



**Milwaukee
Water Works**

Safe, Abundant Drinking Water.

**City of Milwaukee
Department of Public Works
Milwaukee Water Works**

Specifications for

Howard Pumping Station

**HS-26: Medium Voltage Reduced Voltage Solid State Motor
Controller Installation for Pumping Units 5, 6, 7, & 8
At Howard Pumping Station**



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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

HS-26: Medium Voltage Reduced Voltage Solid State Motor Controller Installation for Pumping Units 5, 6, 7, & 8 at Howard Pumping Station.

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JOB REQUIREMENTS

HS-26: SOFT START MOTOR CONTROLLER INSTALLATION FOR PUMPS, 5, 6, 7, AND 8 AT HOWARD PUMPING STATION

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

JR-2 JOB LOCATION The Howard Avenue Pumping Station.

JR-3 GENERAL DESCRIPTION OF WORK The work to be performed under this contract consists of the supply of all labor, materials, transportation, and services necessary for the installation and/or refurbishment of the equipment items described below, including the provision of all design, manufacturing, delivery, plant, materials, and labor connected therewith. The Contractor shall ensure that all equipment installed under this contract is complete and operational before being put into service.

HS-26: SOFT START MOTOR CONTROLLER INSTALLATION FOR PUMPS 5, 6, 7, AND 8

The Contractor shall furnish and install a total of four (4), medium voltage reduced voltage solid-state (Soft Start) motor controllers; one shall be retrofitted onto each of the existing potable water Pumping Units Nos. 5, 6, 7, and 8. Each of the pumps is driven by a 2000HP synchronous motor that is started across-the-line. This work is being done to reduce the starting inrush current of the motors which will be necessary for starting the motors after pending utility modifications to the station electrical service are made.

Work also covered under this contract shall include the reconditioning and minor modification of the motors necessary for their proper operation with the new soft start motor controllers. The Contractor shall also be responsible for all necessary switchgear cubicle and motor electrical cabinet modifications and equipment wiring as detailed in the contract drawings specifications.

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

<u>Contract Drawing No.</u>	<u>Title</u>
HS-26-01	Location Map - Drawing Index
HS-26-02	Pump #5, #6, #7, & #8 Soft Start Breaker and Valve Control Schematics

HS-26-03	Pump #5, #6, #7, & #8 Soft Start Electrical One-Line & Miscellaneous Details
HS-26-04	Pump #5, #6, #7, & #8 Soft Start RVSS Motor Control Schematics
HS-26-05	Pump #5, #6, #7, & #8 Soft Start General Plan of Pump Floor, Wire and Conduit Installation Plan

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.

<u>Reference Drawing No.</u>	<u>Title</u>
HS-5 (HS-07-05)	Howard Avenue Pumping Station General Plan of Pump Floor
HS-9 (HS-07-09)	Howard Avenue Pumping Station Building Section
HS-28 (HS-07-28)	Howard Avenue Pumping Station Functional One-line Diagrams
HS-29 (HS-07-29)	Howard Avenue Pumping Station Comprehensive One-line Diagram
HS-30 (HS-07-30)	Howard Avenue Pumping Station Breaker and Valve Control Typical Schematics
HS-32 (HS-07-32)	Howard Avenue Pumping Station Misc. Details and Typical Schematics
HS-39 (HS-07-39)	Howard Avenue Pumping Station Pump Floor Power Wiring
HS-40 (HS-07-40)	Howard Avenue Pumping Station Basement Power Wiring
HS-16-1	Supervisory Control Equipment

JR-6 PRE-BID MEETING: A **MANDATORY** Pre-Bid Meeting is scheduled for **TUESDAY, SEPTEMBER 13, 2011** in the Howard Avenue Purification Plant Conference Room; 3929 South 6th Street, Milwaukee, WI 53221. 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.j.supinski@milwaukee.gov; bonnie.s.tesch@milwaukee.gov and anthony.aquila@milwaukee.gov at least 24 hours in advance of the Pre-Bid Meeting to be placed on the visitor list for access to the Howard Avenue Purification Plant.**

Site Visit: A site visit will be available 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-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 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 2000. 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 an anticipated 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

Project Completion Date: March 9, 2011

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 shall include:

- 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 SCOPE OF THE CONTRACT**

This contract includes the furnishing of all transportation, equipment, supervision, labor, services, materials, and appurtenances for and in connection with the following project as shown on the Contract Drawings and further specified herein. The work will take place at the Milwaukee Water Works Howard Pumping Station which supplies finished drinking water to the community.

1.01 HS-26: MEDIUM VOLTAGE REDUCED VOLTAGE SOLID STATE MOTOR CONTROLLER INSTALLATION FOR PUMPING UNITS 5, 6, 7, & 8

The work covered by this specification shall consist of furnishing all transportation, equipment, supervision, labor, materials, and services necessary to retrofit each of the four (4), existing 2000 HP synchronous motors for potable water Pumping Units Nos. 5, 6, 7, & 8, with medium voltage reduced voltage solid-state motor controllers. The Contractor shall supply all equipment and peripherals, and provide all labor services, demolition, and restoration, necessary to provide the City with four (4), complete and fully operational pumping units with soft start control.

The Contractor shall be responsible for the removal and off-site disposal of all demolished equipment. The work to be performed shall include but not be limited to the following:

- A. Removal of Pumping Units Nos. 5, 6, 7, & 8 synchronous motor exciters. The Contractor shall be responsible for the removal and off-site disposal of this equipment.
- B. Disconnection, removal, transportation, refurbishment, and reinstallation of synchronous motors. Refurbishment shall include replacement of stator RTDs and replacement of bearing temperature sensors with RTD type.
- C. Supply and installation of four (4), new, pad-mounted, Medium Voltage Reduced Voltage Solid-State (MVRVSS) motor controllers, complete with fused disconnect, static exciters, and manufactured shaft end covers. Contractor shall be responsible for pouring concrete pad for each unit.
- D. Removal of motor bearing temperature relays and indicators, motor winding temperature meter, transfer switch, surge arrestor, and capacitor, and replacement of motor lockout relay in motor cabinet.

- E. Removal of switchgear doors and door-mounted equipment, and installation of new cubicle doors, feeder protective relays, switchgear lockout relay, breaker control switch, and miscellaneous items for Pumping Units Nos. 5, 6, 7, & 8 as detailed in the contract documents,.
- F. Supply and installation of all new power, control and instrumentation wiring as indicated on the contract drawings and as necessary for the implementation of reduced voltage starting of Pumping Units Nos. 5, 6, 7, & 8 in keeping with the intent of these specifications. The Contractor shall be responsible for terminating all new wiring that needs to be run to the SCADA cabinet, however, Milwaukee Water Works will be responsible for making all necessary SCADA software modifications.
- G. Program RVSS and protective relays; Contractor to perform relay coordination study prior to programming relays.
- H. Furnishing of shop drawings, Operation and Maintenance Manuals & data, spare parts, and maintenance materials, as outlined later in this section.
- I. Provide Startup and Training Services as detailed further in the specifications.

1.03 MANUFACTURER QUALIFICATIONS

The new Reduced Voltage Solid-State Motor Controllers shall be standard equipment manufactured by a company with no less than ten (10) years experience in the manufacture of such equipment. Upon request by the Project Engineer, the manufacturer shall provide proof of such 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 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 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 warranties from the date of official acceptance against defective materials or workmanship before the final payment is made. The specific items and warranties to be provided are as follows:

- A. Reduced Voltage Solid-State Motor Controllers– 2 years
- B. Installation Workmanship & Materials – 1 year

During the period of two 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 years from the date that the replacement is performing satisfactorily.

If within ten 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 & 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 specifications to assure efficient and orderly sequence of installation of interdependent construction elements.
- B. Verify that the City requirement characteristics of operating equipment are compatible with building utilities. Coordinate work of various Sections having interdependent responsibilities for installing, connecting to, and placing in service, such 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, for maintenance, and for 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, to minimize disruption of the City of Milwaukee's activities.

1.03 ALTERATIONS

- A. Materials: As specified in product Sections; match existing products and work for patching and extending work.
- B. Close openings in exterior surfaces to protect existing work from weather and extremes of temperature 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 to match existing adjacent work in texture and appearance.
- F. When finished surfaces are cut so that a smooth transition with new work is not possible, terminate existing surface along a straight line at a natural line of division and make recommendation to the City.
- G. Patch or replace portions of existing surfaces which are damaged, lifted, 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 which affects:
 - 1. Structural integrity of element.
 - 2. Integrity of weather-exposed or moisture resistant element.
 - 3. Efficiency, maintenance, or safety of element.
 - 4. Visual qualities of sight-exposed elements.
 - 5. Work of City of Milwaukee or separate contractor.
- C. Execute cutting, fitting, and patching to complete Work, and to:
 - 1. Fit the several parts together, so as 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 of Milwaukee will schedule a pre-construction conference after Notice of Award.
- B. Attendance Required: City and Contractor.
- C. Agenda:
 1. Submission of executed bonds and insurance certificates.
 2. Submission of list of Subcontractor, list of products, 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 of Milwaukee and Contractor.
7. Construction facilities and controls provided by City of Milwaukee.
8. Temporary utilities and controls provided by City of Milwaukee, if any.
9. Security and housekeeping procedures.
10. Procedures for testing.
11. Procedures for start-up of equipment.
12. Requirements for maintaining record documents.
13. Inspection and acceptance of equipment put into service during construction period.
14. Conflicts.

1.06 PROGRESS MEETINGS

- A. The City will Schedule and administer meetings throughout progress of the Work as required.
- B. The City will make arrangements for meetings, prepare agenda with copies for participants, preside at meetings, record minutes, and distribute copies within three days to the City, participants, and those affected by decisions made.
- C. Attendance Required: Contractor's general superintendent, major Subcontractors and suppliers, City, as appropriate to agenda topics for each meeting.
- D. Agenda:
 1. Review minutes of previous meetings.
 2. Review of Work.
 3. Field observations, problems, and decisions.
 4. Field observations of problems which impede planned progress.
 5. Review of SUBMITTALS schedule and status of submittal.

6. Review of off-site fabrication and delivery schedules.
7. Maintenance of progress schedule.
8. Corrective measures to regain projected schedules.
9. Planned progress during succeeding Work period.
10. Coordination of projected progress.
11. Maintenance of quality and Work standards.
12. Other business relating to Work.

1.07 PRE-INSTALLATION CONFERENCES

- A. When determined by the City, convene a pre-installation conference at work site prior to commencing work.
- B. Require attendance of parties directly affecting, or affected by, work of the specific Section.
- C. Notify all parties four 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 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**

A. Index

1. Scope
2. Security and Safety
3. Occupancy during Construction
4. Electric Power
5. Water
6. Toilet Facilities

B. General Conditions

1. 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 Engineering Representative.
2. All removals become the property of the Contractor and shall be disposed of off the site unless otherwise specified.

