

SP- 127036  
(New)



# Iowa Department of Transportation

## SPECIAL PROVISIONS FOR ELECTRICAL SYSTEM

Dubuque County  
SB-IA-2100(765)--7T-31

Effective Date  
September 15, 2015

THE STANDARD SPECIFICATIONS, SERIES 2012, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

## GENERAL ELECTRICAL REQUIREMENTS

### PART 1–GENERAL

#### 1.1 SUMMARY

- A. Work includes general requirements for all electrical work.

#### 1.2 REFERENCES

- A. ANSI/NFPA 70–National Electrical Code.
- B. ANSI/IEEE C2–National Electrical Safety Code.

#### 1.3 CONTRACT DOCUMENTS

- A. Any equipment roughed in improperly and/or not positioned on implied centerlines or as dictated by good practice shall be repositioned at no cost to Contracting Authority.
- B. The drawings are generally diagrammatic, and Contractor shall coordinate the work so that interferences are avoided. Provide all offsets in conduit, fittings, etc., necessary to properly install the work. All offsets, fittings, etc., shall be provided without additional expense to Contracting Authority.

#### 1.4 REGULATORY REQUIREMENTS

- A. Conform to ANSI/NFPA 70.
- B. Conform to ANSI/IEEE C2.
- C. The rules and regulations of the federal, state, local, and civil authorities and utility companies in force at the time of execution of the Contract shall become a part of this specification.
- D. Obtain electrical permits and inspections from authority having jurisdiction. Costs for permits and inspections shall be by Contractor.

#### 1.5 CODES AND ORDINANCES

- A. Contractor is expected to know or to ascertain, in general and in detail, the requirements of all codes and ordinances applicable to the construction and operation of systems covered by this Contract. Contractor shall know or ascertain the rulings and interpretations of code requirements being made by all authorities having jurisdiction over the work to be performed by them.
- B. In preparing Bid, Contractor shall include the cost of all items and procedures necessary to satisfy the requirements of all applicable codes, ordinances, and authorities, whether or not these are specifically covered by the drawings and specifications. All cases of serious conflict or omission between the drawings, specifications, and codes shall be brought to Engineer's attention, as herein before specified. Contractor shall carry out work and complete construction as required by applicable codes and ordinances and in such a manner as to obtain approval of all authorities whose approval is required.
- C. When requested by Engineer, Contractor shall provide written calculations to show

compliance with applicable codes or the Contract Documents. This shall include, but not be limited to, conduit and wire sizing, junction and pull box fill and sizing, handhole sizing, conductor derating, and voltage drop. Contractor shall indicate calculation method used as well as compliance with applicable code, drawing, or specification.

#### 1.6 EQUIPMENT PROVIDED UNDER OTHER SPECIAL PROVISIONS

- A. Included in this Contract are electrical connections to equipment provided under other special provisions. Contractor shall refer to final shop drawings for equipment being furnished under other Special Provisions, for exact location of electrical equipment, and the various connections required.

#### 1.7 ELECTRICAL DISTRIBUTION SYSTEM

- A. Provide a complete electrical distribution system consisting of components indicated on the drawings or specified herein including, but not limited to:
  - 1. All miscellaneous equipment coordination and related appurtenances required by power company.
  - 2. Feeders, branch wiring, and electrical distribution equipment.
  - 3. 120/240-volt, single-phase, 3-wire service entrance conductors.
  - 4. All control wiring.
  - 5. Network cabling and components.
  - 6. Access panels and access doors for access to equipment installed under this Special Provision.
  - 7. Wiring between system components if equipment is not prewired.
  - 8. Lighting fixtures, lighting controls, and associated wiring.
  - 9. Support system design and supports for electrical raceways.
  - 10. Code-required disconnects.
- B. Contractor shall connect the following equipment furnished under other Special Provisions consisting of components indicated on the drawings or specified herein, including, but not limited to:
  - 1. Irrigation Pumping Station.
  - 2. Flag pole lighting.
  - 3. Valve heaters.
- C. Provide balancing and adjusting of electrical loads.
- D. Contractor shall instruct Contracting Authority's representative in the operation and maintenance of all equipment. The instruction shall include a complete operating cycle on all apparatus.
- E. Provide miscellaneous items for a complete and functioning system as indicated on the drawings and specified herein.
- F. A partial list of work not included in this Special Provision is as follows: Painting (except as otherwise specified herein).

#### 1.8 NOISE

- A. Eliminate any abnormal noises that are not considered by Engineer to be an inherent part of the systems as designed. Abnormal buzzing in equipment components will not be acceptable.

## 1.9 DRAWINGS

- A. The drawings indicate approximate locations of the various items of the electrical systems. These items are shown approximately to scale and attempt to show how these items should be integrated with construction. Locate all the various items by on-the-job measurements in conformance with contract documents and cooperation with other trades.
- B. Prior to locating equipment, confer with Engineer as to desired location in the various areas. In no case should equipment locations be determined by scaling drawings. Relocate equipment and bear cost of redoing work or other trades' work necessitated by failure to comply with this requirement.
- C. In certain instances, receptacles, switches, light fixtures, or other electrical devices and equipment, etc., may be relocated. Where relocation is within 10 feet of location shown on the drawings, and when Contractor is informed of necessary relocation before work is begun on this portion of the job, the relocation shall be at Contractor's expense.
- D. The drawings are schematic in nature and are not intended to show exact locations of conduit, but rather to indicate distribution, circuitry, and control.

## 1.10 EXISTING UNDERGROUND UTILITIES

- A. Record drawings of existing underground electrical utilities are not available. Contractor shall excavate and verify the location of all underground electrical prior to installing new electrical equipment. This shall include, but not be limited to, feeders to pathway control cabinets and equipment, branch circuit wiring, phone and communication cabling, instrument wiring, and control wiring. Contractor shall temporarily relocate existing underground electrical to keep existing facilities in operation and for any new construction, and all costs for relocating existing electrical shall be included in the Bid.

## 1.11 SUBMITTALS

- A. Contractor shall submit to Engineer for approval prior to beginning work, shop drawings on the equipment and materials proposed to be furnished and installed. See Submittals section for requirements.
- B. Contractor shall, in addition, submit drawings and/or diagrams for review and for job coordination in all cases where deviation from the contract documents are contemplated because of job conditions, interference or substitution of equipment, or when requested by Engineer for purposes of clarification of Contractor's intent. Contractor shall also submit detailed drawings, rough-in sheets, etc., for all special or custom-built items or equipment. Drawings and details under this section shall include, but not be limited to, the following, where applicable to this project:
  - 1. Electrical interconnection wiring diagrams; see Controls and Instrumentation.
  - 2. Major feeder and conduit routing in plan and elevation, including service entrance raceways and cable.
- C. These drawings and diagrams shall show all electrical switch and breaker sizes as well as the manufacturer's name and catalog number for each piece of equipment used.
- D. Equipment and material submittals must show sufficient data to indicate complete compliance with contract documents as follows:

1. Proper sizes and capacities.
  2. That the item will fit in the available space in the manner that will allow proper service.
  3. Construction materials and finishes.
- E. When the manufacturer's reference numbers are different from those specified, provide correct cross-reference number for each item. The shop drawings shall be clearly marked and noted accordingly.
- F. When fixtures, equipment, and items specified include accessories, parts, and additional items under one designation, shop drawings shall be complete and include all components.

## PART 2-PRODUCTS

### 2.1 STANDARD PRODUCTS

- A. All equipment shall be UL and NEMA approved.
- B. Unless specified otherwise, major distribution equipment such as panelboards, SPD, control cabinets, etc., shall each be by the same manufacturer.
- C. All equipment and wiring shall be selected and installed for conditions in which it will perform (e.g., general purpose, weatherproof, raintight, dustproof, or any other special type).

### 2.2 SUBSTITUTION OF MATERIALS AND EQUIPMENT

- A. While it is not the intention of Contracting Authority to discriminate against any manufacturer of equipment which may be equivalent to specified equipment, a strict interpretation of such equivalency will be exercised in considering any equipment offered as a substitute for specified equipment. Contractor shall submit with each request for approval of substitute material or equipment sufficient data to show conclusively that it is equivalent to that specified in the following respects:
1. Performance:
    - a. Capacity at conditions and operating speeds scheduled shall be equal to or greater than that of the specified equipment.
    - b. Energy consumption at the point of rating shall not exceed that of the specified equipment.
    - c. Vibration and noise production at the point of rating shall not exceed that of the specified equipment.
  2. Materials of construction.
  3. Gauges, weights, and sizes of all portions and component parts.
  4. Design arrangements, methods of construction, and workmanship.
  5. Coatings, finishes, and durability of wearing parts.
  6. National reputation of the manufacturer as a producer of first quality equipment of the type under consideration.
  7. Availability of prompt, reliable, and efficient service facilities franchised by or affiliated with the equipment manufacturer. This shall include the maintenance of local stocks of critical replacement parts equal to those maintained for the specified equipment.
- B. Requests for substitution shall include Contractor's reason for the request.

