components in an area that otherwise does not have power supplied to it.
8. Operation of isolation switch handle and door interlocks must be verified. The interlocking prevents the opening of any medium voltage door on a medium voltage cabinet when the isolation switch handle has been moved the full ON position.

D. Witness Testing

1. At the conclusion of VFD testing, the customer will reconvene with the Application Engineer or Project Manager to discuss any concerns or issues that arose during the test. Any modifications or changes requested by the Purchaser will be documented and discussed at this meeting. The Project Manager or Applications Engineer will respond to the Purchaser at the earliest possible time with an outline of the financial and/or schedule impact of the changes.
2. If requested, a review of the electrical and mechanical drawings for the purchased equipment shall be done with the City, Manufacturer's and Manufacturer's Representative's Application Engineer or Project Manager prior to commencing the tests. Any questions or clarifications, prior to commencing the test, will be addressed at this time.
3. The witness test shall include a Drive System Run Test that shall consist of operating the variable frequency drive connected to a dynamometer. During the testing of the drive, a demonstration of the operator interface and functionality will be provided as well as demonstration of the operation of the drive.
4. The drive will be tested up to rated horsepower at both steady state and varying speeds.
5. The drive will be tested with the facility isolation transformer, facility input contactor and facility DC link.
6. For liquid-cooled drives, the test facility heat exchanger will be utilized.
7. All of the following equipment, if furnished under this Contract, shall also be tested with costs for such included in the Contract Lump sum Bid:
   a. Isolation devices
   b. Contactors
   c. Harmonic filters
   d. Bypass starters
   e. Synchronous transfer
   f. Remote communications options.
8. A Certified Test Report shall be issued to the City.

3.02 MANUFACTURER'S FIELD SERVICES

A. The service division of the variable frequency drive manufacturer shall perform all startup services. The use of third party supplier start-up personnel is not allowed.

B. Start-up personnel shall be direct employees of the variable frequency drive manufacturer.

C. Provide a minimum of 20 hours of on-site start-up service; services shall include:
   1. Pre-Installation Meeting
      a. The start-up plan
      b. The start-up schedule
      c. The drive's installation requirements

   2. Pre-Power Check
      a. Inspect the drive's mechanical and electrical devices enclosed
      b. Perform a tug test on all internal connections within the drive and verify wiring.
      c. Verify critical mechanical connections for proper torque requirements.
      d. Verify and adjust mechanical interlocks for permanent location.
      e. Confirm all sectional wiring is connected properly.
      f. Re-verify control wiring from any external control devices.
      g. Set up all drive internal power supplies and thyristor control circuits.
      h. Confirm cabling of drive to motor, isolation transformer and line feed.
      i. Megger Motor Resistances.

   3. Drive Power-up and Commissioning
      a. Apply medium voltage to the drive and perform operational checks.
      b. Bump motor and tune drive to the systems attributes.
      c. Run the drive motor system throughout the operational range to verify proper performance.
      d. Record all measurements
      e. Provide Drive Parameter Listing

3.03 TRAINING

A. Manufacturer shall provide three days (24 hours) training. The training shall be conducted for the necessary operations staff and shall be scheduled to accommodate all three (3) shifts of personnel.
   1. The service engineer shall perform training.
   2. The manufacturer shall outline the training session duration and content.
   3. The basis of the training shall be the variable frequency drive, the engineered drawings and the user manual.
   4. The instruction shall include the operational and maintenance requirements of the variable
      frequency drive.

B. At a minimum, the training shall:
   1. Review of the engineered drawings identifying the components shown on the drawings.
   2. Review starting/stopping and speed control options for the controller.
   3. Review operation of the Operator Interface for programming and monitoring of the variable frequency drive.
   4. Review cooling system operation.
   5. Review the maintenance requirements of the variable frequency drive.
      a. Board replacement procedures.
      b. Power device replacement procedures.
      c. Fault analysis and troubleshooting.
      d. Preventative maintenance procedures.
   6. Review safety concerns with operating the variable frequency drive.