C. Temporary Ventilation

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

D. Barriers

1. Provide barriers to prevent unauthorized entry to construction areas and to protect existing facilities and adjacent properties from damage from construction operations and demolition.
2. Protect non-owned vehicular traffic stored materials, site and structures from damage.

E. Progress Cleaning

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

PART 2 SECURITY AND SAFETY

A. General

The Milwaukee Water Works consists of a number of facilities to treat and deliver drinking water to the City and surrounding suburban communities. To insure the safety and security of drinking water, the Milwaukee Water Works has instituted protocols for visitors and contractors to control entry to these facilities. It is essential that contractors strictly comply with the security policy outlined in the specification section.

For this project, the Contractor shall continuously coordinate building and site security measures, including accessing the site, with the designated Water Engineering representative or the Water Security Manager, Mr. Michael Schaefer, who can be reached at **Telephone # (414) 286-3465 or Facsimile # (414) 286-2672.**

B. Scope

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

1. Milwaukee Water Works site security policies and procedures.
2. Contractor and Sub-Contractor Obligations.
3. Permit System.

C. Policies

During the "Security Briefing" portion of the "Pre-Construction Meeting", Milwaukee Water Works Security staff shall provide the Prime Contractor with site polices to be reviewed by the Prime and Sub Contractors. These documents may include:

1. Lock-out / Tag-out Policy.
2. Confined Space Entry Procedures.
3. Evacuation Procedure for Propane, Lox, & Ammonia Releases.
4. Personal Protective Equipment Guidelines.
5. No Smoking Policy .
6. Prohibited Materials.

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.

The Prime Contractor shall be required to review these documents and is responsible for conveying the contents of these submittals to their employees, sub-contractors, and any other parties working directly or indirectly for them. These policies apply equally to all contractors. Failure to comply with established policies and procedures may result in access privileges being withdrawn.

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.

D. Contractor Responsibilities

Contractors shall provide the following documents **no less than 7 business days prior** to the start of contracted work:

1. Scope of work to be performed.
2. Name of primary contractor’s onsite representative.
3. Names of all companies sub-contracted to do work on the project.

4. Completed "Contract Firm Registration Form" (see attachment 'A') for prime contract firm and every sub-contract firm.
5. A "Contractor Employee Registration Form" completed for the contractors and every employee who needs to be granted site access (see attachment 'B').
6. List of items to be stored on-site.
7. Material Safety data Sheets for all Chemicals to be used/stored on-site.

Note: It is the responsibility of the Prime Contractor to facilitate gathering and submittal of the "Contractor Employee Registration Form" for all sub-contractors working on the project. A sub-contractor is defined as an individual or firm hired by the primary contractor to perform a specific task as part of the overall project. This would not include an organization making deliveries of supplies or equipment to the job site; procedures for these firms are covered under Part 8, "DELIVERIES".

In the event it is necessary for the Prime Contractor to add additional employees to the list of approved personnel, a minimum of 72 hours, or 3 business days, must be allowed for processing of the request. Site access will be denied to the additional personnel until processing is complete.

Additionally, Contract Firms are obligated to notify MWW in a timely manner of any site-authorized staff that leaves the employ of the Contractor.

At no time should anyone but the Prime Contractor be contacting Milwaukee Water Works employees with issues or access requests. If a request for site access does not come from the Prime Contractor, the request will not be processed.

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 the 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.

E. Contractor Special Work Permits

Contractors must notify Engineering / Site Management Staff of any welding, torching, or potentially hazardous or operational impact request prior to commencing such operations. Special Permits shall be issued to the contractor, and these must also be displayed at the work site.

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.

F. Contractor Identification and Daily Registration

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.

G. Contractor Gate Access and Parking

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.

NOTE: Parking privileges may be rescinded at any time as Site Operational Requirements dictate.

PART 3 CITY OF MILWAUKEE PERMITS

The Contractor shall obtain the necessary permits for this Project.

PART 4 OCCUPANCY DURING CONSTRUCTION

The Water Works facility shall be in continuous operation during this contract. Contractor and Sub-Contractors are to take any and all necessary precautions to insure 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 engineering representative.

PART 5 ELECTRICAL POWER AND TELEPHONE SERVICE

On-site electrical service is available for Contractor use during project duration. Contractor shall provide and maintain all necessary power cords, electrical lighting, heat, ventilation, and

telephone service and shall make all necessary connections in accordance with OSHA regulations. Contractor shall provide and pay for his own wireless telephone service.

PART 6 WATER

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

PART 7 TOILET FACILITIES

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 Engineering Representative.

PART 8 DELIVERIES

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. Contractor shall provide the following information in the notification:

- A. Trucking/Delivery Company
- B. Driver Name
- C. Truck License Plate Number

The driver of the delivery vehicle is required to display picture identification as a pre-requisite for entry to the MWW facility for the delivery. Failure to comply with the above will result in denial of project site access, requiring the contractor to re-schedule delivery.

END OF SECTION

Milwaukee Water Works

Safe, Abundant Drinking Water.

WP-306
Attachment "A"

FORM A

CONTRACT FIRM REGISTRATION FORM

CONTRACTOR: _____

PLANT/SITE: _____

CONTRACT/SERVICE ORDER No. _____

WATER ENGINEERING PROJECT No. _____

PRIMARY CONTACT PERSON: _____

OFFICE PHONE NUMBER: _____

CELL PHONE NUMBER: _____

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

NUMBER OF EMPLOYEES TO BE WORKING ON-SITE: _____

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

SIGNATURE: _____

PRIMARY CONTACT PERSON

DATE: _____

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

Milwaukee Water Works

Safe, Abundant Drinking Water.

WP-306
Attachment "B"

FORM B

CONTRACTOR EMPLOYEE REGISTRATION FORM

Contract Firm: _____

Plant/Site/Project: _____

Employee Name (Printed): _____

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

EMPLOYEE
SIGNATURE: _____
Required

DATE: _____

ONSITE PARKING

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

Contractor Personal Vehicle Liability Waiver

EMPLOYEE VEHICLE
MAKE & MODEL: _____ LICENSE PLATE: _____

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

EMPLOYEE
SIGNATURE: _____
Required

DATE: _____

SECTION 01600**MATERIALS AND EQUIPMENT****PART 1 GENERAL**

1.01 PRODUCTS

- A. Products: Defined as new material, machinery, components, equipment, fixtures and systems forming the work; does not include machinery and equipment used for preparation, fabrication, conveying and erection of the work.
- B. Do not use materials and equipment removed from existing premises, except as specifically permitted.
- C. Assure standardization and uniformity in all parts of the work by providing like items of equipment or certain materials as products of one manufacturer.
- D. Uniformity in equipment items is required in order to provide the CITY with interchangeability capabilities, simplified spare parts inventories and standardized maintenance programs and manufacturers services.

1.02 TRANSPORTATION AND HANDLING

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

1.03 STORAGE AND PROTECTION

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

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

END OF SECTION

SECTION 01640**EQUIPMENT MANUFACTURERS' SERVICES****PART 1 GENERAL****1.01 DEFINITIONS**

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

1.02 SUBMITTALS

- A. Informational Submittals:

1. Training Schedule: Submit not less than 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 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 & 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 manufacturer' services to avoid 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 intended and as warranted by manufacturer and necessary to furnish Manufacturer's Certificate of Proper Installation.
 - 3. Providing of, on a daily basis, copies of all manufacturers' representatives' field notes and data to CITY.
 - 4. Revisiting the site as required to correct problems and until installation and operation are acceptable to CITY.
 - 5. Resolution of assembly or installation problems attributable to or associated with, respective manufacturer's products and systems.
 - 6. Assistance during functional and performance testing, and facility startup and evaluation.
 - 7. Training of CITY'S personnel in the operation and maintenance of respective product 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. When so specified, a Manufacturers' Certificate of Proper Installation form, Attachment "C" which is 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, etc.).
 - 3. Course description and outline of course content.
 - 4. Format (e.g., lecture, self-study, demonstration, hands-on).
 - 5. Instruction materials and equipment requirements.
 - 6. Resumes of instructors providing the training.
- D. Pre-startup Training:
- 1. Coordinate training sessions with CITY's operating personnel and manufacturers' representatives.
 - 2. Complete at least 14 days (if feasible) prior to beginning of facility startup.
- E. Post-startup Training: If required in Specifications, furnish and coordinate training of CITY's operating personnel by respective manufacturers' representatives.

3.05 SUPPLEMENTS

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

END OF SECTION

ATTACHMENT "C"

**MANUFACTURERS' CERTIFICATE OF PROPER INSTALLATION FOR MOTOR
CONTROLLER**

LOCATION :

CONTROLLER SERIAL NO :

PUMP/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 SECTION INCLUDES

- A. Closeout Procedures
- B. Final Cleaning
- C. Adjusting
- D. Project Record Documents
- E. Operation and Maintenance Data
- F. Guarantee
- G. Spare Parts and Maintenance Materials

1.02 CLOSEOUT PROCEDURES

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

1.03 FINAL CLEANING

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

1.04 ADJUSTING

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

1.05 PROJECT RECORD DOCUMENTS

- A. Maintain onsite, one set of the following record documents; record actual revisions to the work:
 - 1. Contract Drawings
 - 2. Specifications
 - 3. Addenda
 - 4. Change Orders
 - 5. Reviewed shop drawings, Product data, and samples.
- B. Store Record Documents separate from documents used for construction.
- C. Record information concurrent with construction progress. Electrical boxes and conduit location determined in the field and not specifically shown on the drawings shall be recorded and documented.
- D. Specifications: Legibly mark and record at each Product section description of actual Products installed, including the following:
 - 1. Manufacturer's name and product model and number
 - 2. Product substitutions or alternate utilized.
 - 3. Changes made by Addenda or Change Orders.
- E. Record Documents and Shop Drawings: Legibly mark each item to record actual construction including:
 - 1. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
 - 2. Field changes of dimensions and details.
 - 3. Details not on original Contract Drawings.

- F. Delete Consultant, City of Milwaukee title block and Engineer's seal from all documents.
- G. Submit **five (5)** sets of documents with **one (1)** reproducible "Mylar" to CITY prior to final Application for Payment.
 - 1. Accompany submittal with transmittal letter containing the following:
 - a) Date
 - b) Project title and number
 - c) Contractor's name and address
 - d) Title and number of each record document
 - e) Certification that each document as submitted is complete and accurate.
 - f) Signature of Contractor, or his authorized representative.

1.06 OPERATION AND MAINTENANCE DATA

- A. Submit **six (6)** sets prior to final inspection, bound in 8 ½ x 11 -inch text pages, three D side ring binder capacity expansion binders with durable plastic covers.
- B. Prepare binder covers with printed title "OPERATION MAINTENANCE INSTRUCTIONS", title of project, and subject of binder when multiple binders are required.
- C. Internally subdivide the binder contents with permanent dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.
- D. Contents: Prepare a Table of Contents for each volume, with each Product or system description identified type on 30-pound white paper.
- E. Special Requirements for Operation and Maintenance Data and Manuals. Adequate operation and maintenance information shall be supplied for all equipment requiring maintenance or other attention. The Contractor shall provide operation and maintenance manuals for each type of equipment supplied.
 - 1. Operation and Maintenance Manuals shall include the following:
 - a. All sets of manuals shall be originals. Copies will not be acceptable.