- C. If Engineer does not consider the items equivalent to those specified, Contractor shall provide those specified.
- D. See General Conditions for additional requirements.

### PART 3-EXECUTION

#### 3.1 UTILITY SERVICES

- A. Utility connection requirements shall be determined. All costs for coordinating utility services shall be included in the price bid as described in Electrical Service System of these specifications.
- B. All costs for temporary service, temporary routing of piping, or any other requirements of a temporary nature associated with the utility services shall be included in the Base Bid.
- C. It is the intent that in the latter stages of construction, the permanent electrical services will be used and the temporary construction services discontinued. The following requirements shall govern the use of the permanent services:
  - 1. No permanent service shall be available until the pathway control cabinet is installed.
  - 2. Only permanently connected and protected circuits and outlets shall be available.
  - 3. Temporary wiring shall not be connected to permanent distribution equipment.
  - 4. Under the above conditions, the use of permanent service equipment shall in no way affect the Contract conditions of the guarantee.
- D. It shall be Contractor's responsibility to police this situation and protect its equipment.

#### 3.2 CONTINUITY OF SERVICE

- A. Contractor shall provide and maintain continuous services (power, controls, alarms, etc.) during the entire construction period.
- B. No service shall be interrupted or changed without permission from Engineer. Written permission shall be obtained before any work is started.
- C. When interruption of service is required, all persons concerned shall be notified and a prearranged time agreed upon. Notice shall be a minimum of 72 hours prior to the interruption.

#### 3.3 CLEANING UP AND REMOVAL OF RUBBISH

- A. All lighting and appliance panelboards, junction boxes, and pullboxes shall be cleaned of debris and wires neatly arranged with surplus length cut off prior to installation of covers.
- B. All lighting fixture lenses shall be cleaned at time of installation, and all lens exteriors shall be cleaned just prior to final inspection.
- C. Equipment shall be thoroughly cleaned of all stains, paint spots, dirt, and dust. All temporary labels not used for instruction or operation shall be removed.

### 3.4 CONCRETE WORK

- A. All cast-in-place concrete for new electrical equipment bases shown on the drawings shall be provided by Contractor, except where specifically noted to be provided by others. All new equipment shall be set on 3 1/2 inch minimum leveling slabs including pathway control cabinets, free-standing enclosures, etc. Pads shall be 3 inches larger than equipment being supported.
- B. Provide all anchor bolts, metal shapes, and templates to be cast in concrete or used to form concrete for support of electrical equipment.

### 3.5 PAINTING

- A. All painting of electrical equipment shall be done by Contractor unless equipment is specified to be furnished with factory-applied finish coats.
- B. All electrical equipment shall be provided with factory-applied prime finish, unless otherwise specified.
- C. If the factory finish on any equipment furnished by Contractor is damaged in shipment or during construction, the equipment shall be refinished by Contractor.
- D. One can of touch-up paint shall be provided for each different color factory finish which is to be the final finished surface of the product.

### 3.6 CAULKING

- A. Caulk with a caulking sealant where indicated on the electrical drawings or hereinafter specified.
- B. Caulking sealant shall be silicone construction sealant as manufactured by General Electric or two-part polysulfide conforming to the requirements and bearing the seal of the Thiokol Chemical Corporation.
- C. Caulking sealant shall contain no acid or ingredients that will stain stone, corrode metal, or have injurious effect on painting. It shall be colored to match adjacent surroundings.
- D. Caulking shall be performed by craftsman skilled at such work.

### 3.7 COORDINATION

- A. Provide wiring for all electrically powered or electrically controlled equipment.
- B. All disconnects, relays, wire, conduit, and other devices for the power and control of electrical equipment shall be provided by Contractor except as specifically noted elsewhere in these specifications or on the drawings.
- C. Where other devices are provided by others, they shall be connected and wired by Contractor.
- D. Contractor shall provide all line voltage power and control wiring (100 volts and above). Low-voltage control wiring (below 100 volts) shall be provided by Contractor supplying the equipment that has low-voltage wiring, unless otherwise noted. Contractor shall provide raceways for ALL low-voltage wiring.

- E. Contractor shall connect and wire all apparatus according to approved wiring diagrams furnished by the various trades.

### 3.8 EXCAVATION AND BACKFILL

- A. Backfilling of all trenches beneath concrete shall be accomplished with gravel fill and shall be specially compacted to same density as surrounding area. Backfill of exterior trenches shall be compacted granular fill, unless otherwise noted. Compaction shall meet the requirements of Excavation, Fill, Backfill, and Grading. Refer to Conduit for additional requirements associated with PVC conduit installed in earth.
- B. Care shall be taken to ensure no disturbance of bearing soil under foundations.
- C. Contractor shall follow underground pipe runs where possible to avoid additional rock excavation.

### 3.9 EQUIPMENT ACCESS AND LOCATION

- A. Contractor shall coordinate work of this Special Provision with that of other Special Provisions so that all systems, equipment, and other components will be installed at the proper time, will fit the available space, and will allow proper service access to those items requiring maintenance. This means adequate access to all equipment not just that installed under this Special Provision. Any components for the electrical systems that are installed without regard to the above shall be removed and relocated as required to provide adequate access at Contractor's expense.
- B. Where various items of equipment and materials are specified and scheduled, the purpose is to define the general type and quality level, not to set forth the exact trim to fit the various types of ceiling, wall, or floor finishes. Provide materials that will fit properly the types of finishes actually installed.
- C. All equipment, junction and pull boxes, and accessories shall be installed to permit access to equipment for maintenance. Any relocation of conduits, equipment, or accessories to provide maintenance access shall be accomplished by Contractor at no additional cost.
- D. Electrical equipment, devices, instruments, hardware, etc., shall be installed with ample space allowed for removal, repair, calibration or changes to the equipment. Ready accessibility to equipment and wiring shall be provided without moving other equipment that is to be installed or that is already in place.

### 3.10 WORKMANSHIP

- A. Install work using procedures defined in NECA Standard of Installation.
- B. Location of process equipment as shown on the drawings is approximate.
- C. Utilization equipment and control devices required under these specifications shall be mounted in a code-approved manner.
- D. Locations of utilization equipment and control devices as shown on drawings are within 10 feet of actual positions. Any mounting of this equipment within this 10 foot distance will be performed at no additional cost to Contracting Authority.



- E. Unless otherwise noted, equipment shall be fastened to equipment framework and not placed on the floor.
- F. Where materials, equipment apparatus, or other products are specified by manufacturer, brand name, and type or catalog number, such designation is to establish standards of desired quality and style and shall be the basis of the Bid.
- G. Materials and equipment of the types for which there are National Board of Fire Underwriters Laboratories (UL) listing shall be so labeled and shall be used by Contractor.

## WIRE

### PART 1–GENERAL

#### 1.1 SUMMARY

- A. Work Included:
  - 1. Wire.
  - 2. Terminal blocks and accessories.
  - 3. Wiring connections and terminations.

#### 1.2 QUALITY ASSURANCE

- A. Manufacturers of Wire: Firms regularly engaged in the manufacture of electrical wire products of the types and ratings needed whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer: A firm with at least 5 years of successful installation experience on projects with electrical wiring installation work similar to that in this project.
- C. Code Compliance: Comply with National Electrical Code (NFPA 70) and any and all local codes as applicable to construction and installation of electrical wiring devices, material, and equipment herein specified.
- D. UL Labels: Provide electrical raceways, wire, connectors, outlets, switches, etc., which have been listed and labeled by Underwriters Laboratories.
- E. NECA Standard: Comply with applicable portions of National Electrical Contractor's Association's "Standard of Installation."

#### 1.3 SUBMITTALS

- A. Submit shop drawings and product data under the provisions of Submittals section.
- B. Submit shop drawings for wiring system including layout of distribution devices, branch circuit conduit and cables, circuiting arrangement, and outlet devices.
- C. Submit manufacturer's instructions.

#### 1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Provide factory-wrapped, waterproof, flexible-barrier material for covering wire on wood reels, where applicable, and weather-resistant fiberboard containers for factory-packaging of wire, connectors, outlets, boxes, lamps, fuses, etc., to protect against physical damage in transit. Do not install damaged wire or other material; remove from project site.
- B. Store wire and other material in factory-installed coverings in a clean, dry, indoor space which provides protection against the weather.