3.04 FUNCTIONAL DESCRIPTION

A. Modes of Operation
   1. The Pump No. 5 VFD unit shall be used to meet water demand in the Riverside pressure district. The unit will normally run in "VFD Mode," except at times when the drive is out of service; in that situation the Operator shall be capable of running it in, "Bypass Mode." When in "VFD Mode," the drive shall be able to run by one of three methods:
      a. Local
      b. Remote-Manual
      c. Remote-Automatic
   2. When the VFD is selected and is in LOCAL Mode, the drive shall be operated via a START/STOP signal entered by the operator into the door-mounted HMI; VFD speed reference is only via the HIM. LOCAL mode disables automatic references.
   3. When the VFD is selected and is in REMOTE-MANUAL Mode, the drive shall be operated via a START/STOP signal from SCADA; speed reference shall be via a remote setpoint entered into SCADA by the operator.
   4. When the VFD is selected and is in REMOTE-AUTOMATIC Mode, the drive shall be operated via a START/STOP signal from SCADA; speed reference shall be via PID loop. The PID shall work to maintain the discharge pressure within an acceptable range by comparing the 4-20mA DC high service discharge pressure signal from the gatehouse to a setpoint entered via the door-mounted HMI. When in "BYPASS MODE," the motor can be run by one of two methods:
      a. LOCAL
      b. REMOTE-MANUAL
   5. When BYPASS is selected and is in LOCAL Mode, the motor shall be operated via a START/STOP signal entered by the operator into the door-mounted HMI.
   6. When BYPASS is selected and is in REMOTE-MANUAL Mode, the motor shall be operated via a remote START/STOP signal from SCADA.

B. Startup Sequence
   Upon receiving a PUMP START command from the SCADA and it has been verified that the pump is primed and the valve is closed, the pump shall begin pumping against the closed valve. The VFD shall include a N.O. contact to indicate to the valve controller that the VFD has reached minimum speed. Once the VFD is at minimum speed and the discharge pressure has built up sufficiently, the valve controller shall open the valve.

C. Shutdown Sequence

1. Upon receiving a STOP command from the discharge valve controller, the VFD shall allow the motor to coast to a stop.
2. RTD inputs shall be run directly to the PLC in the variable frequency drive enclosure.
3. The VFD shall send a “HI TEMPERATURE” alarm to SCADA when the stator windings are bearing have reached a temperature within 10% of their maximum (HI HI TEMPERATURE) operating temperature. Once the windings or bearings reach maximum operating temperature, the VFD shall activate a contact output to trip the 86M motor lockout relay; a trip of the 86M relay shall initiate closing the discharge valve at normal speed and a normal shutdown of the pump and motor. A VFD or feeder fault shall trip the GESR750 Feeder Management Protective Relay in the switchgear and trip the 86S switchgear lockout relay. A trip of the 86S relay shall activate a contact output to trip the valve controller, causing the discharge valve to close at high speed and the motor to coast to a stop.

END OF SECTION

APPENDIX “A”

LEAD PAINT ANALYSIS

Delahey Industries, Inc.

13000 W. Bluemound Rd.
Elm Grove, WI 53122
(262) 821-9296
Fax: (262) 821-1709

Asbestos Response Specialists • Inspections • EPA Certified

December 31, 2012

Mr. Philip Greuel
Frank P. Zeidler Municipal Building
841 North Broadway, Room 409
Milwaukee, WI 53202-2583

Re: Riverside Pumping Station – paint sampling
Delahey Industries, Inc. Project #12061

Dear Mr. Greuel:

Per your request, various paint samples were collected on December 19, 2012 at the City of Milwaukee Riverside Pumping Station.

Paint Sampling Summary

The following surfacing materials were sampled for lead (Pb) paint analysis:

Sample #/Surface/Material	Location	Lead (Pb) by weight
L-01; black paint on 54" pipe	West main gate house	<0.02%
L-02; green paint on 42" flow tube	Pump #5	<0.02
L-03; dark blue paint on pump	**Pump #5**	**11.72%**
L-04; light blue paint on 24" pipe	**Pump #5**	**6.92%**

Wisconsin Environmental Health Chapter 254.11 defines "lead bearing paint" as any paint or other surface coating material containing more than 0.06% lead by weight, calculated as lead metal.

Inspection Findings and Response Recommendations:

The dark blue and light blue paints on pump #5 are considered to be lead (Pb) bearing.

Attached are the laboratory analytical documents, which indicate the results of the analysis. If you have any questions concerning the results, feel free to call me at (262) 821-9296.

Regards,
Delahey Industries, Inc.