- b. Equipment function, normal operating characteristics, and limiting conditions.
 - c. Assembly, installation, alignment, adjustment, and checking instructions.
 - d. Operation instructions for start up, routine and normal operation, regulation and control, shutdown, and emergency conditions.
 - e. Lubrication and maintenance instructions, including lubrication cross references to a minimum of three locally available suppliers.
 - f. Guide to "troubleshooting."
 - g. Parts list and predicted life of parts subject to wear.
 - h. Outline, cross-section, and detailed assembly drawings; engineering data; wiring diagrams.
 - i. Test data and performance curves, where applicable.
2. The operation and maintenance manuals shall be in addition to any instructions or parts packed with or attached to the equipment when delivered, or instructions that may be required by the Contractor.
 3. Manuals and other data shall be printed on heavy, first quality paper, in an 8 ½ x 11-inch size with standard 3-hole punching. Drawings and diagrams shall be reduced to 8 ½ x 11-inches, or 11 x 17 inches. Where reduction is not practicable, larger drawings shall be folded separately and placed in an envelope that is bound into the manuals. Each envelope shall bear suitable identification on the outside.
 4. Material shall be assembled and bound in the same order as it appears in the Specifications, and each volume shall have a table of contents and suitable index tabs.
 5. All submittals shall be marked with Contract identification, and inapplicable information shall be erased or deleted.
 6. Shipment of equipment will not be considered complete until required data and manuals have been received.
- F. Part 1: Directory, listing names, addresses, and telephone numbers of CITY, Contractor, Subcontractors, and major equipment suppliers.
- G. 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.
 6. Maintenance instructions for special finishes, including recommended cleaning methods and materials and special precautions identifying detrimental agents.
- H. Part 3: Project documents and certificates, including the following:
1. Shop drawings and product data.
 2. Air and water balance reports.
 3. Certificates.
 4. Photocopies or warranties and bonds, if required.
- I. Copies will be returned after final inspection, with CITY'S comments. Revise content of documents as required prior to final submittal.
- J. Submit final volumes within **ten (10)** days after receipt of CITY'S comments.
- 1.07 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.
- 1.08 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.

END OF SECTION

SECTION 01810**EQUIPMENT TESTING AND FACILITY STARTUP****PART 1 GENERAL****1.01 DEFINITIONS**

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

1.02 SUBMITTALS

- A. Informational Submittals:
 - 1. Facility Startup and Performance Demonstration Plan.
 - 2. Functional and performance test results.
 - 3. Completed Unit Process Startup Form for each unit process.
 - 4. Completed Facility Performance Demonstration/Certification Form.

5. Completed Contractor Startup Field Checklist Pump/Motor Assembly and Control System.

1.03 FACILITY STARTUP AND PERFORMANCE DEMONSTRATION PLAN

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

- c) CONTRACTOR certification facility is capable of performing its intended function(s), including fully automatic operation.
- d) Signature spaces for CONTRACTOR and CITY.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.01 GENERAL

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

3.02 EQUIPMENT TESTING

- A. Preparation:
 - 1. Complete installation before testing.
 - 2. Furnish qualified manufacturers' representatives, when required by individual Specification sections.

3. Obtain and submit from equipment manufacturer's representative Manufacturer's Certificate of Proper Installation Form, in accordance with Section 01640, MANUFACTURERS' SERVICES, when required by individual Specification sections.
4. Equipment Test Report Form: Provide written test report for each item of equipment to be tested, to include the minimum information:
 - a) CITY/Project Name.
 - b) Equipment or item tested.
 - c) Date and time of test.
 - d) Type of test performed (Functional or Performance).
 - e) Test method.
 - f) Test conditions.
 - g) Test results.
 - h) Signature spaces for CONTRACTOR and CITY as witness.
5. Cleaning and Checking: Prior to beginning functional testing:
 - a) Calibrate testing equipment in accordance with manufacturer's instructions.
 - b) Inspect and clean equipment, devices, connected piping, and structures to ensure they are free of foreign material.
 - c) Lubricate equipment in accordance with manufacturer's instructions.
 - d) Turn rotating equipment by hand when possible to confirm that equipment is not bound.
 - e) Open and close valves by hand and operate other devices to check for binding, interference, or improper functioning.
 - f) Check power supply to electric-powered equipment for correct voltage.
 - g) Adjust clearances and torque.
 - h) Test piping for leaks.
6. Ready-to-test determination will be by CITY based at least on the following:

- a) Acceptable Operation and Maintenance Data.
- b) Notification by CONTRACTOR of equipment readiness for testing.
- c) Receipt of Manufacturer's Certificate of Proper Installation.
- d) Adequate completion of work adjacent to, or interfacing with, equipment to be tested.
- e) Availability and acceptability of manufacturer's representative, when specified, to assist in testing of respective equipment.
- f) Satisfactory fulfillment of other specified manufacturer's responsibilities.
- g) Equipment and electrical tagging complete.
- h) Delivery of all spare parts and special tools.

B. Functional Testing:

- 1. Conduct as specified in individual Specification sections.
- 2. Notify CITY in writing at least 10 days prior to scheduled date of testing.
- 3. Prepare Equipment Test Report summarizing test method and results.
- 4. When, in CITY's opinion, equipment meets functional requirements specified, such equipment will be accepted for purposes of advancing to performance testing phase, if so required by individual Specification sections. Such acceptance will be evidenced by CITY's signature as witness on Equipment Test Report.

C. Performance Testing:

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

7. When, in CITY's opinion, equipment meets performance requirements specified, such equipment will be accepted as conforming to Contract requirements. Such acceptance will be evidenced by CITY's signature on Equipment Test Report.

3.03 STARTUP OF UNIT PROCESSES

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

3.04 FACILITY PERFORMANCE DEMONSTRATION

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

3.05 SUPPLEMENTS

- A. Supplements listed below, following "END OF SECTION," are a part of this Specification:

1. Unit Process Startup Form.
2. Facility Performance Demonstration/Certification Form.
3. Contractor Startup Field Checklist Motor Assembly and Motor Control System Form.

END OF SECTION

ATTACHMENT "E"
UNIT PROCESS STARTUP FORM

CITY:

PROJECT:

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

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

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

Evaluation Comments:

ATTACHMENT "F"

FACILITY PERFORMANCE DEMONSTRATION/CERTIFICATION FORM

CITY:

PROJECT:

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

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

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

Contractor:

Date: _____, 20__

CITY:

Date: _____, 20__

(Authorized Signature)

ATTACHMENT "G"

**CONTRACTOR STARTUP FIELD CHECKLIST MOTOR ASSEMBLY AND
MOTOR 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 SECTION INCLUDES**

- A. Disconnect and remove the existing, direct-connected exciter from each motor; remove and dispose of off-site.
- B. Disconnect and remove existing doors of the motor breaker control and field application switchgear sections for Pumps 5, 6, 7, and 8 and turn over all door-mounted equipment to Milwaukee Water Works for spare parts. Remove and dispose of doors off-site.

1.02 CITY'S OCCUPANCY

- A. City will occupy the premises during the entire period of construction for the conduct of its normal operations. Cooperate with CITY in all construction operations to minimize conflict and to facilitate CITY usage.

1.03 SUBMITTALS**A. Quality Control SUBMITTALS:**

- 1. Schedule of demolition, as part of and consistent with the progress schedule.
- 2. Methods of demolition and equipment proposed. Copies of any authorizations and permits required to execute the Work.

PART 2 EXECUTION**2.01 PREPARATION****A. Utilities:**

- 1. Notify CITY and appropriate utilities to turn off affected services before starting demolition or alterations.
- 2. Note that the demolition and new work for Motors 5 and 6 shall be done together and

the work for Motors 6 and 7 shall be done together.

B. Removal and storage of Equipment for Reuse:

1. Do not remove equipment and materials without approval of CITY.
2. Properly store and maintain equipment and materials in same condition as when removed.
3. CITY will determine condition of equipment and materials prior to removal.

2.02 DEMOLITION

- A. Drawings define minimum portion of structures to be removed. Unless otherwise shown, rough cuts or breaks may be made exceeding limits of demolition shown.
- B. Remove all materials associated with existing equipment that is to be removed or relocated.

2.03 SALVAGE

- A. Equipment and materials within the limits of demolition, unless otherwise specified, will become the property of the **CONTRACTOR**.

END OF SECTION

SECTION 03300**CONCRETE WORK**

This section includes specifications for furnishing all labor and material to install foundation supports for concrete work as shown on 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 (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 not later than ten days after Notice to Proceed.

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 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 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 sixteen (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 effect the necessary water retention and 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 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 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 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 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 11310**SYNCHRONOUS ELECTRIC MOTOR RECONDITIONING****PART 1 -GENERAL****1.1 SCOPE**

This section covers the alterations, repairs and reconditioning of the four Allis Chalmers, synchronous motors serving Howard High Service Water Pumping Units 5, 6, 7, and 8. The synchronous motors to be altered, inspected and reconditioned under this section, shall be done so according to the Original Equipment Manufacturer's (OEM) specifications in conjunction with the RVSS Motor Starter's Manufacturer's requirements.

The Contractor shall be responsible for all modifications to the motor necessary for the complete compatibility and full functionality of the motor with the new RVSS motor starter. This shall include, but not be limited to: the removal of the static exciter for each motor and the fabrication and installation of a cover for the non drive end of the generator shaft. Fabrication drawings for the shaft cover shall be submitted along with the other required shop drawings.

The Contractor shall also be responsible for the following: disconnection, removal, transportation, reconditioning, reinstallation, and reconnection of the four synchronous motors, as detailed herein.

1.2 GENERAL

For reference purposes, Appendix No. 1 of these specifications contains the motor data and the results of an inspection performed on these motors on February 8, 2011.

1.3 SPECIFICATIONS AND STANDARDS

All materials, general design, design loads & tolerances, allowable stresses, 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. ANSI, American National Standards Institute
- B. ASME, American Society of Mechanical Engineers
- C. NEC, National Electric Code
- D. ASTM, American Society for Testing and Material
- E. The Wisconsin Administrative Code
- F. OSHA, U.S. Department of Labor Occupational Safety and Health Act
- G. IEEE, Institute of Electrical and Electronic Engineers
- H. NEMA, Standards of National Electrical Manufacturers Association

- I. United States Environmental Protection Agency (EPA)
- J. National Electrical Motor Association

The Contractor shall be familiar with the requirements of the above agencies. Any conflict in the Specifications or in the Contractor's rebuilding methods shall result in the Contractor performing in a manner that conforms to the applicable requirements.

1.4 QUALITY ASSURANCE

The motor reconditioning shop shall have experience in the design and repair of substantially similar equipment, and shall show evidence of satisfactory completion in at least five (5) refurbishments and installations.