#### 1.5 MEASUREMENT AND PAYMENT

- A. All Work of this Special Provision is incidental to the lump sum Electrical bid item.

PART 2-PRODUCTS

## 2.1 WIRE

- A. All wire for permanent installation shall be new stranded copper delivered to project in unopened cartons or reels, except where specifically noted and be UL listed for the use intended. No wire smaller than No. 12 AWG shall be used unless specifically noted. The use of multiconductor cable is not allowed.
- B. All wiring within pathway control cabinets that does not extend outside of the enclosure or pathway control cabinet shall be insulation type MTW, minimum size No. 16 AWG.
- C. All wiring that extends outside of pathway control cabinets shall be XHHW-2.
- D. All available colors shall be used; however, green shall be used only for equipment grounds. Where color-coded wire in larger sizes is not available, one wrap of 1 inch wide colored self-adhesive tape at each terminal end shall be used for identification. Initial phase color shall be used throughout the run, even for switch legs. Colors must meet code requirements for each class voltage. Do not duplicate colors, including neutral, on different voltages.
- E. Color Coding:

	120/240 V
A Phase	Black
B Phase	Red
Neutral	White
Travelers	Yellow
Equipment Ground	Green

- F. Branch circuit wiring for exterior lights and receptacles shall be minimum No. 10 AWG. Circuits 150 feet or over shall be sized for a maximum 2% voltage drop.

## 2.2 WIRING CONNECTIONS AND TERMINATIONS

- A. Provide crimp type UL or ETL listed terminations for No. 6 AWG and smaller stranded conductor connections to electrical devices and equipment such as receptacles, switches, and terminal strips. Crimp devices shall be Sta-kon, or equal.
- B. Provide insulated, silicone-filled spring wire connectors with plastic caps for No. 8 AWG conductors and smaller. Connectors shall be King Silicone-Filled Safety Connectors, or equal. Spring wire connectors shall only be allowed in junction, outlet, or switch boxes.
- C. No splices will be allowed unless reviewed by Engineer or shown on drawings. Where allowed, provide in-line splices for all conductor connections, No. 4 AWG and larger. Splice shall be made with NSi Industries Easy-Splice Gel Tap Splice Kit Model ESGTS Series, or equal. Splice kit shall include sealant gel, hinged splice enclosure, and be rated up to 1000 volts.

## 2.3 TERMINAL BLOCKS AND ACCESSORIES

- A. Terminal Blocks: ANSI/NEMA ICS 4: UL listed.
- B. Power Terminals: Unit construction type, closed-back type, with tubular pressure screw connectors, rated 600 volts.
- C. Signal and Control Terminals: Modular construction type, channel mounted; tubular pressure screw connectors, rated 300 volts, as manufactured by Phoenix Contact Model UK 5 N, or equal. Multi-level terminal blocks are not allowed.

## PART 3-EXECUTION

### 3.1 INSPECTION

- A. Examine the areas and conditions under which the work is to be installed and notify Contractor of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

### 3.2 GENERAL WIRING METHODS

- A. Install electrical wire and connectors in accordance with the manufacturer's written instructions, applicable requirements of the NEC, the National Electrical Contractors Association's "Standard of Installation," and in accordance with recognized industry practices to ensure that products serve the intended functions. Use appropriate wiring methods and materials for the equipment or environment.
- B. Stranded conductors shall be terminated using crimp-type devices specified herein. Conductors may not be wrapped around a terminal screw.
- C. Place an equal number of conductors for each phase of a circuit in same raceway.
- D. Torque conductor connections and terminations with calibrated torque wrench to manufacturer's recommended values. Provide permanent marking on lug, bolt, nut, or connection for conductors larger than No. 4 AWG.
- E. Splice only in junction boxes, outlet boxes, or handholes. Splicing is not allowed in pathway control cabinets, light poles, etc. Avoid splices between terminals of interconnecting power and control wiring.
- F. Spring wire connectors shall only be used in junction, outlet, or switch boxes. Equipment wireways, pathway control cabinets, and light poles shall not have any spring-wire connectors installed; all terminations shall be on terminal strips.
- G. Neatly train, lace, and tie wrap all wiring inside boxes, equipment, and panelboards.
- H. Make conductor lengths for parallel circuits equal.
- I. The same color shall be used for each numbered wire throughout its entire length.
- J. Terminate all wiring on terminal blocks in control panels, pathway control cabinets, and similar equipment. This shall include all spare or unused wires.

- K. Provide preprinted adhesive or heat shrink-type wire numbering labels at all terminations and splices. Wire numbering preprinted on the conductor, flag-type labels, and individual wraparound numbers (e.g., Brady labels) are not acceptable.
- L. Provide a dedicated neutral for each branch circuit or feeder requiring a neutral. Ampacity of neutral conductor shall match that of the branch circuit or feeder.
- M. Do not use a pulling means that can damage the raceway.
- N. Signal wiring (below 100 volts) and intrinsically safe wiring must be in a conduit separate from power and/or control wiring (over 100 volts). Signal wire shall include, but not be limited to, loop-powered devices, voice and data communications, and communication wiring (i.e., DeviceNet, RS-232, etc.). Analog wiring shall be in a conduit separate from all other wiring. Intrinsically safe wiring shall be separated and identified in accordance with Article 504 of the NEC.
- O. Provide junction or pull boxes to facilitate the "pulling in" of wires or to make necessary connections. All raceways and apparatus shall be thoroughly blown out and cleaned of foreign matter prior to pulling in wires.
- P. Thoroughly clean wires before installing lugs and connectors.
- Q. Make splices, taps, and terminations to carry full capacity of conductors without perceptible temperature rise.
- R. Terminate spare conductors within equipment, pathway control cabinets, etc., on terminal strips and label as "SPARE." Spare wiring in pull or junction boxes may be terminated with electrical tape and labeled as "SPARE." All spare conductor labels shall indicate where the conductors terminate. Refer to Electrical Identification, for additional requirements.

### 3.3 WIRING INSTALLATION IN RACEWAYS

- A. Pull all conductors into a raceway at the same time. Use UL-listed wire-pulling lubricant for pulling No. 4 AWG and larger wires. Wax-based pulling lubricant is not allowed unless it includes a Teflon additive.
- B. Install wire in raceway after all mechanical work likely to injure conductors has been completed.
- C. Completely and thoroughly swab raceway system before installing conductors.
- D. Conductors No. 6 AWG and larger shall be pulled into conduits utilizing a tugger with built-in tension meter. Contractor shall provide a report to Engineer for each pull indicating maximum tension reached during the pull along with manufacturer's maximum pulling tension. Motorized machines of any type are not allowed for any wire pulling.
- E. Conductors shall be installed in conduit system in such a manner that insulation is not damaged, conductors are not overstressed in pulling, and walls are not damaged. No splices are permitted except in junction boxes, outlet boxes, or handholes.
- F. Contractor shall observe code limitation on the number and size of wires in an outlet box. Contractor shall either lay out work so that the wires do not exceed the particular box limitation or provide larger boxes approved for additional capacity.

- G. Circuiting is indicated diagrammatically on the drawings.

### 3.4 FIELD QUALITY CONTROL

- A. Inspect wire for physical damage and proper connection.
- B. Prior to energizing, check conduit, raceways, outlet boxes, and wire for continuity of circuitry and for short circuits. Correct malfunction when detected.
- C. Subsequent to wire hookups, energize circuitry and demonstrate functioning in accordance with these specifications.
- D. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.
- E. Perform field inspection and testing according to provisions of this section.

### 3.5 ACCEPTANCE TESTS

- A. Contractor shall furnish all materials, labor, and equipment necessary for the acceptance tests specified herein. Acceptance tests shall be performed in the presence of Engineer and must be passed before final acceptance of the work.
- B. Contractor shall be responsible for powered tests of each field-installed device unless specifically noted otherwise. Contractor shall be responsible for device operation as powered from its power source and signals as received at the I/O modules.
- C. Operation Test: By operational testing, Engineer will give final acceptance of the wiring system when all of the wiring is considered a complete system. All equipment shall function and operate in the proper manner as indicated in the details of the specifications and on the drawings.
- D. At the request of Engineer, demonstrate by test the compliance of the installation with these specifications and drawings, the National Electrical Code, and the accepted standards of good workmanship. These tests shall include operation of equipment, continuity of the conduit system, grounding resistance and insulation resistance.
- E. A written record of performance tests on electrical and control and instrumentation systems and equipment shall be supplied to Contracting Authority. Such tests shall show compliance with governing codes.
- F. The transformer, feeder, and subfeeds to the lighting panels shall be completely phased out as to sequence and rotation. Phase sequence shall be A-B as follows:
  - 1. Front-to-rear, top-to-bottom, or left-to-right when facing equipment.
  - 2. Phasing shall be accomplished by using distinctive colors for the various phases. The same color or variation of it shall be used for a particular phase throughout the building and project.