John P. Hey

Account Information:
R638
DELAHEY INDUSTRIES
13000 W BLUEMOUND RD
ELM GROVE WI 53122
262-821-9296

OrderingPhysician:

ACL laboratories

8901 W. Lincoln Ave.
West Allis, WI 53227

Milwaukee 414-328-7945
National 800-624-3134
Fax 414-328-8560

Date Received: 12/19/2012 **Time:** 14:00:00

Date Analyzed/Reported: 12/20/2012

Analyst: Sharon Zawicki, MT(ASCP)

Director/Supervisor: Mary Laska, MT(ASCP)

ACL Content Verification: DMB

Collected By: NONE PROVIDED

Date	Sample ID	Sample Name	Sample Description	Accession #	Test Name	Units	Result
12/19/2012	E12-08574	R638, PAINT L-01	BLACK PAINT - WEST MAIN GATE HOUSE	E000064064	PBPAINT	%	<0.02
12/19/2012	E12-08575	R638, PAINT L-02	GREEN PAINT - PUMP 5	E000064065	PBPAINT	%	<0.02
12/19/2012	E12-08576	R638, PAINT L-03	DARK BLUE PAINT - PUMP 5	E000064066	PBPAINT	%	11.72
12/19/2012	E12-08577	R638, PAINT L-04	LIGHT BLUE PAINT - PUMP 5	E000064067	PBPAINT	%	6.92

Note: Sample results are not corrected for contamination based upon results obtained from field blanks/analytical blanks.

Note: Results derived from wipes not meeting ASTM E 1792 are not recognized under AIHA laboratory accreditation.

Note: All samples received in good condition unless otherwise noted under sample description as part of content verification.

TEST	GUIDELINES/STANDARDS		METHODOLOGY	REPORTING LIMIT
LEAD IN WATER	EPA PERMISSIBLE LEVEL:	Up to 15 mcg/Liter (15 ppb)	APHA 3113B	1 mcg/Liter (1 ppb)
COPPER IN WATER	EPA PERMISSIBLE LEVEL:	Up to 1300 mcg/Liter (1300 ppb)	APHA 3120B	10 mcg/Liter (10 ppb)
LEAD IN SOIL	EPA LEVEL OF CONCERN:	400 ppm (400 mcg/gm)	Modified NIOSH 7300	10 mcg lead/gram soil
	EPA HAZARD LEVEL:	2000 ppm (2000 mcg/gm)		
LEAD IN PAINT	CPSC[2] NEW PAINT PERMISSIBLE LEVEL:	Up to 0.06%	Modified NIOSH 7300	0.02% Lead
	EPA[3]/HUD[4] ACTION LEVEL:	Above 0.5%		
LEAD IN DUST WIPES	HUD CLEARANCE STANDARDS:	FLOORS - 40 mcg/square foot	Modified NIOSH 7300	5 mcg lead/wipe
		WINDOW WELLS - 400 mcg/square foot		
		WINDOW SILLS - 250 mcg/square foot		
		OTHER SITUATIONS - Lab recommendation 50 mcg/square foot		

[2]Consumer Protection Agency [3]Environmental Protection Agency [4]Department of Housing and Urban Development

Job #: 12061/RIVERSIDE **Job Location: PUMPING STATION**

12-20-12
SC

ACL laboratories

8901 W Lincoln Avenue
West Allis, WI 53227
Tel: 414-328-7945
Fax: 414-328-8560

Analytical Quality Control Report

Please refer to the additional enclosed report(s) for your submitted sample test results.
Test results for your submitted samples are located on a separate page and relate only to the items tested. The values listed on this report page are laboratory quality control samples only. These controls are prepared daily and analyzed along with your submitted samples.

Instrument used for analysis: Optima 4300 ICP-OE Today's Date: December 20, 2012

Laboratory Control Sample: LCS-W

QC Sample Media: Wipes

Analyte	LCS Value	Acceptable Range	Pass/Fail
Lead in wipes	N/A	1556-2334 mcg/gram	Pass

Laboratory Control Sample : LCS-P

QC Sample Media: Paint chips

Analyte	LCS Value	Acceptable Range	Pass/Fail
Lead in paint	0.0365	0.0280-0.0409%	Pass

Laboratory Control Sample: LCS-S

QC Sample Media: Soil

Analyte	LCS Value	Acceptable Range	Pass/Fail
Lead in soil	N/A	400-600 mcg/gram	Pass

The quality control results in this report apply only to the samples tested on this date at ACL Industrial Toxicology. The analytes used for QC determination are the same analytes that appear in the submitted samples for the report and are indicative of overall assay performance for the compounds found in those samples. The acceptable range for an analyte is based on the standard deviation of each analyte, which has been determined from statistical evaluation of the historical performance of the assay. A result outside of the acceptable range is considered to have failed QC requirements. All other quality control and calibration checks used for this specific test were found to be within acceptable ranges.

ACL Industrial Toxicology is accredited by the AIHA-LAP,LLC. Laboratory ID number 101066

End of Analytical QC Report