PART 2 – PERFORMANCE

The repaired synchronous electric motors, including all separate components, shall be well lubricated and be in sound working order. Motors shall also pass all acceptance tests, including electrical and vibration. All mechanical tolerances must satisfy regulation and OEM requirements.

PART 3 - PRODUCTS

All products used for the rebuild of the motor shall be of OEM quality.

The Contractor shall submit shop drawings for the shaft end covers for review and approval, prior to fabrication.

PART 4 – PROCEDURE

All refurbished, synchronous pump motors shall be rebuilt and repaired in a manner that will make them functional per OEM specifications. The procedure for the reconditioning includes but is not limited to the following:

1. Record nameplate information and other observed characteristics.
2. Disconnect motor leads and mechanically disconnect motor from pump and foundation.
3. Provide for and transport motor to and from the repair facility.
4. Disassemble, steam clean, and inspect all parts.
5. Test the stator and the rotor for opens, shorts, and grounds- to include:
 - a. Megger ohmmeter test per NEMA standards to measure and record electrical resistance, Hi-pot, and Surge, AC voltage drop tests.
6. Replace existing 10 ohm copper stator winding RTDs.
7. Replace inboard and outboard bearing temperature sensors with RTD type.
8. Steam clean, bake and re-insulate the stator and the rotor.
9. Inspect the stator and rotor windings for loose edges and blocks.
10. Test and inspect the rotor for open and loose rotor bars.
11. Core test the stator laminations for hot spots and efficiency and advise condition.
12. Inspect motor leads.

13. Inspect the bearing fits with a micrometer- to include:
 - a. Shaft O.D., bearing I.D., bearing O.D. and housing I.D.
14. Check shaft run-out and record results.
15. Rebuild the brush rigging and replace the brushes.
16. Re-surface the slip rings.
17. Reassemble and test at full voltage and RPM and record voltage watts, current, vibration, and bearing temperature.
18. Scribe axial float and magnetic center onto the output shaft.
19. Perform final inspection, paint the unit and prepare for shipment.
20. Provide formal test reports.
21. Connect motor leads and mechanically reconnect motor to pump and foundation.

END OF SECTION

SECTION 16010**BASIC ELECTRICAL REQUIREMENTS****PART 1 GENERAL****1.01 RELATED SECTION**

Requirements specified within this section apply to all sections and shall be performed as if specified in the individual sections. The electrical work included in all other divisions is the responsibility of the contractor performing the division 16 work unless noted otherwise.

1.02 REFERENCE STANDARDS

All work shall be performed and materials furnished in accordance with the Wisconsin State Electrical Code, National Electric Code (NEC), National Electrical Safety Code (NESC), and the following standards where applicable:

ANSI American National Standards Institute
ASTM American Society for Testing and Materials
EPA Environmental Protection Agency
ETL Electrical Testing Laboratories, Inc.
IEEE Institute of Electrical and Electronics Engineers
IES Illuminating Engineering Society
ISA Instrument Society of America
NBS National Bureau of Standards
NEC National Electric Code
NEMA National Electrical Manufacturers Association
NESC National Electrical Safety Code
NFPA National Fire Protection Association
UL Underwriters Laboratories Inc.

1.03 REGULATORY REQUIREMENTS

All work and materials are to conform in every detail to applicable rules and requirements of the Wisconsin State Electrical Code, The National Electric Code (ANSI/NFPA 70), other applicable National Fire Protection Association codes, the National Electrical Safety Code, and present manufacturing standards (including NEMA).

All Division 16 work shall be done under the direction of a currently certified State of Wisconsin Certified Master Electrician.

1.04 QUALITY ASSURANCE

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.

Manufacturer references used herein are intended to establish a level of quality and performance requirements unless more explicit restrictions are stated to apply.

All materials, except medium voltage equipment and components, shall be listed by and shall bear the label of an approved electrical testing laboratory. If none of the approved electrical testing laboratories has published standards for a particular item, then other national independent testing standards, if available, applicable, and approved by the Engineer, 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.

1.05 CONTINUITY OF EXISTING SERVICES AND SYSTEMS

No outages shall be permitted on existing systems except at the time and duration specified by the Engineer. Any outage must be scheduled when the interruption causes the least interference with normal business routines. No extra costs will be paid to the Contractor for such outages which must occur outside of regular weekly working hours.

This Contractor shall restore any circuit interrupted as a result of this work to proper operation as soon as possible.

1.06 INTENT

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.

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 the Engineer's intent (as determined by the Milwaukee Water Works Project Manager).

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.

All sizes given are minimum sizes, except as noted.

Materials and labor shall be new (unless noted or stated otherwise), first class, and workmanlike, and shall be subject at all times to the Engineer's inspections, tests and approval from the commencement until the acceptance of the completed work.

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.

1.07 SCOPE OF WORK

The Contractor shall furnish and install all labor, materials, equipment and services needed to retrofit each of the Milwaukee Water Works High Service Pumping Units 5, 6, 7, and 8, with a RVSS motor controller and make the associated wiring changes and equipment modifications as shown on the contract drawings and described in the specifications.

Contractor shall be responsible for the development of all required master electrical power and control interconnect wiring diagrams, necessary for construction, that shall include coordination of electrical control devices and new and existing equipment in order to integrate the new motor controllers into the City's pump operating procedure. These drawings shall be included as part of the submittal package sent to the City for review, prior to construction.

The Contractor shall set the new RVSS controllers in place, disconnect and remove the old, direct-connected exciter from each motor, program the RVSS controller, and make all controller and motor electrical connections. New feeder conductors shall be run from the switchgear to the RVSS controller, and new feeder and field excitation conductors from the controller to the motor. The Contractor shall reuse the existing 5" feeder conduit and run the new 5kV feeder up through the top of the Motor High Voltage Cabinet and over to the RVSS motor controller cabinet and shall install new control, indication, and communication conduit and signal wiring as necessary to transfer control of the motor and discharge valve, from the 4.16KV switchgear, to the RVSS controller.

The work includes disconnecting and removing all devices, meters, relays, pilot lights, and switches from the existing doors of the motor breaker control and field application switchgear sections for Pumps 5, 6, 7, and 8 and removing the old doors. The Contractor shall furnish and install new doors on those sections and shall furnish and install a new breaker control switch, feeder management relay, 86S lockout relay, heater toggle switch, discharge valve and breaker status lights, and in the new door of the feeder section. All items removed from the old doors shall be given to the Milwaukee Water Works for use

as spare parts. Once this work is complete, the circuit breaker for each High Service Pump motor feeder will only be locally controllable, not remotely; motor protection for each unit shall be performed by the motor protective relay in the RVSS controller cabinet.

All relay coordination studies and feeder and motor protective relay programming shall be performed by the Contractor. 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. The Contractor shall make note of all existing and new power and control voltage requirements and take these into consideration when preparing submittals and ordering equipment.

The Contractor shall be responsible for termination of all wiring in the SCADA cabinet, however, all associated SCADA system monitoring and control function programming and changes for the new equipment shall be performed by the City.

1.08 SYSTEM FUNCTIONAL DESCRIPTION

To start the pump, the motor controller receives the start signal, either from a START push-to-close input at the controller when in LOCAL mode, or a remote contact closure from SCADA when in REMOTE mode, causing the main contactor to close and the motor to ramp up to speed, providing that the pump is primed and the motor lockout relay is de-energized. Once the motor is synchronized, at full speed, and the pump pressure discharge switch is closed, the motor controller shall issue a signal to open the pump discharge valve. Once the motor controller receives the stop signal, either from a STOP push-to-open input at the controller when in LOCAL mode or a remote contact closure from SCADA when the controller is in REMOTE mode, the valve shall begin to close. When the valve reaches 95% closed, the RVSS controller shall de-energize the motor, shutting off the pump.

In the event of a power loss, emergency stop, or fault detection at the motor protective relay or SMC flex unit, the 86M lockout relay in the motor Low Voltage Cabinet shall become energized and cause the motor controller to immediately open both contactors and disconnect power to the motor without going through the normal shutdown procedure described above. Energizing the 86M relay shall also simultaneously close the valve and lock out the motor.

1.09 OMISSIONS

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

PART 2 PRODUCTS

2.01 GENERAL

- A. Provide materials and equipment listed by UL wherever standards have been established by that agency.
- B. Equipment Finish:
 1. Provide manufacturer's standard finish and color, except where specified color is indicated.
 2. If manufacturer has no standard color, provide equipment with ANSI No. 61, light gray color.

2.02 MOTOR MANAGEMENT RELAY

- A. GE Multilin 469 Motor Management and Protection Relay, no substitutions.

Motor protection shall be provided using a drawout type, digital relay rated for use on 120VAC control power system. The primary protection function shall be the thermal model. The stator protective thermal model shall combine inputs from positive and negative sequence currents and RTD winding feedback. The relay shall include but not be limited to the following protective features:

- Thermal overload(thermal model)
- Negative sequence unbalance/single phase biasing
- RTD biasing(hot/cold motor compensation)
- Motor cooling time constants
- Stall Jam
- Minimum 12 programmable RTD inputs
- Ground fault
- Short circuit
- Current differential using CT inputs (6) from both sides of the machine windings
- Overvoltage
- Undervoltage
- Phase reversal
- Overfrequency
- Underfrequency

- B. Metering and Monitoring

The relay shall meter and record all AC signals including voltage, current, RTD, and power metering. The following system values shall be accurately metered and

displayed:

- Phase, differential, and ground currents, average current, motor load, current unbalance
- Phase-to-ground and phase-to-phase voltages, average phase voltage, system frequency
- Real, reactive, apparent power, power factor, watthours, varhours, torque
- Current and power demand
- Analog inputs and RTD temperatures
- Thermal capacity used, lockout times, motor speed

The relay shall have monitoring facilities to capture data and present it in a user-friendly format. The following information shall be easily accessible:

- Status of inputs, outputs, and alarms
- Last trip data
- Motor learned parameters; acceleration times, starting currents and starting TCU, average currents, RTD maximums
- Trip and general counters, motor running hours and start timers
- An events recorder shall store a minimum of 40 of the last events; events shall be date and time stamped each time an event occurs.
- Oscillography; a minimum of sixteen(16) cycles of waveform data shall be stored, minimum 12 samples per cycle, each time a fault occurs. Each time a trip occurs, the following waveforms shall be recorded: Ia, Ib, Ic, Ig, Diffa, Diffb, Diffc, Va, Vb, Vc.