### 3.6 WIRE INSTALLATION SCHEDULE

- A. Install all wiring in raceways except as otherwise noted. This includes all low-voltage wiring such as instruments, network, fiber-optic, etc.

ELECTRICAL SERVICE  
SYSTEM

PART 1–GENERAL

1.1 SUMMARY

- A. Work Included:
  - 1. Utility company.
  - 2. Secondary service characteristics.
  - 3. Definitions.
  - 4. Sequencing, scheduling.
  - 5. Underground electrical service.
  
- B. Contractor shall include\_in the Bid the cost of the following items specified in this Section. Refer to the individual sections listed below for a complete description of the Work required. Electric Utility Service Entrance, Section 1.06–Underground Electrical Service.

1.2 UTILITY COMPANY

- A. The Utility Company is Alliant Energy.

1.3 SECONDARY SERVICE CHARACTERISTICS

- A. The secondary service for both pathway control cabinets will be 120/240-volt, 3-wire, single-phase for combined lighting and power.

1.4 DEFINITIONS

- A. Service: As defined in the NEC, Article 100.
- B. Primary Voltage: Above 600 volts.
- C. Secondary Voltage: 600 volts and below.

1.5 SEQUENCING, SCHEDULING

- A. Provide electrical service system, except the Utility Company will provide:
  - 1. Transformer.
  - 2. Meter.

1.6 UNDERGROUND ELECTRICAL SERVICE

- 1.7 Provide complete underground electrical service except for items furnished and installed by the Utility Company.

1.8 MEASUREMENT AND PAYMENT

- A. Coordinate the new electrical services with the Utility, and all Utility costs shall be paid by Contracting Authority. All costs associated with temporary service of any type shall be incidental to the lump sum Electrical bid item.

## SECONDARY GROUNDING

### PART 1–GENERAL

#### 1.1 SUMMARY

- A. Work Included:
  - 1. Power System Grounding.
  - 2. Electrical Equipment and Raceway Grounding and Bonding.

#### 1.2 SUBMITTALS

- A. Indicate location of system grounding electrode connections and routing of grounding electrode conductor.
- B. Submit shop drawings and product data in accordance with provisions written in Submittals section.

#### 1.3 MEASUREMENT AND PAYMENT

- A. All Work of this Special Provision is incidental to the lump sum Electrical bid item.

### PART 2–PRODUCTS

#### 2.1 MATERIALS

- A. Ground Rods: Copper-bonded, 5/8-inch diameter; minimum length 10 feet.
- B. Ground Connections Below Grade: Exothermic type by Cadweld, compression type by Thomas & Betts, or equal. Compression connectors shall be prefilled with an oxide inhibitor.
- C. Ground Fittings: O-Z/Gedney, Type ABG, CG, TG, KG, GBL, or equal.

### PART 3–EXECUTION

#### 3.1 INSTALLATION

- A. Compression-type connectors shall be installed with the manufacturer recommended tools. Compression dies shall emboss index on the connector when installed correctly. An indenter crimp shall be made on ground rods prior to connection of grounding conductor.
- B. Provide a separate insulated equipment grounding conductor for each feeder and branch circuit. Provide a dedicated neutral conductor sized to match the circuit or feeder conductors for each feeder or branch circuit requiring a neutral. Terminate each end on a grounding lug, bus, or bushing.
- C. Bond together system neutrals, service equipment enclosures, exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding



conductor in raceways and cables, and receptacle ground connectors.

- D. Connect grounding electrode conductors using suitable ground clamps.
- E. Ground system, transformer neutrals, and equipment as required by code and local ordinances.
- F. All feeder neutrals shall be connected to neutral at only one point in the pathway control cabinets.
- G. All bare copper conductors installed outdoors shall be buried a minimum of 2 feet below grade.
- H. A minimum of three ground rods at 15 foot separations near each service entrance shall be provided and ground wires must attach to point ahead of meter or service shutoff valve. These shall be connected to ground bus by conductors sized to code requirements. The above are minimum requirements.
- I. All service entrance grounding electrode conductors shall be installed in PVC conduit. All conduit bends shall be made using sweep elbows. Conduit bodies and 90 degree bends are not allowed.
- J. Include ground for grounded receptacles, light fixtures, motors, and equipment items shown on the drawings.
- K. Flexible connections do not qualify for ground. All flexible connections must have separate green ground wire from the lighting fixture or equipment frame to conduit system.
- L. Provide a separate grounding conductor system for the grounding of all lighting fixtures and devices installed in the same conduit as the branch circuit conductors. Ground conductors shall be individually connected at each fixture or device.
- M. All equipment that is fed from circuits in PVC conduit shall be provided with a separate green ground wire that is terminated at the metallic conduit system and the equipment.
- N. Refer to Instrument Wire and Cable for Additional Grounding Requirements.

### 3.2 TESTING

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
- B. Provide ground system resistance test report for each ground grid. Test reports shall document ground system resistance following the three-point "Fall-of-Potential" test. The test results shall include a graph of the results plus a diagram of the testing layout. The remote current probe (C2) shall be placed a minimum of 100 feet from the ground system potential/current probe (P1/C1) or as required to provide sufficient spacing to demonstrate a resistance plateau on the graph. The ground resistance shall be tested with the potential probe (P2) between the P1/C1 probe and the C2 probe at 10% intervals starting at 0% and ending at 100% of the distance between P1/C1 and C2, 11 points total. A single point of measurement is not acceptable, and the two-point method of ground system testing shall only be used where there is no or insufficient

"open earth" area to use the three-point Fall-of-Potential method. Resistance at any point in the grounding system shall not exceed 5 ohms. All ground system tests shall be witnessed by Engineer.

- C. The test meter shall be Associated Research Vibroground test set with null balance, James A. Biddle Megger Earth-Tester-Null Balance, or equal. All ground system tests shall be performed in accordance with the procedures outlined in the instruction manuals of the ground system test report.
- D. In lieu of testing the ground grid as a system, Contractor may choose to test individual ground rods separately. Individual ground rods when tested separately shall be isolated from all metallic connections, such as from the ground rod to other grounded structures and electrical system neutrals.
- E. Multiple ground rod grids shall be isolated from all metallic connections such as from grid under test to other grounded structures and electrical system neutrals.
- F. Provide test report using the attached form. Each ground grid, including service entrance transformers, motor control center, control cabinet, etc., shall have a form submitted.

GROUND ROD RESISTANCE TO EARTH TEST RECORD

1. DATE \_\_\_\_\_
2. PROJECT NAME \_\_\_\_\_
3. LOCATION OF TEST \_\_\_\_\_
4. DRAWING NO. \_\_\_\_\_
5. GROUND ROD TYPE \_\_\_\_\_  
DIAMETER \_\_\_\_\_  
LENGTH \_\_\_\_\_
6. TEST METHOD \_\_\_\_\_  
INSTRUMENT TYPE \_\_\_\_\_  
SERIAL NO. \_\_\_\_\_
7. REQUIRED MAXIMUM RESISTANCE TO EARTH \_\_\_\_\_
8. MEASURED RESISTANCE TO EARTH  
ROD 1 \_\_\_\_\_  
ROD 2 \_\_\_\_\_  
ROD 3 \_\_\_\_\_  
GROUND ROD SYSTEM \_\_\_\_\_

TEST PERFORMED BY: \_\_\_\_\_  
Signature

TEST WITNESSED BY: \_\_\_\_\_  
Signature

## SUPPORTING DEVICES

### PART 1–GENERAL

#### 1.1 SUMMARY

- A. Work Included:
  - 1. Conduit and equipment support members.
  - 2. Fastening hardware.

#### 1.2 QUALITY ASSURANCE

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

#### 1.3 SUBMITTALS

- A. Submit shop drawings and product data in accordance with provisions of Submittals section.

#### 1.4 MEASUREMENT AND PAYMENT

- A. All Work of this Special Provision is incidental to the lump sum Electrical bid item.

### PART 2–PRODUCTS

#### 2.1 MATERIAL

- A. Support Members: 316 stainless steel. PVC-coated steel where used with PVC-coated conduit.
- B. Hardware: Stainless steel in all locations.
- C. Manufacturers: Unistrut P-1000, B-line, Superstrut, or equal.

### PART 3–EXECUTION

#### 3.1 INSTALLATION

- A. All supporting devices and support structures shall be constructed such that the structure adequately supports the load of the equipment installed on it including any wind and/or snow loads. Provide additional support members to those shown on the Drawings where required to adequately support load.
- B. Where support members are used for conduit, cutoff ends shall be ground smooth. Cutoff PVC-coated support members shall be ground smooth and touched up with PVC coating material from the manufacturer.
- C. Do not fasten supports to piping or conduit.

- D. Do not use powder-actuated anchors.
- E. Do not drill structural steel members.
- F. Fabricate supports with welded end caps and all welds and surfaces ground smooth for neat appearance. Use hexagon head bolts with steel spring-lock washers under all nuts.
- G. Install free-standing electrical equipment on concrete pads. Anchor all equipment with standoffs and caulk.
- H. Install cabinets and panelboards with minimum of four anchors.
- I. Do not use chain hangers.
- J. All welds shall be continuous and ground smooth.

## CONDUIT

### PART 1–GENERAL

#### 1.1 SUMMARY

- A. Work Included:
  - 1. Rigid aluminum conduit.
  - 2. PVC externally and internally coated galvanized rigid metal conduit.
  - 3. Polyvinyl chloride conduit and fittings.
  - 4. High density polyethylene conduit.
  - 5. Conduit seals and special fittings.

#### 1.2 REFERENCES

- A. ANSI C80.5–Electrical Rigid Aluminum Conduit (ERAC).
- B. ANSI/NEMA FB 1–Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, and Cable.
- C. NEMA RN 1–Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit.

#### 1.3 QUALITY ASSURANCE

- A. Manufacturers of Raceways: Firms regularly engaged in the manufacture of electrical raceways of the types and capacities required whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer: A firm with at least 5 years of successful installation experience on projects with electrical wiring installation work similar to that for the project.
- C. Code Compliance: Comply with National Electrical Code (NFPA 70) and any and all local codes as applicable to construction and installation of electrical wiring devices, material, and equipment herein specified.
- D. UL Labels: Provide electrical cable, raceways, wire, connectors, outlets, switches, etc., which have been listed and labeled by Underwriters Laboratories.
- E. Prior to shipment to the site, all conduit provided shall be new, unused material and may not have been stored outdoors or exposed to weather.
- F. NECA Standard: Comply with applicable portions of National Electrical Contractor's Association's "Standard of Installation."

#### 1.4 SUBMITTALS

- A. Submit shop drawings and product data in accordance with provisions of Submittals section.

#### 1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Provide color-coded thread protectors on the exposed threads of threaded rigid

metal conduit.

- B. Handle conduit carefully to prevent end damage and to avoid scoring the finish.
- C. Store conduit inside and protect from weather. When necessary to store outdoors, elevate well above grade and enclose with durable, waterproof wrapping.

## 1.6 MEASUREMENT AND PAYMENT

- A. All Work of this Special Provision is incidental to the lump sum Electrical bid item.

## PART 2--PRODUCTS

### 2.1 RIGID METAL CONDUIT AND FITTINGS

- A. Rigid Aluminum Conduit: ANSI C80.5. Heavy wall.
- B. Conduit bodies for rigid aluminum conduit shall be as manufactured by Appleton, Form 85, or equal, and be constructed of pressure-cast, copper-free aluminum for sizes 2 inches and under, and sand-cast, copper-free aluminum for sizes over 2 inches. Conduit bodies shall have built-in pulling rollers, domed gasketed covers, and stainless steel screws. Covers for conduit bodies shall have bolts that thread into the conduit body. Snaptight and wedge nut covers are not allowed. Contractor shall select body style and size per application.
- C. PVC coated conduit and fittings shall be internally and externally hot dipped galvanized rigid metal conduit with hot dipped galvanized threads and PVC coating. PVC coating shall be UL listed with rigid metal conduit as the primary means of corrosion protection for the conduit, and PVC coating shall have an external 40 mil thickness with an internal 2 mil urethane coating. Acceptable manufacturers shall be Plasti-bond RedH2OT by Robroy Industries, Ocal-Blue by Thomas & Betts, or equal. PVC coated conduit and fittings shall meet the following listings and manufacturing standards, without exception. All installers shall be field-certified from the factory for installation and shall provide proof of certification:
  1. Federal Specification WW-C-581 E.
  2. ANSI C80.1.
  3. UL6.
  4. NEMA RN1.
- D. Conduit bodies for PVC-coated rigid conduit shall be as manufactured by Plasti-bond RedH2OT by Robroy Industries, Ocal Blue by Thomas & Betts, or equal, and have a 40 mil PVC exterior coating and 2 mil red urethane interior coating. Conduit bodies shall be Form 8 style or pulling elbow and include pulling rollers, domed, gasketed covers and stainless steel screws. Covers for conduit bodies shall have bolts that thread into the conduit body. Snaptight and wedge nut covers are not allowed. Contractor shall select body style and size according to application.
- E. Fittings and Conduit Bodies: ANSI/NEMA FB 1; threaded-type material to match conduit.
- F. Supports: One-hole or two-hole pipe straps may be used for surface-mounted conduit. Where one-hole straps are used, provide conduit clamp and back spacer. Where standoffs are required, provide pipe straps and supporting devices as specified in Supporting Devices. Support material shall match that of the conduit type provided.

## 2.2 POLYVINYL CHLORIDE CONDUIT (PVC) AND FITTINGS

- A. Conduit: Heavy wall rigid, Schedule 40, Schedule 80 where noted, UL listed for underground, encased, and aboveground applications. PVC conduit installed in exterior locations shall be UV resistant.
- B. Conduit bodies for PVC conduit shall be as manufactured by Carlon, or equal, and be suitable for use with Schedule 40 or Schedule 80 PVC conduit. Conduit bodies shall have smooth hubs, textured lids, and foam-in-place gaskets. Contractor shall select body style and size per application.
- C. Supports: Two-hole nonmetallic clamps or conduit support straps may be used for surface-mounted conduit. Where standoffs are required, provide pipe straps and supporting devices as specified in Supporting Devices. Support material shall match that of the conduit type being provided.

## 2.3 HIGH DENSITY POLYETHYLENE (HDPE) CONDUIT

- A. Conduit shown on the drawings for fiber-optic cable shall be HDPE conduit with an SDR of 13.5.
- B. Conduit shall be Schedule 40 high density polyethylene, orange in color unless otherwise noted and be longitudinally ribbed on the inside wall.

## 2.4 CONDUIT SEALS AND SPECIAL FITTINGS

- A. Expansion Fittings: Crouse Hinds or Robroy type XJG, or equal, for rigid or PVC-coated rigid conduit. Crouse Hinds, type XD, or equal for PVC conduit.
- B. Expansion Deflection Fittings: O-Z type "DX," Crouse Hinds, type XD (PVC conduit only), or Appleton.
- C. Ground Bushings: Crouse-Hinds GLL, or equal.
- D. Watertight Hubs: Diecast, insulated and gasketed, rated for wet locations outdoors. Watertight hubs shall be Appleton HUB, Crouse-Hinds Myers Hubs, or equal.
- E. Conduit Plugs: Kwik N Sure pipe plug as manufactured by Cherne Industries, or equal. Plug shall include natural rubber O-ring with galvanized wing nut and hex nut.

## PART 3—EXECUTION

### 3.1 CONDUIT SIZING, ARRANGEMENT, AND SUPPORT

- A. Size conduits for branch circuit conductors, control wires, and instrumentation cables so as to have not less than 25% spare capacity after installation; 3/4 inch minimum size.
- B. Maintain at least 1 inch of separation between conduit sizes to 1 1/2 inches and 2 inches between conduits 1 1/2 inches or larger. Maintain 1 foot of separation between signal conduits (below 100 volts) and power conduits (100 volts and above).
- C. All conduit shall be supported in accordance with the NEC and as specified herein.



This shall apply to all conduit types.

- D. Provide for the proper application, installation, and location of inserts, supports, and anchor bolts for a satisfactory raceway system. Where any component of the raceway system is damaged, replace or provide new raceway system.
- E. Run conduits concealed to avoid adverse conditions such as heat and moisture, to permit drainage, and to avoid all materials and equipment of other trades.
- F. Center conduit in structural slabs (other than topping), clear of reinforcing steel and spaced on centers equal to or exceeding three times the conduit diameter. Outside diameter of conduit shall not exceed one-third the slab thickness for each run of conduit 1 1/4 inches or larger. Provide shop drawings when it will be installed in structural slabs. Conduits shall not be run in slabs-on-grade or structural topping slabs.
- G. Independently support or attach the raceway system to structural parts of construction in accordance with good industry practice.
- H. Conduit installed belowgrade containing fiber optic cable shall be buried a minimum of 42 inches.
  1. Two 4 inch fiber conduits shall be installed from each pathway control cabinet to the adjacent fiber vault.
  2. In areas where fiber-optic conduit is open trenched, it shall also contain 3 inch non-detectable underground tape reading: "CAUTION BURIED FIBER OPTIC LINE BELOW" (Orange) at approximately 18 inches to 24 inches in depth.
  3. Tracer wire shall be tied together at all fiber vault locations.
  4. An orange 10 gauge tracer wire shall also be installed along with all fiber conduits. The tracer wire shall not be installed inside any of the conduits.
- I. Watertight hubs shall be used in all locations.