C. User Interfaces and Communications

The relay shall include the following:

- 40 character illuminated vacuum fluorescent display with keypad for local monitoring and relay configuration
- Front RS232 serial port for setpoint programming
- Ethernet and RS485 ports to support multiple protocols; Modbus RTU, Modbus TCP/IP, and Devicenet
- An additional, independent RS485 port for use by maintenance personnel and added security
- Interface software in a Windows format

D. Inputs and Outputs

In addition to the standard current and voltage transformer inputs required for protective functions, the relay shall also include the following:

- Four(4) assignable digital inputs
- Four(4) assignable 4-20mA inputs
- Six(6) Form-C output relays

2.03 FEEDER MANAGEMENT RELAY

A. GE Multilin 750 Feeder Management and Protection Relay; no substitutions.

Feeder protection shall be provided using a drawout type, digital relay rated for use on 130VDC control power system. The relay shall provide primary protection of the feeder and shall include, but not be limited to, the following functions:

- Complete time overcurrent (51P, 51N, 51G), including sensitive ground
- Complete instantaneous overcurrent (50P, 50N, 50G)
- Directional overcurrent(67P, 67N, 67G, 67_2)
- Bus and Line undervoltage and overvoltage (27/59)
- Negative sequence voltage (47)
- Undervoltage automatic restoration (27/79)
- Bus Overfrequency (81O) with voltage and current level monitoring
- Bus Underfrequency (81U) with voltage and current level monitoring
- Frequency rate-of-change (81D) monitoring
- Underfrequency automatic restoration (81/79)
- Neutral displacement overvoltage (59N)

B. Metering and Monitoring

The relay shall meter and record all AC signals including voltage, current, and apparent, real, and reactive power metering. The following system values shall be accurately metered and displayed:

- Current Phasors: Ia, Ib, and Ic RMS current values
- Voltage Phasors: Va-n, Vb-n, and Vc-n line-to-neutral RMS voltage values and Va-b, Vb-c, and Vc-a line-to-line RMS voltage values
- Frequency: Measured from a-n and a-b bus and line voltage, range 16-65 Hz
- Symmetrical components
- Real, reactive, apparent power, power factor, watthours, varhours
- Current and power demand

The relay shall have monitoring facilities to capture data and present it in a user-friendly format. The following information shall be easily accessible:

- Status of inputs, outputs, and alarms
- Last trip report including date, time, cause, phase, ground, sensitive ground, and neutral currents, Line-Line voltage, Line-ground voltage, neutral voltage,

frequency, and analog input.

- Trip and general counters, motor running hours and start timers
- An events recorder shall record 512 of the last events; events shall be date and time stamped each time an event occurs.
- Oscillography; up to 256 cycles of voltage and current waveform data shall be stored, as well as digital data for the output relays and input contact states, each time a fault occurs. The amount of data and the trigger point shall be user configurable.
- A data logger with storage capability of up to 85 days of data displaying actual values at user-defined intervals.
- The screen shall sequentially display up to 30 default messages when no front panel activity is detected. Any actual value or setpoint message shall be selectable for display.
- The relay shall have coil (Trip/Close) monitoring inputs for the detection of a failed circuit, regardless of the breaker state.

C. User Interfaces and Communications

The relay shall include the following:

- 40 character illuminated vacuum fluorescent display with keypad for local monitoring and relay configuration
- Front RS232 serial port for setpoint programming
- Ethernet and RS485 ports to support multiple protocols; Modbus RTU, Modbus TCP/IP, and Devicenet
- An additional, independent RS485 port for use by maintenance personnel and added security
- Interface software in a Windows format

D. Inputs and Outputs

Control shall include manual control, cold load pickup control; in addition to the standard current and voltage transformer inputs required for protective functions, the relay shall also include the following:

- Four(4) assignable digital inputs
- Four(4) settings groups
- Twenty(20) programmable logic inputs
- Two(2) breaker control relay outputs
- One(1) internal failure relay output
- One(1) solid state trip output
- One(1) analog transducer input
- Eight(8) analog transducer outputs

2.04 ROTARY SWITCHES

- A. Breaker Control Switch shall be as manufactured by Electroswitch; Series 24 CSR, or approved equal, ANSI/IEEE 37.90 and 37.90 .1; rated for 125VDC operation. Mechanical target shall indicate last active position, latching when handle returns to NORMAL position; GREEN FOR TRIP, RED FOR CLOSE.
- B. Lockout Relay shall be as manufactured by Electroswitch; Series 24 LOR, or approved equal; rated for 125VDC operation, manual reset.
- C. Pilot Lights shall be as manufactured by Square D; K Series, or approved equal; heavy duty, 30 mm, LED with domed Fresnel cover; rated for 125VDC/120VAC operation.

PART 3 EXECUTION

3.01 BUILDING ACCESS

Arrange for the necessary openings in the building to allow for admittance of all apparatus. When the building access was not previously arranged and must be provided by this contractor, restore any opening to its original condition after the apparatus has been brought into the building.

3.02 EQUIPMENT ACCESS

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

The Contractor shall cooperate with other trades and Milwaukee Water Works personnel in locating work in a proper manner. Should it be necessary to raise or lower or move longitudinally any part of the electrical work to better fit the general installation, such work shall be done at no extra cost to the owner, provided such decision is reached prior to actual installation. The Contractor shall check location of electrical outlets with respect to other installations before installing.

The Contractor shall verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to, light fixtures, panelboards, devices, etc. and recessed or semi-recessed heating units installed in/on architectural surfaces.

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.

3.04 SLEEVES

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

In wet area floor penetrations, top of sleeve shall 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.

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

Fire and/or Smoke Penetrations:

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.

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.

None-Rated Surfaces:

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.

Use galvanized sheet metal sleeves in hollow wall penetrations to provide a backing for the sealant. Grout area around sleeve in masonry construction.

3.06 HOUSEKEEPING AND CLEAN UP

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**

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

1.01 SCOPE

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 1 - GENERAL

Scope

Related Work

PART 2 - PRODUCTS

Rigid Metal Conduit

Polyvinyl Chloride (PVC) Coated Rigid Metal Conduit

Flexible Metal Conduit and Fittings

Liquidtight Flexible Conduit and Fittings

Conduit Supports

General

PART 3 - EXECUTION

Conduit Sizing, Arrangement and Support

Conduit Installation

1.02 RELATED WORK

Section 16190 - Supporting Devices.

PART 2 PRODUCTS**2.01 RIGID METAL CONDUIT AND FITTINGS**

Conduit: Heavy wall, galvanized steel, schedule 40, threaded.

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

2.02 FLEXIBLE METAL CONDUIT AND FITTINGS

Conduit: steel, galvanized, spiral strip.

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

2.03 LIQUIDTIGHT FLEXIBLE METAL CONDUIT AND FITTINGS

Conduit: flexible, steel, galvanized, spiral strip with an outer Liquidtight, nonmetallic, sunlight-resistant jacket.

Fittings and Conduit Bodies: ANSI/NEMA FB 1, compression type. There shall be a metallic cover/insert on the end of the conduit inside the connector housing to seal the cut conduit end.

2.04 CONDUIT SUPPORTS

See section 16190.

2.05 GENERAL

All steel fittings and conduit bodies shall be galvanized.

No cast metal, split or gland type fittings permitted.

Condulets larger than 2 inch (50 mm) not permitted except as approved or detailed.

All conduit covers must be fastened to the conduit body with screws and be of the same manufacture.

Wireways and gutters shall not be used in lieu of pull boxes and condulets.

PART 3 EXECUTION

3.01 CONDUIT SIZING, ARRANGEMENT, AND SUPPORT

Size power conductor raceways for conductor type installed. Conduit size shall be 1/2 inch (13 mm) minimum except as specified elsewhere. **Caution: Per the NEC, the allowable conductor ampacity is reduced when more than three current-carrying conductors are installed in a raceway. Contractor must take the NEC ampacity adjustment factors into account when sizing the raceway and wiring system.**

Size conduit for all other wiring, including but not limited to data, control, signal, etc. shall be sized per number of conductors pulled and their cross-section. A maximum of 40% fill shall be used for all new conduit fills.

Arrange conduit to maintain headroom and present a neat appearance.

Route exposed conduit and conduit above accessible ceilings parallel and perpendicular to walls and adjacent piping.

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.

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.

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.

Do not fasten conduit with wire or perforated pipe straps. Before conductors are pulled, remove all wire used for temporary conduit support during construction.

Support and fasten metal conduit at a maximum of 8 feet (2.4 m) on center.

Supports shall be independent of the installations of other trades, e.g. ceiling support wires, HVAC pipes, etc., unless so approved or detailed.

Contractor shall verify with Engineer all surface conduit installations.

Changes in direction shall be made with symmetrical bends, cast steel boxes, stamped metal boxes or cast steel conduit bodies.

No continuous conduit run shall exceed 100 feet (30 meters) without a junction box.

3.02 CONDUIT INSTALLATION

Cut conduit square using a saw or pipecutter; de-burr cut ends.

Bring conduit to the shoulder of fittings and couplings and fasten securely.

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).

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 conduits not terminated in box walls.

Install no more than the equivalent of three 90 degree bends between boxes.

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.

Conduit shall be bent according to manufacturer's recommendations.

Use suitable conduit caps or other approved seals to protect installed conduit against entrance of dirt and moisture.

Provide 1/8 inch (3 mm) nylon pull string in empty conduit, except sleeves and nipples.

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.

Avoid moisture traps where possible. Where moisture traps are unavoidable, provide junction boxes with drain fittings at conduit low points.

Identify conduit under provisions of Section 16195.

END OF SECTION

SECTION 16121
MEDIUM VOLTAGE CABLE
(ABOVE 600 VOLTS)

PART 1 GENERAL

Applicable provisions of Division 1 shall govern all work under this section.

1.01 SCOPE

Furnishing and installing medium voltage cable including pulling, racking, splicing, and terminating. Included are the following topics:

PART 1 - GENERAL

- Scope
- Definition
- Submittals
- Project Record Documents
- Quality Assurance
- Code Requirements
- Delivery, Storage, and Handling

PART 2 - PRODUCTS

- General
- Medium Voltage Cable - Shielded
- Jumper Cable
- Cable Terminations
- Cable Splices
- Cable Labeling

PART 3 - EXECUTION

- Cable Pulling
- Cable Routing in Manholes and Switchgear
- Splices and Terminations Installation
- Fireproofing of Medium Voltage Cables
- Cable Acceptance Tests
- Cable Identification and Labeling

1.02 DEFINITION

Manufacturer: Company that owns controlling interest in the factory that actually produces the cable being furnished for this project.

1.03 SUBMITTALS

Submit product data under the provisions of Division 1, General Conditions of the Contract, and Section 16010.

Submit product data indicating cable and accessory construction, materials, ratings, and all other parameters identified in Part 2 - Products below.

Submit manufacturer's installation instructions.

Submit manufacturer's certificate stating approval for field acceptance testing per National Electrical Testing Association standards (at least 36 kV DC for 5 kV rated cable and 64 kV DC for 15 kV rated cable).

Submit manufacturer's certificate stating that medium voltage cable meets or exceeds all requirements specified below.

1.04 PROJECT RECORD DOCUMENTS

Submit record documents under provisions of Division 1 and Section 16010.

Accurately record the exact sizes, lengths, types, locations, and quantities of cables. Also show where all splices are located for each cable.

1.05 QUALITY ASSURANCE

The manufacturer shall be a company specializing in the manufacture of medium voltage cable and/or accessories with minimum five years documented experience in producing cable and/or accessories similar to those specified below.

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.

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.

The Contractor shall be a company specializing in installation of medium voltage cable and accessories with a minimum of five years documented experience in installation of the type of cable and accessories described below.