### 3.2 GENERAL CONDUIT INSTALLATION REQUIREMENTS

- A. Exterior conduit shall be buried below grade. Exposed conduit runs are not allowed.
- B. All conduit installed below grade shall be buried a minimum of 2 feet 0 inches, except conduits for fiber-optic cabling shall be buried a minimum of 42 inches.
- C. PVC conduit installed in earth shall be bedded in compacted sand with a minimum of 6 inch cover on all sides.
- D. Ream conduit smooth at ends, cap upon installation and securely fasten to all outlet boxes, panel cabinets, junction boxes, pull boxes, safety switches, and all other components of the raceway system.
- E. Conduits installed for future equipment or electrical work shall be cut off and capped watertight. Conduit ends shall have threaded fittings to accommodate future conduit installation.
- F. Provide all empty raceways 2 1/2 inches and over with No. 10 galvanized fishwire, and nylon cord for conduits smaller than 2 1/2 inches. Empty raceways and fishwire/nylon cord shall be identified with permanent label, and label shall include conduit termination point. All empty conduits shall be threaded and capped. Exposed conduits shall be threaded and capped.

- G. Provide conduit raceway for exposed cables that are not UV resistant. This shall include, but not be limited to, instrument wiring, etc.
- H. Provide conduit expansion-deflection fittings as specified herein in all conduit runs where movement perpendicular to axis of conduit may be encountered.
- I. Conduits shall be pitched so that drainage is towards handholes and away from all pathway control cabinets.
- J. Conduit bends for PVC conduit shall be made using a hot box, heat blanket, or glycol bender. Open flame or point heat sources of any type are not allowed.
- K. The PVC-coated rigid conduit manufacturer's touch-up compound shall be used on all conduit interior and exterior bare steel exposed because of nicks, cuts, abrasions, thread cutting, and reaming; minimum six coats.
- L. If splicing from HDPE to HDPE, a fusion splice is required. Fusion splicing shall not cause significant interior deformation or ridges. If deformation or ridges are present, the conduit shall be cut and refused.
- M. In all PVC conduit runs below grade 200 feet and longer, PVC coated rigid steel conduit shall be used for all 90 degree bends.
- N. Where below-grade PVC conduit is connected to rigid metal conduit, the length of PVC conduit shall be a minimum of 10 feet. For short, below-grade conduit runs where required lengths of rigid metal conduit limit the length of PVC conduit to less than 10 feet, rigid metal conduit shall be used for the entire run.
- O. If splicing from HDPE to PVC, use a Shurlock II system as manufactured by AD Technologies, or equal.

### 3.3 CONDUIT PENETRATIONS AND TERMINATIONS

- A. Where fittings are brought into an enclosure with a knockout, a gasket assembly consisting of an O-ring and retainer shall be installed on the outside. Fittings shall be insulated throat type.
- B. Conduit penetrations for control panels or enclosures containing electronic equipment shall be made on the sides or bottom of the enclosure. Conduits shall not penetrate the top of the enclosure.
- C. Provide conduit expansion fittings as specified herein for conduits protruding from earth where the conduit is terminated within 5 feet of finished grade.
- D. All conduits that protrude from poured concrete shall be PVC-coated rigid conduit. Conduit shall extend continuously (i.e., no joints) a minimum of 4 feet beyond the poured concrete (both sides).
- E. Conduits passing through masonry, concrete, or similar construction shall be cast in place using PVC-coated rigid conduit extending completely through the construction.
- F. All spare conduits that terminate belowgrade shall be plugged with conduit plugs as specified herein.

### 3.4 CONDUIT INSTALLATION SCHEDULE

- A. The following schedule lists specific conduit types allowed in designated areas. Those areas not listed under a specific conduit type shall not have that type of conduit installed:
1. Rigid aluminum:
    - a. Exterior locations (except in earth) and locations exposed to weather.
    - b. All locations where attached to aluminum railings or aluminum structural members.
    - c. Where noted on drawings.
  2. PVC coated rigid steel:
    - a. Conduits protruding from concrete.
    - b. All exterior locations.
    - c. Earth.
    - d. Within 6 feet of a handhole.
  3. PVC:
    - a. Earth, except within 6 feet of a vault or handhole. PVC conduit under pavement or roadways shall be Schedule 80.
    - b. Service entrance ground conductors.
    - c. Buried below slabs on grade.
  4. HDPE: Earth, for fiber optic cabling only.

## HANDHOLES AND VAULTS

### PART 1–GENERAL

#### 1.1 DESCRIPTION

- A. Work Included:
  - 1. Precast vaults.
  - 2. Precast polymer concrete handholes.

#### 1.2 REFERENCES

- A. ASTM D4101–Specification for Polypropylene Injection and Extrusion Materials.
- B. ANSI/SCTE 77–Specification for Underground Enclosure Integrity.

#### 1.3 SUBMITTALS

- A. Submit shop drawings and product data in accordance with provisions of Submittals section.
- B. Shop drawing submittals shall include the following:
  - 1. Vaults: Plan and section drawings showing arrangement of each vault, including elevations, location of vault wall penetrations, and site-specific design details.
  - 2. Castings: Where site-specific castings are specified with unique lettering on the vault cover, provide shop drawing for castings indicating appropriate detail to indicate conformance to the Contract Documents.
  - 3. Interior elevations of each wall of all vaults and handholes provided under this Contract. Each conduit shall be identified as to what it serves.
  - 4. Interior elevations of each wall of all existing vaults used under this Contract. Include all existing conduits and additional conduits provided under this Contract. Each conduit shall be identified as to what it serves.
  - 5. Product data (Vaults): Manufacturer's technical information for vaults and accessories proposed for use:
    - a. Drawings showing interior and exterior dimensions and details of typical openings, jointing, inserts, and typical reinforcing.
    - b. Fabrication and erection of all frame and cover assemblies. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items. Provide setting drawings for location and installation of castings and anchorage devices.
  - 6. Product data (Handholes): Manufacturer's technical information for handholes and accessories proposed for use.

#### 1.4 MEASUREMENT AND PAYMENT

- A. All Work of this Special Provision is incidental to the lump sum Electrical bid item.

PART 2-PRODUCTS

## 2.1 PRECAST VAULTS

## A. Material and Construction:

1. Precast reinforced concrete.
2. Minimum interior dimensions as shown or per the NEC. All vaults shall be square. Provide a 12 inch by 12 inch by 6 inch deep sump with four 3/4 inch drain holes in vault floor.
3. Precast vaults:
  - a. Except where otherwise specified, precast manhole components shall consist of reinforced concrete sections especially designed for vault construction and manufactured in accordance with ASTM C857 and C858, except as modified herein.
  - b. Precast reinforced concrete vault bases, riser sections, flat slabs and other components shall be manufactured by wet cast methods only, using forms which will provide smooth surfaces free from irregularities, honeycombing, or other imperfections.
  - c. Precast vault components shall be of sufficient strength to withstand the loads imposed upon them. They shall be designed for a minimum earth cover loading of 130 pounds per cubic foot, an H-20 wheel loading, and an allowance of 30% in roadways and 15% in rights-of-way for impact. Vault bases shall have two cages of reinforcing steel in their walls, each of the area equal to that required in the riser sections. Wall thickness shall be at least 5 inches. Concrete top slabs shall be at least 8 inches thick.
  - d. Lifting holes, if used, shall be tapered and no more than two shall be cast in each section. Tapered solid rubber plugs shall be furnished to seal the lifting holes. The lifting holes shall be made to be sealed by plugs driven from the outside face of the section only.
  - e. Mark date of manufacture and name or trademark of manufacturer on inside of the vault.
  - f. A precast slab shall be provided at the top of the vault body. Vault cover frame shall be cast into the top slab. Grouting the frame into the top slab in the field is not acceptable.