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 CODE REQUIREMENTS

NFPA 70--National Electrical Code
ANSI/IEEE C2--National Electrical Safety Code.
Wisconsin Administrative Code

1.07 DELIVERY, STORAGE, AND HANDLING

Deliver products to and receive products at the site under provisions of Division 1, General Requirements and Section 16010.

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

PART 2 PRODUCTS

2.01 GENERAL

All cable shall be new, delivered to the site, and be less than two years since manufacture. It shall be from manufacturer's stock; not suppliers' warehouse stock. Manufacturer's certification of factory test values shall be submitted for all cable furnished. All specified dimensions are nominal.

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, unless otherwise noted. See Section 16170 for more grounding requirements.

2.02 MEDIUM VOLTAGE CABLE – SHIELDED

Usage: This cable shall be used for all above and under ground applications (except for jumper cable applications, see JUMPER CABLE below) and shall be contained in conduit or other raceways. It may be used in cable trays in electrical vaults only.

Cable: Single conductor, insulated cable rated 5 KV, 133% insulation level, ungrounded, NEC-UL Type MV-105. Sizes as indicated on the Drawings.

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.

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.

Insulation: Extruded EPR (ethylene propylene rubber), rated at 5 KV, 133 per cent insulation level, minimum nominal thickness of .115 inches.

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.

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.

Cable Rating: Continuous duty at 105 degrees C., wet or dry locations, suitable for underground duct installations, NEC-UL type MV-105.

2.03 JUMPER CABLE

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.

Cable: Single conductor, flexible, non-shielded, insulated cable rated 15 KV, ungrounded. Sizes as indicated on the Drawings.

Conductor: Soft annealed copper, uncoated, concentric stranded.

Conductor shield: extruded semiconductor, clean stripping from the conductor and firmly bonded to the overlying insulation.

Insulation: Extruded EPR (ethylene propylene rubber), rated at 15 KV, minimum thickness of .175 inches

Cable Rating: Continuous duty at 90 degrees C., dry locations.

2.04 CABLE TERMINATIONS

Modular Molded Shrink Type Termination: IEEE 48; Class 1; 5 KV, 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.

Submittal for approval shall show electric field distribution (via equipotential lines) of termination device.

Lugs shall be copper, long barrel, two holed or four holed 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 holed pad, the cable lug shall be four holed type.

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 LABELING

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

PART 3 EXECUTION

3.01 CABLE PULLING

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.

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.

Cable ends shall be sealed and firmly held in the pulling device during the pulling operation.

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.

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.

Pulling lubricant shall be used to ease pulling tensions. Lubricant shall be of a type which is noninjurious to the cable material used. Lubricant shall not harden or become adhesive with age.

Avoid abrasion and other damage to cables during installation.

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

3.02 CABLE ROUTING IN SWITCHGEAR

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.

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

Splices are to be held to a minimum. Splice locations shall be determined by cable lengths available, pulling conditions and termination points.

Only experienced electricians shall be employed in this phase of the work.

Follow cable manufacturer's installation instructions, splice or termination manufacturer's installation instructions, and ANSI/IEEE C2 standards.

Clean, white lint-free gloves shall be used to handle end of cable during tape wrapping procedures.

Termination or splicing of the copper conductors (both power and ground conductors) shall be made only with tool applied compression (swaged) fittings.

Ground system connections:

Cable to bus: compression cable fitting bolted to bus with lock washers under nut.

Cable to ground rod: approved bolted fitting with backing plate between cable and rod.

Ground cable shield at each termination and splice.

Install Scotch #70 tape for anti-tracking on all exposed terminations.

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.

Lugs shall be bolted to termination pads in equipment using corrosion resistant bolts, nuts, and washers. Use 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

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.

Arc proofing material shall be Scotch #77 electrical arc and fireproofing tape, or approved equal.

Install the fireproofing on the cables as follows:

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.

Install the tape with the coated side towards the cable and extend it not less than one inch into each duct.

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 IDENTIFICATION AND LABELING

Provide the following information on cable identification label:

Main feeder circuit breaker number

Phase

To and From Data

EXAMPLE:

FDR C.B.: 1

PHASE: B

TO:

Pump MOTOR NO. 3

FROM: SWITCHGEAR SECTION NO. 24

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:

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

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

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**WIRE AND CABLE
(Below 600 Volts)****PART 1 GENERAL**

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

1.01 SCOPE

Furnishing and installing required wiring and cabling systems including pulling, terminating and splicing. Included are the following topics:

PART 1 - GENERAL

- Scope
- Related Work
- References
- Submittals
- Project Conditions

PART 2 - PRODUCTS

- General
- Building Wire
- Underground Wire for Exterior Work
- Remote Control and Signal Cable
- Modular Wiring Systems - Light Fixtures
- Modular Wiring Systems - Receptacles
- Wiring Connectors

PART 3 - EXECUTION

- General Wiring Methods
- Wiring Installation In Raceways
- Free-Air Cable Installation
- Modular Wiring System Installation
- Wiring Connections and Terminations
- Field Quality Control
- Wire Color
- Branch Circuits
- Emergency Circuits

1.02 RELATED WORK

Section 16111 - Conduit.

Section 16130 - Boxes.
Section 16195 - Identification.

1.03 REFERENCES

NFPA 70 - National Electrical Code.

1.04 SUBMITTALS

Submit under provisions of General Conditions of the Contract and Section 16010.

Submit product data: Provide for each cable assembly type.

Submit factory test reports: Indicate procedures and values obtained.

Submit shop drawings for modular wiring system including layout of distribution devices, branch circuit conduit and cables, circuiting arrangement, and outlet devices.

Submit manufacturer's installation instructions. Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

1.05 PROJECT CONDITIONS

Verify that field measurements are as shown on Drawings.

Conductor sizes are based on copper.

Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.

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

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.

All conductors shall be copper.

Insulation shall have a 600 volt rating.

In mechanical rooms, light fixtures, and other high temperature applications, the insulation shall be rated 90 degrees C. Other areas shall use insulation rated 75 degrees C unless stated otherwise in other parts of these specifications and drawings.

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:

All conductors terminated with crimp type devices must be stranded.

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

Description: Single conductor insulated wire.

Insulation: Type THHN/THWN, XHHW-2 insulation for feeders and branch circuits.

2.03 REMOTE CONTROL AND SIGNAL CABLE

Refer to Section 16741 for requirements for cable to be used on communication systems.

All other systems cabling shall meet the requirements of NEC Article 725 and the following:

Control Cable for Class 1 Remote Control and Signal Circuits: 600 volt insulation, individual conductors twisted together, and covered with an overall PVC jacket.

Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits shall be constructed, UL listed, temperature rated, and plenum or non-plenum rated for the application as required in the NEC Article 725.

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.

Cable shall be UL listed, temperature rated, and plenum or non-plenum rated for the application as required in the National Electrical Code.

Split Bolt Connectors: Not acceptable.

Solderless Pressure Connectors: High copper alloy terminal; may be used only for cable termination to equipment pads or terminals. Not approved for splicing.

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.

Mechanical Connectors: Bolted type tin-plated; high conductivity copper alloy; spacer between conductors; beveled cable entrances.

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

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.

Do not use wire smaller than 12 AWG for power and lighting circuits, 14 AWG for control wiring greater than 60 volts, or #18 AWG for voltages less than 60 volts, all sizes subject to NEC 725 requirements.

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 100 feet (30 m), and for 20 ampere, 277 volt branch circuit home runs longer than 200 feet (61 m).

Make conductor lengths for parallel conductors equal.

Splice only in junction or outlet boxes.

Identify ALL low voltage, 600v and lower, wire per section 16195.

Neatly train & lace wiring inside boxes, equipment, and panelboards.

3.01 WIRING INSTALLATION IN RACEWAYS

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.

Install wire in raceway, after interior of building has been physically protected from the weather and all mechanical work likely to damage conductors, has been completed.

Completely and thoroughly swab raceway system before installing conductors.

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.

3.02 WIRING CONNECTIONS AND TERMINATIONS

Splice only in accessible junction boxes.

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.

All splices shall be so made that they have an electrical resistance not in excess of two feet (600 mm) of the conductor.

Use solderless spring type pressure connectors with insulating covers for wire splices and taps, 10 AWG and smaller.

Use mechanical or compression connectors for wire splices and taps, 8 AWG and larger. Tape uninsulated conductors & connectors with electrical tape up to 150 percent of the insulation value of conductor.

Thoroughly clean wires before installing lugs and connectors.

At all splices and terminations, leave tails long enough to cut splice out and completely re-splice.

3.03 FIELD QUALITY CONTROL

Field inspection and testing will be performed under provisions of Section 16010.

3.04 WIRE COLOR

A. General:

Wire sizes 10 AWG and smaller - Wire shall be colored as indicated below.

Wire sizes 8 AWG and larger - Identify wire with colored tape at all terminals, splices and boxes. Colors to be as indicated below.

In existing facilities, use existing color scheme.

In new facilities, 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.

B. 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.

C. Branch Circuit Conductors:

Three or four wire home runs shall have each phase uniquely color coded.

D. Feeder Circuit Conductors:

Each phase shall be uniquely color coded.

E. Grounded 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.

3.05 BRANCH CIRCUITS

The use of multi-wire branch circuits with a common neutral feeding loads is not permitted.

All branch circuits shall be furnished and installed with an individual accompanying neutral, sized the same as the phase conductor.

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 & 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 1/4" 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 & 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:

<u>System</u>	<u>Color(s)</u>
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: 1/2 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 16345**MEDIUM VOLTAGE REDUCED VOLTAGE SOLID-STATE MOTOR
CONTROLLERS****PART 1 GENERAL****1.1 SUMMARY****A. Section includes:**

1. This specification covers materials, equipment, and start-up services required to retrofit and place into service, a total of four(4) medium voltage reduced voltage solid-state (MV-RVSS) motor controllers; one on each of the existing Pumping Units 5, 6, 7, & 8.
2. Each MV-RVSS system shall consist of all components required to meet the performance, protection, safety, and certification criteria of this specification.
3. Include all material and labor necessary to interconnect MV-RVSS system elements required to make it fully operational in accordance with the City's functional description.
4. Contractor shall provide completed Manufacturers' Certificate of Proper Installation form, Attachment "C", for each MV-RVSS motor controller.

B. Related Sections**1.2 QUALIFICATIONS****A. Manufacturer**

1. The manufacturer shall have a minimum of 10 years of experience in the manufacture of medium voltage reduced voltage solid-state motor starter (MV-RVSS) 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.
2. The approved manufacturers are:
 - a. Rockwell Automation, Allen-Bradley brand. No substitutions for City control network and equipment compatibility reasons.

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 10 years.
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 RVSS shall be factory pre-wired, assembled and tested as a complete package by the RVSS supplier. Specific motor and application data shall be pre-loaded 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 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-assemblies 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.