## B. Accessories:

1. Frames and covers (not in roadways):
  - a. Cover shall be reinforced to support a minimum live load of 300 pounds per square foot with a maximum deflection of 1/150th of the span.
  - b. Material: Aluminum alloy conforming to ASTM, with a 1/4 inch aluminum diamond pattern and mill finish with bituminous coating.
  - c. Frame shall be channel-type with 1/4 inch extruded aluminum with bend-down anchor tabs around the perimeter. Cover shall be minimum 30 inches square.
  - d. Hinges shall be heavy forged 316 stainless steel, specifically designed for horizontal installation and shall be through bolted to the cover with tamperproof Type 316 stainless steel lock bolts and shall be through bolted to the frame with Type 316 stainless steel bolts and locknuts. Hinge pins shall be minimum 1/4 inch diameter 316 stainless steel.
  - e. Lifting mechanisms shall be compression spring operators enclosed in 316 stainless steel telescopic tubes to provide, smooth, easy, and controlled cover operation throughout the entire arc of opening and to act as a check in retarding downward motion of the cover when closing. The upper tube shall be the outer tube to prevent accumulation of moisture, grit, and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support

- shoe fastened to a formed 1/4 inch gusset support plate. A hole-open arm shall be provided and lock the cover in the open position.
- f. A removable exterior turn/lift handle with a spring loaded ball detent shall be provided to open the cover and the latch release shall be protected by a flush, gasketed, removable screw plug. A 316 stainless steel snap lock with fixed handle shall be mounted on the underside of the cover.
  - g. Covers and frames shall be as manufactured by Bilco, or equal. Contractor shall provide nameplate for door similar to covers specified for roadways.
2. Pulling irons shall be provided in all vaults and be galvanized steel. Pulling irons shall be as manufactured by MacLean Power Systems, catalog number J8119, or equal.
  3. Cable racks:
    - a. Material: Galvanized steel.
    - b. Cable racks shall adequately support cables with space allowed for future cables.
    - c. Each rack shall be a vertical assembly of 24 inch cable racks extending from within 6 inches of the vault roof slab to within 6 inches of the vault floor.
    - d. Cable racks shall be MacLean Power Systems catalog number J5125, or equal.
  4. Cable hooks:
    - a. Material: Galvanized steel.
    - b. Length: 7.5 inches minimum.
    - c. Cable hooks shall be MacLean Power Systems catalog number J5132A, or equal.
  5. Insulators:
    - a. Material: Porcelain.
    - b. Insulators shall be MacLean Power Systems catalog number J5122, or equal.

## 2.2 PRECAST POLYMER CONCRETE HANDHOLES

- A. Material and Construction:
  1. Precast polymer concrete.
  2. Duct entrances sized and located to suit duct banks.
  3. Enclosures, boxes and covers are required to conform to test provisions of ANSI/SCTE 77 for Tier 22 applications.
  4. All covers are required to have a minimum coefficient of friction of 0.50 in accordance with ASTM C1028.
  5. Covers shall have the following stamped logos: "ELECTRICAL" or "COMMUNICATION"
  6. Handholes shall be Hubbel, Quazite, PG-Style, or equal.
  7. Handholes for 120/240-volt power shall be minimum 13 inches by 24 inches. Handholes for Ethernet or fiber-optic cabling shall be minimum 11 inches by 18 inches. All handholes installed in grassy areas shall be colored forest green.

## PART 3-EXECUTION

### 3.1 INSPECTION AND COORDINATION

- A. Examine conditions under which the Work is to be installed and notify Engineer in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.
- B. Coordinate vault and handhole installation with piping, sheeting, and other underground systems and structures, and locate clear of interferences.

### 3.2 INSTALLATION

- A. Install vaults and handholes where shown and verify locations in field. Perform excavation and backfilling required for installation. Excavation and backfilling shall be in accordance with General Electrical Requirements.
- B. Install vaults and handholes on a 3/4 inch crushed stone foundation 1 foot under all vaults and handholes, and within 2 feet of exterior of vaults and handholes. Vault and handhole bases shall be set at the proper grade and carefully leveled and aligned.
- C. Precast Vaults:
  - 1. Set sections vertical with steps and sections in true alignment. The base of the bell or groove end at joints between components shall be buttered with 1:2 proportion cement sand mortar to provide a uniform bearing between components. Joints shall be sealed with cement mortar inside and out, and trowel smooth to the contour of the wall surface. Raised or rough joint finishes are not acceptable.
  - 2. Install sections, joints and gaskets in accordance with manufacturer's recommendations.
  - 3. Lifting holes shall be sealed tight with a solid rubber plug driven into the hole from the outside of the vault, and the remaining void filled with a one- to two-proportion cement sand mortar.
- D. Complete installation of vaults so that structures are watertight. Apply foam sealant to all penetrations.
- E. Cable Supports in Vaults:
  - 1. Attach cable racks with 3 inch by 3/8 inch diameter "tamp-in" studs mounted in 1 inch holes drilled into walls of vaults in the absence of inserts. Apply PVC coating to racks.
  - 2. Provide cable hooks to support each cable on each rack along the cable run within the vaults. Apply PVC coating to hooks. Provide a minimum of four cable hooks.
  - 3. Individually support each cable at each hook on porcelain insulators. Provide sufficient slack for each cable.
  - 4. Securely tie each cable in place at each insulator block to prevent excessive movement of insulators and cables. Tie cables with nonmetallic 3/4 inch strapping tape as manufactured by 3M, or tie down with nylon straps.
- F. Grounding: Install a 5/8 inch by 10 foot copper-clad ground rod for each vault and handhole. Bond all exposed metal vault accessories and the concrete reinforcing rods with No. 4 AWG minimum bare copper wire, and connect to the ground rod.
- G. Provide grade rings for vaults when required to adjust cover to proper grade. Grading ring shall be constructed on the roof slab on which the vault frame and cover shall be placed. The height of the grading ring shall be such as is necessary to bring the frame to the proper grade, and shall not exceed 12 inches in height.
- H. All conduits must enter the sides of vaults and handholes. Conduits entering the bottom will not be permitted.
- I. Vaults and handholes shall be considered wet locations for purposes of equipment selection.
- J. All conduits shall be pitched so that drainage is towards vaults or handholes and away from all structures.

### 3.3 GRADING AT VAULTS AND HANDHOLES

- A. Vaults and handholes in unpaved areas shall be built as shown to a rim elevation higher than the original ground. The ground surface shall be graded to drain away from the vault or handhole. Fill shall be placed around vaults and handholes to the level of the upper rim of the vaults or handhole frame, and the surface evenly graded on a one (vertical) to five (horizontal) slope to surrounding ground, unless otherwise shown.
- B. Contractor shall be solely responsible for proper height of vaults and handholes necessary to reach final grade. Engineer's review of shop drawings for vault and handhole components is general in nature, and Contractor shall provide random length precast vault and handhole riser sections to adjust vaults and handholes to meet field conditions for final grading.

#### 3.4 VAULT WATERTIGHTNESS

- A. Vaults shall be free of visible leakage. Each vault shall be observed and leaks shall be repaired.



## ELECTRICAL IDENTIFICATION

PART 1–GENERAL

## 1.1 SUMMARY

- A. Work Included:
  - 1. Nameplates.
  - 2. Labeling tags.
  - 3. Wire markers.

## 1.2 SUBMITTALS

- A. Submit shop drawings and product data in accordance with provisions of Submittals section.
- B. Provide schedule for nameplates and labeling tags with shop drawings. Reference drawings for type used.

## 1.3 MEASUREMENT AND PAYMENT

- A. All Work of this Special Provision is incidental to the lump sum Electrical bid item.

PART 2–PRODUCTS

## 2.1 NAMEPLATES

- A. Type "A":
  - 1. Use: Field devices.
  - 2. Size: 2 inch by 3 inch.
  - 3. Material: Three layer laminated Micarta.
  - 4. Background Color: Black.
  - 5. Character Color: White.
  - 6. Character Size: 1/4 inch.
  - 7. Engraving: As requested by Engineer. Label shall include equipment number and description.
  - 8. Mounting Location: Front exterior.
- B. Type "B":
  - 1. Use: Pathway Control Cabinets.
  - 2. Size: 4 inch by 4 inch.
  - 3. Material: Three layer laminated Micarta.
  - 4. Background Color: Black.
  - 5. Character Color: White.
  - 6. Character Size: 2 1/4 inch.
  - 7. Engraving: Equipment label. Label shall include equipment number and description.
  - 8. Mounting Location: Equipment: Top wireway.
- C. Type "C":
  - 1. Use: Electrical Distribution System Equipment not previously specified.

2. Size: As necessary.
3. Material: Three layer laminated Micarta.
4. Background Color: Yellow.
5. Character Color: Black.
6. Character Size: 3/16 inch.
7. Engraving and Mounting Location: As requested by Engineer.