1.3 REFERENCES

A. Reduced Voltage Solid State Starter

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 and Electronic Engineers (IEEE)
4. National Electrical Manufacturer's Association (NEMA) "Medium Voltage Controllers Rated 1501 to 7200V AC ICS 3-2 (formerly ICS 2-324)"
5. Underwriters Laboratories, Inc. (UL) (High Voltage Industrial Control Equipment 347)
6. UL 347A Medium Voltage Power Conversion Equipment Preliminary Standard
7. National Electrical Code (NEC)
8. Occupational Safety & Health Act (OSHA)

1.4 ENVIRONMENTAL REQUIREMENTS

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

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

1.5 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 smart motor controllers
 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. Contractor shall provide recommended spare parts list with list prices.
 2. Critical Spares- Spare parts that are identified as being associated with long lead times and/or are critical to the unit's operation shall be held in reserve to limit unforeseen downtime.
 3. Maintenance Spares- Spare parts required to regularly perform scheduled maintenance on the equipment shall be identified. These spares include, but are not limited to, consumable spares that are required to be exchanged during scheduled maintenance periods.
- E. Testing and Test Reports
 1. Testing shall be per manufacturer's standard.
 2. A copy of test reports shall be provided as part of the Closeout documentation

PART 2 GENERAL

2.1 RATINGS

- A. Voltage
 - 1. The RVSS shall be rated to operate from a nominal voltage of 4160V +/- 10%, 60 Hz +/-3%, three-phase, three-wire.
- B. Environmental Ratings
 - 1. Storage Ambient temperature range: -40degrees C to 70 degrees C.
 - 2. Operating Ambient temperature range : 0 degrees to 40 degrees C without derating.
 - 3. Relative humidity range: 5% to 95% non-condensing.
 - 4. Operating Elevation: Up to 1000 meters (3,300ft) without derating
- C. Audible Noise Level
 - 1. The maximum audible noise from the RVSS shall comply with OSHA standard 3074, limiting the allowable noise level to 85dB(A), measured at a distance of one meter from the front of the equipment, with the doors closed.
- D. Motor Compatibility
 - 1. The smart motor controllers shall be capable of operating a standard 2000 HP, 4160 VAC brush-type synchronous motor.
 - 2. RVSS induced torque pulsations to the output shaft of the mechanical system shall be less than 1% to minimize the possibility of exciting a resonance.
- E. Sizing
 - 1. Load sizing shall be as shown on the contract drawings.

2.2 RVSS STARTER UNIT DESIGN

- A. The controller shall be medium voltage, solid-state, and shall consist of a metal-enclosed, free-standing, dead front, vertical steel structure. The controller shall be manufactured by Allen-Bradley, no exceptions.
- B. Each structure shall be suitable for future expansion at each end. Each structure shall also have two (2) non-removable base sill channels and removable lifting angles or brackets for ease of handling and installation.
- C. The controller shall be of modular design to provide for ease and speed of maintenance. The modules are to be designed and manufactured by Allen-Bradley/Rockwell Automation solely, for ease of maintenance, including removal of medium voltage components and power electronic components.

- D. The structure shall be divided into isolated compartments as follows:
 1. Main power bus and ground bus compartment
 2. Power cell compartment
 3. Low voltage compartment

- E. Metal or glass polyester barriers shall be provided between the low voltage compartment and the power cell and/or main power bus compartment, and between the power cell and main bus compartment. Personnel shall have access to the low voltage compartment, with the controller energized, without being exposed to any medium voltage.

2.3 STRUCTURE AND CONTROLLER

Each structure shall contain the following:

- A. Combination Controller (includes isolating controller)
 1. Tin-plated copper horizontal power bus
 2. Termination lugs sized for incoming power cable
 3. A continuous bare copper ground bus
 4. Power electronics
 5. A non-load-break isolation switch and operating handle, complete with ground connection when open
 6. A vacuum type isolation contactor
 7. A vacuum type bypass contactor
 8. Three (3) current limiting power fuses for NEMA Class E2 operation
 9. Three (3) current transformers
 10. A control power transformer
 11. A low voltage control panel complete with microprocessor-based control module
 12. Space for necessary auxiliary control and metering devices
 13. Top and bottom plates to accommodate cable entry and exit

- B. ENCLOSURE
 1. Controller enclosures shall be NEMA Type 12, oil and dust tight.
 2. The enclosure shall be properly sized to adequately dissipate the heat generated by the controller at its full ratings within the limits of the specified environmental operating conditions.
 3. LV door latches shall be heavy-duty, ¼-turn type units.
 4. Medium Voltage doors shall be held closed using 3/8" bolts.
 5. All back plates shall be removable.

- C. STRUCTURE FINISH

All exterior and interior metal parts, with the exception of power cell back plates and the low voltage panel) shall be painted ANSI 49 medium light

gray. All metal back plates in the power cell and low voltage compartments shall be painted high gloss white for greater visibility.

Description	Hybrid epoxy powder paint-high gloss
Color	ANSI 49 medium light gray
Procedure	Continuous paint line; all parts shall be painted prior to assembly.
Preparation	Alkaline wash/ rinse/iron phosphate rinse/iron-chrome sealer rinse/ re-circulate, de-ionized water rinse and virgin de-ionized water rinse.
Painting	Air-atomized electrostatic spray; total paint thickness 0.002” (0.051mm) minimum
Baking	Gas oven at 179degrees C

D. BUS BRACING

The vertical bus work and the cabling in the main power cell shall be braced and tested in accordance with NEMA ICS 3-2 and UL 347. The bus work and cabling shall be braced to withstand the let-through energy allowed by the largest fuse during a short circuit fault.

E. VERTICAL BUS

Vertical power bus risers shall be provided from the main horizontal power bus to the isolating switch line terminals. Cabling from the main horizontal power bus to the isolating switch is not acceptable. If cabling must be used, the cable shall be braced to withstand a fault condition.

F. GROUND BUS

A continuous copper ground bus shall be provided along the entire length of the controller line-up. A mechanical lug for #8 to #1/0 AWG or #6 to 250 MCM cable, as suitable, shall be supplied at the incoming end of the line-up. The ground bus shall be 6.4 x 51 mm (1/4 in. x 2 in.) bare copper.

2.4 EQUIPMENT DESIGN AND SELECTION

A. INPUT AND BYPASS CONTACTOR SPECIFICATIONS

The electrically held medium voltage contactor shall be Allen-Bradley Bulletin 1502 vacuum type, with the following ratings:

1. 400 A Rated Continuous Current

GET AIR BREAK CONTACTOR RATINGS

The contactor shall have visual contact wear indicators; no special tools shall be required for checking contact wear.

B. ISOLATION CONTACTOR

The input contactor shall be fixed mounted inside the power cell. The contactor shall be interlocked with the non-load-break isolating switch, both electrically and mechanically, and shall provide the following safety features:

1. Prevent isolating switch from being opened or closed when the contactor is in the closed position.
2. Prevent the opening of the medium voltage door when the isolating switch is in the closed position.
3. Prevent the closing of the isolating switch when the medium voltage door of the controller is open.
4. Remove power from the control power transformer (CPT), power transformers (PTs) or external power source to the control circuit when the isolating switch and contactor are in the open position.

C. BYPASS CONTACTOR

A contactor shall be provided to bypass the SCRs once the motor is up to full speed. When a stop option is selected, the bypass contactor shall open, bringing the SCRs back into the power circuit. It shall be fixed mounted in the main power cell.

D. CONTROL WIRE SPECIFICATIONS

1. The control wire shall be, insulated with a flame retarding thermoplastic compound, flexible stranded, tinned copper, supported and neatly bundled. Red wire shall indicate AC control, blue wire shall indicate DC control, and green wire shall indicate ground. Other colors or combinations may be used for specific applications. The control wire shall be isolated from high voltage components in the power cell, whenever possible, and wire markers which are numbered according to the electrical diagram, shall be provided at each end of the wire.
2. All of the control wire terminations shall be a screw-type copper-compression-type terminal block or connector that firmly grips the conductor. Non-insulated, locking type, fork tongue lugs shall be provided on the control wire terminating on the control power transformer and current transformers.

E. LOW VOLTAGE CONTROL PANEL

Each controller shall have a separate, front accessible, low voltage control compartment. The compartment shall be completely isolated, using metal barriers between the low voltage compartment and the power cell and/ or main power bus compartments for safety.

Meters, motor protection relays, selector switches, operators, indicating lights, etc., shall be mounted on the front of the low voltage control panel and arranged in a logical and symmetrical manner. The low voltage panel shall provide the following features:

1. Space shall be provided for low voltage control devices, transducers, and metering.
2. Terminal blocks shall be provided as needed.
3. Low voltage panel access shall be provided, without turning the controller "OFF" when opening the low voltage control panel door.
4. All remote shall be able to enter the structure from the top. Access to wireways shall be by means of removable entry plates on the top and bottom of the structure.
5. Combination controllers shall incorporate a swing-out low voltage panel to provide easier access to the power cell to make bus splicing and load cable connections. All products shall have a swing-out low voltage panel, that is interlocked with the power cell compartment (the panel shall not have the ability to swing open until the power is "OFF" and isolated from the main power bus) to facilitate access to medium voltage equipment.
6. Pilot control relays shall be used to operate and economize the contactor.
7. The control panel supply voltage shall be 120 VAC, 60 Hz. It shall be rectified to provide a DC operating voltage for the contactor coils and economizing relay.
8. There shall be a two-pole, three-conductor (with a grounding prong) male plug to provide a two-pole, three-conductor receptacle from a remote 120 VAC, 60 Hz supply to operate the control circuit when it's in the TEST position.
9. The low voltage control panel door shall have a viewing window, to allow monitoring of the MV RVSS-Flex controller operation via the built-in display.

F. INTELLIVAC CONTROL

IntelliVAC contactor control shall be provided with the following features:

1. Universal input voltage (110-240 V AC, 60 Hz or 110-250 V DC)
2. Consistent contactor pick-up time
3. Selectable and repeatable contactor drop-out time
4. Altitude compensation

5. Power loss ride-through (TDUV)
6. Temporary motor jog function
7. Delayed motor restart
8. Anti-kiss and anti-plugging protection
9. Status indication (LEDs and relay outputs)
10. Field upgrade capability to IntelliVAC Plus

G. MAIN ISOLATING SWITCH

The main power cell shall have an externally operated, three-pole, gang-operated, fixed mounted, non-load-break isolating switch providing the following features:

1. The isolating switch shall isolate the power bus compartment from the power cell by means of a positively driven shutter mechanism to prevent accidental contact with the line terminals in the power bus compartment.
2. The main power cell door shall have a viewing window through which the operator can verify that the isolating switch is open.
3. The isolating switch shall the ability to only interrupt the no-load (magnetizing) current of the control power transformer (CPT) and potential transformers (PTs) supplied inside the controller power cell.
4. In the OFF position, the isolating switch shall provide a means of grounding appropriate medium voltage power cell components, bleeding off hazardous stored energy, to provide safe operation and maintenance.
5. Main isolation switch shall be rated 400 A.
6. Normally open (N.O.) and normally closed (N.C.) auxiliary contacts shall be provide and arranged to open the secondary circuit of the control power transformer (CPT) and potential transformers (PTs) to de-energize the control circuit. This to ensure there is no load on the isolating switch when it is opened or closed and to prevent backfeeding through the CPT and/or PTs and isolate the power cell, when the control circuit is in the TEST mode. It shall only be possible to operate the TEST control circuit when the isolating switch is open.
7. The isolating switch shall remain connected to the external operating handle at all times.
8. The isolating switch must be electrically and mechanically interlocked with the main contactor.
9. The external isolating switch shall have provisions to be padlocked, with up to three padlocks in the open position, and one padlock in the closed position.
10. The power cell door on each controller shall be interlocked with the isolating switch such that the door cannot be opened when the isolating switch is fully closed, and the isolating switch cannot be

closed with the door open (without circumventing the interlock using a tool).

H. INTERLOCKING

1. Mechanical interlocking, including cable interlocks, horizontal and vertical ram interlocks, shall be provided to prevent the opening of any power cell door or medium voltage compartment until the non-load-break isolating switch is fully in the open position and power is removed (the external operating handle must be in the OFF position).
2. Key interlocks shall be configured to operate with the operating handle or power cell door shall be provided for interlocking with the main breaker.

I. POWER FUSES AND FUSE HOLDERS

1. R-rated current limiting power fuses shall be provided. R-rated fuses shall be used for the short circuit protection of medium voltage motors and motor controllers.
2. The MV RVSS shall have fixed power fuse holders that are separately mounted in the power cell, not on the contactor, and shall be located to facilitate inspection and replacement without any disassembly. The power fuses shall have a spring actuated blown fuse indicator. The power fuse size shall be selected when the motor data and the protective device characteristics are known.

J. CONTROL POWER TRANSFORMER

1. The control power shall be 110/120 VAC, and shall be obtained from a control power transformer (CPT) located in each controller power cell. The dry-type CPT shall be 500VA in size and shall have primary and secondary fuses.
2. The secondary circuit of the transformer shall be disconnected from the control circuit by means of isolating switch auxiliary contacts, in order to prevent backfeeding through the transformer and to isolate the power cell when the control circuit is in TEST mode.
3. The control power transformers shall be compensated type with output accuracy of approximately 4% over nominal at no load. They shall be designed to maintain voltage at inrushes of up to 600%, which results in a 2% over-voltage at full load.

K. PRIMARY FUSES

1. The primary side of the control power transformer and/or potential transformers shall be protected by current limiting fuses sized in accordance with requirements. The interrupting rating of the primary fuses shall be 50kA symmetrical.

L. SECONDARY FUSES

1. The secondary side of the control power transformer and/or potential transformers shall be fused appropriately to protect the transformer from overloads. The standard control circuit shall have one leg of the secondary grounded.

M. CURRENT TRANSFORMERS

1. The medium voltage power cell shall include three (3) current transformers of sufficient VA capacity to meet the requirements of all devices connected to them.
2. Each current transformer shall have the primary rating sized appropriately in relation to the full load current rating of the motor or feeder. The secondary of the current transformers shall have a five (5) ampere output and accuracy suitable for the type and quantity of protection or metering devices connected to it. All current transformer control wiring shall be terminated on the current transformer with locking-type, fork tongue lugs.
3. An appropriate load termination location shall be provided to accommodate lugs with single or two-hole mounting, for connection of the load cables, when either bar or donut-type current transformers are supplied.
4. The power cell shall have provisions to locate a toroid style ground fault sensing current transformer, when the optional ground fault sequence ground fault protection is required.

N. CONTROL MODULE-LOGIC DESIGN FEATURES

1. Mechanical – The control module shall be designed for mounting within the low voltage panel and shall be compatible with the full range of current and voltage ratings.

The control module shall consist of a power supply, logic control circuitry, silicon controlled rectifier (SCR) firing circuitry, I/O circuitry, digital programming keypad, backlit LCD display, and serial communication port.

2. Programming and Display – Digital parameter adjustment shall be provided through a built-in keypad; analog potentiometer adjustments are unacceptable. A built-in backlit LCD display shall be provided for controller set-up, diagnostics, status, and monitoring. The display shall be three-line, 16 characters minimum.

The display shall be programmed to display alphanumeric characters in English, and shall be capable of displays in a variety of other languages, by adjustment of a single parameter.

3. Communications – A serial communications port (DPI) shall be provided in addition to a module for Ethernet communication.
5. Electrical – The control module shall provide closed-loop digital microprocessor control and supervision of all controller operations, including SCR pulse firing control.
6. Control Modes – The control module shall offer the following features:
 - a. Soft Start - with Selectable Kickstart
 - b. Soft Stop
 - c. Current Limit Start – with Selectable Kickstart
 - d. Dual Ramp – with Selectable Kickstart
 - e. Full Voltage
7. Monitoring – The controller shall provide the following monitoring functions indicated through the built-in LCD display.
 - a. Phase-to-phase supply voltage
 - b. Three-phase line current
 - c. Three-phase power (MW, MWh, power factor)
 - d. Elapsed Time
 - e. Motor thermal capacity usage
 - f. Motor speed
8. Protection and Diagnostics – The following protection and diagnostics shall be provided with the controller:
 - a. Power loss (with phase indication; prestart)
 - b. Line fault (with phase indication; prestart) advising: -Shorted SCR
 - c. Missing load connection
 - d. Line fault (running protection) advising: -Shorted SCR
 - e. Voltage unbalance
 - f. Phase reversal

- g. Undervoltage
- h. Overvoltage
- i. Stall
- j. Jam
- k. Overload
- l. Underload
- m. Open gate (with phase indication)
- n. Overtemperature (power stack, with phase indication)
- o. Communication loss
- p. Motor temperature
- q. Power loss (with phase indication; prestart)
- r. Line fault (with phase indication; prestart) advising: -Shorted SCR
- s. Missing load connection
- t. Line fault (running protection) advising: -Shorted SCR
- u. Voltage unbalance

Overload Protection shall include:

- a. The control module shall meet applicable standards as a motor overload protective device
- b. Three-phase current shall be utilized
- c. Overload trip classes of 10, 15, 20, and 30 shall be provided and user-programmable
- d. Electronic thermal memory shall be provided for enhanced motor protection
- e. Protection shall be available through the controller while in bypass configuration

O. SCR POWER CIRCUIT DESIGN

1. The SCRs shall be protected from voltage transients with an R-C snubber network to prevent false SCR firing.
2. The SCRs shall be protected from overvoltage with voltage threshold gating circuitry.
3. The SCR firing circuitry shall be fully isolated from the control circuits. Fiber optic cables shall be used for isolation from the logic circuits.
4. Current loop gate drivers shall be utilized to increase efficiency of the controller, reducing power consumption and heat.
5. The SCRs shall have a dv/dt rating of 2000V/ microsecond and a di/dt rating of 200 A/ microsecond. Designs that use lower rated shall include an integral input line reactor for SCR protection.
6. The SCR power stack shall have a PIV rating of 13,000 V for a 5kV unit.

P. POWER WIRE SPECIFICATION

1. The power cell shall be wired with the appropriate size of power wire based on the controller current rating. Power wire shall be rated for 8.0 kV.

Q. MOTOR PROTECTION DEVICES

1. Each starter unit shall be supplied with a GE Multilin 469 Motor/Feeder Protection relay with Ethernet capability. The overload protection relay shall be connected to the secondary of the three (3) current transformers.

R. UNDERVOLTAGE PROTECTION

1. Instantaneous undervoltage protection shall be provided with the ability to be configured to include time delay to keep electrically held contactors closed during a voltage dip or brief power loss. If the undervoltage condition persists beyond the set time delay time, the contactor shall open and an undervoltage fault condition shall occur.

S. SYNCHRONOUS CONTROL (BRUSH TYPE)

1. A 250 VDC static exciter shall be provided for each of the existing brush-type synchronous motors and shall be sized based on the motor information included in these specifications.
2. The assembly shall be either three phase or single phase depending on the output current requirements, with integral single or three phase firing board.
3. The bridge rectifier shall incorporate a solid state field switch mounted directly on the bridge assembly. The switch shall remove the discharge resistor connection at the appropriate time; an integral field switch snubber assembly shall be provided to provide protection and diagnostics for proper operation of the solid state switch.
4. The exciter shall be regulated using a closed loop feedback from the DC field current. This provides a constant current based on the user setting. The following items shall be included:
 - a. A DC current transducer (DCCT) shall be used to measure current
 - b. A field current adjustment potentiometer shall be provided on the front of the door
 - c. A 3 1/2" field DC ammeter shall be provided on the front of the door

T. RECTIFIER TRANSFORMER

1. The rectifier transformer shall be of the dry type with 25kV BIL rating minimum. It shall be integral to the controller and sized according to the field and rectifier bridge load requirements.
2. The transformer shall be energized/de-energized by the MV contactor.
3. Appropriately sized primary and secondary fuse protection shall be provided; main power fuses for the motor controller shall not be used as the primary protection for the rectifier transformer.

U. FIELD DISCHARGE RESISTOR

1. The field discharge resistor shall be mounted internal to the main structures, space permitting. If the resistor is too large to be mounted internally, it shall be mounted on the roof of the structure in a protective enclosure.
2. The resistor shall be steel grid or wire edge wound type and shall be based on the motor data provided by the City.

V. FIELD APPLICATION AND PROTECTION

1. An Allen-Bradley SyncProII programmable field application and protection system shall be provided to provide supervisory protection and field control to the brush-type synchronous motor controller, proper field application timing, squirrel-cage protection against long acceleration and stall conditions, as well as pull-out protection by monitoring power factor.
2. The SyncPro II system shall consist of a Rockwell Automation Micrologix 1200 programmable small logic controller, with the following additional peripheral items:
 - a. PanelView 300
 - b. Phase Angle Transducer
 - c. Analog/Digital Pulse board
 - d. Conditioning Resistors
 - e. Interposing Relays FCR and ESR
 - f. Specialized firmware for synchronous control and protection
3. The system shall provide the following protection and control:
 - a. Squirrel-cage winding protection
 - b. Field winding application control
 - c. Incomplete sequence
 - d. Field voltage failure
 - e. Auto load
 - f. Stall protection
 - g. Pull-out protection (power factor)
 - h. Restart lockout
4. The field application and control system, in conjunction with the PanelView 300 Micro Terminal, shall perform the following metering and display functions:

- i. Display all detected fault conditions
 - ii. Display the slip frequency and starting time during startup
 - iii. Display the power factor during run mode
 - iv. Accept set points for the following:
 - Maximum % of synchronous speed
 - Power factor set point and trip delay
 - Maximum allowable time at stalled state
 - Maximum allowable time at 50% speed
 - Maximum allowable time at synchronizing speed
 - Function order
 - Incomplete sequence timer trip delay
 - Fault mask for PF transducer diagnostics
5. The SyncProII application and control system shall operate on an input line voltage of between 115 and 230 V AC, +/- 10 % at 60 Hz.