D. Type "D":

1. Use: Operator instructions.
2. Size: As necessary.
3. Material: Three layer laminated Micarta.
4. Background Color: Yellow.
5. Character Color: Black.
6. Character Size: 3/16 inch.
7. Engraving and Mounting Location: As requested by Engineer.

## 2.2 LABELING TAGS

A. Use: Field-mounted Devices.

1. Size: 1 inch by 3 inch.
2. Material: 1/32 inch thick stainless steel.
3. Character Size: 1/4 inch.
4. Engraving: As requested by Engineer.

## 2.3 WIRE MARKERS

- A. Wire markers shall be permanently attached sleeve or heat shrink-type labels. Wire numbering preprinted on the conductor, flag-type labels, and individual wraparound numbers (such as Brady preprinted markers) are not acceptable. All wire markers shall be the same throughout the project.
- B. Wire markers shall be specifically printed for this project using permanently attached computerized adhesive tags, such as Brady BMP51 labeling printer with self-laminating vinyl, permasleeve heat-shrink polyolefin, or equal. Handwritten markers are not acceptable.

## PART 3—EXECUTION

### 3.1 INSTALLATION

- A. Degrease and clean surfaces to receive nameplates.
- B. Install nameplates parallel to equipment lines.
- C. Affix nameplates with UV-resistant adhesive.
- D. Affix labeling tags with permanent bonding cement or locking wire ties. Provide 3/8 inch hole to accommodate wire tie.
- E. Prepare and install neatly-typed directions in all panels where work is done under this Contract.

### 3.2 WIRE IDENTIFICATION

- A. Provide wire markers on each conductor, including neutral and spare conductors, 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 for control wiring. Spare conductors shall have control wire number or shall indicate termination point of wire.
  
- B. Conductors in pull boxes, pathway control cabinets, control panels, cabinets, and panelboards shall be grouped as to circuits and arranged in a neat manner. All conductors of a feeder or branch circuit shall be grouped, bound together with nylon ties, and identified. Phase identification shall be consistent throughout the system.

## PANELBOARDS

### PART 1–GENERAL

#### 1.1 SUMMARY

- A. Work Included: Lighting and appliance panelboards.

#### 1.2 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of electrical equipment, cable, and wire products of the types and ratings necessary, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer: A firm with at least 5 years of successful installation experience on projects with electrical equipment installation work similar to that in this project.
- C. Code Compliance: Comply with National Electrical Code (NFPA 70) as applicable to construction and installation of electrical equipment, cable, wire, and connectors.
- D. UL Labels: All electrical equipment and material shall be listed and labeled by Underwriters Laboratories, except where UL does not include the equipment in their listing procedures.
- E. NEMA/ANSI Compliance: Comply with National Electrical Manufacturers Association, American National Standards Institute, and other standards pertaining to material, construction, and testing, where applicable.

#### 1.3 SUBMITTALS

- A. Submit shop drawings and product data in accordance with provisions of Submittals section.

#### 1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. All electrical equipment and material shall be received and stored with the factory tamperproof wrapping intact. Provide factory-wrapped waterproof flexible barrier material for factory packaging of equipment and material to protect against physical damage in transit. Do not install damaged equipment or material; remove from project site. Store equipment in factory coverings in a clean, dry, indoor space that provides protection against weather.

#### 1.5 MEASUREMENT AND PAYMENT

- A. All Work of this Special Provision is incidental to the lump sum Electrical bid item.

### PART 2–PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. Square D.
- B. Cutler-Hammer.

- C. Substitutions: Under provisions of the General Conditions.
- D. The drawings and specifications were prepared based on Cutler-Hammer. Contractor shall include in the Bid and shall be responsible for the cost of any changes to accommodate other equipment including but not limited to structural, mechanical, and electrical work. Contractor shall also pay additional costs necessary for revisions of drawings and/or specifications by Engineer.

2.2 PANELBOARDS

- A. Lighting and appliance panelboards shall be provided as indicated on the drawings and as scheduled. Panelboards shall be factory-assembled and constructed in accordance with latest NEMA, UL, and NEC requirements and shall bear the UL label. Panelboard cabinets, including boxes and fronts, shall be code gauge galvanized steel. Front covers shall be hinged to allow access to wiring gutters without removal of panel trim (door-in-door type). All fronts shall be complete with cylinder-type lock and catch, and all cylinders shall be keyed alike. Provide two keys per panelboard to Contracting Authority.
- B. Gutter and wiring space shall be provided according to NEMA and UL standards, except provide additional 6-inch-wide or -high wiring space for all double-lugged two or more section panels, feed-through panels. Contractor shall instruct manufacturer as to where additional wiring space is needed, i.e., top, bottom, right, left, or combination. Where oversized cabinets are necessary for one section of a panelboard, all sections of the panelboard shall be the same size.
- C. Panelboards shall have full ampacity bussing throughout (full length of panel) and shall be full-size in regard to number of possible pole spaces. All lighting and appliance panels shall have poles as shown on the drawings. Panelboards shall be identified with phases reading left to right and circuits alternately numbered left to right, odd numbers on the left, even numbers on the right.
- D. Panelboards shall have copper bussing. Provide copper ground bus in all panelboards.
- E. Lugs for incoming feeders shall be UL listed for use with copper conductors. Lugs shall be sized by Contractor in accordance with feeder sizes shown. Main lugs or main breakers shall be top- or bottom-mounted to coordinate with incoming feeder entrance location. Location shall be selected by Contractor.
- F. Branch circuit breakers shall be quick-make, quick-break, with thermal magnetic trip bolt-on type. Multipole breakers shall have common internal trip, UL listed as multipole units; handle ties are not permitted. All breakers shall be of the same manufacturer as the panelboard and provided at ampere capacity as scheduled.
- G. Lighting and Appliance Panelboards shall be provided as follows (types listed are Cutler-Hammer):

Type	Maximum Voltage	Maximum Bus Amps	Maximum Brk. Amps	Minimum I.C.
Pow R-Line 1a	240	400	100	22,000

- H. All panelboards scheduled with main circuit breakers shall be individually mounted main circuit breaker panels. Main circuit breakers installed in the location of branch

circuit devices (branch-mounted mains) are not acceptable.

### PART 3-EXECUTION

#### 3.1 INSPECTION

- A. Examine the areas and conditions under which work is to be installed and notify Contractor of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Panelboards shall be provided as indicated. Final locations, sizes, and mounting of panelboards shall be reviewed with Engineer prior to installation.
- B. Each panelboard shall have a typewritten circuit schedule provided on the inside cover. This schedule shall be covered with clear plastic in a metal frame and shall include area or item served by each branch circuit.
- C. Prior to final inspection, clean all panelboard interiors, adjust trims, covers, hinges and locks, and refinish covers to original condition.
- D. Balance load on all panelboards so phases are balanced to 15% of each other. Reconnect or redistribute circuits and/or circuit breakers to achieve balanced condition. Submit ammeter readings for all panelboard feeders indicating normal operating load and phase balance.

## CABINETS AND ENCLOSURES

PART 1–GENERAL

## 1.1 SUMMARY

- A. Work Included:
  - 1. Hinged cover enclosures.
  - 2. Cabinets.

## 1.2 REFERENCES

- A. NEMA 250–Enclosures for Electrical Equipment (1000 Volts Maximum).
- B. ANSI/NEMA ICS 1–Industrial Control and Systems.
- C. ANSI/NEMA ICS 6–Enclosures for Industrial Control Equipment and Systems.

## 1.3 SUBMITTALS

- A. Submit shop drawings and product data in accordance with provisions of Submittals section.
- B. Show Drawings for Equipment Panels: Include wiring schematic diagram, connection diagram, outline drawing, and construction diagram as described in ANSI/NEMA ICS 1.

## 1.4 MEASUREMENT AND PAYMENT

- A. All Work of this Special Provision is incidental to the lump sum Electrical bid item.

PART 2–PRODUCTS

## 2.1 HINGED COVER ENCLOSURES

- A. Construction: NEMA 250, larger than 12 inches in any dimension. Acceptable manufacturers: Hoffman, B-Line, or equal.
- B. Covers: Continuous hinge, applicable NEMA rating with hasp and staple for padlock.
- C. Back Panel for Mounting Terminal Blocks or Electrical Components: 14 gauge steel, white enamel finish.
- D. All cabinets with double doors or that are free-standing shall have three point latch.

## 2.2 CABINETS

- A. Construction: NEMA 250. Acceptable manufacturers: Hoffman, Saginaw, or equal.
- B. Cabinet Fronts: Steel, surface-type with screw cover front, concealed hinge and flush lock. Finish in white baked-enamel.

## 2.3 PATHWAY CONTROL CABINETS (PCC)

- A. Description: Lighting control cabinet, base, and accessories shall be provided as specified herein. The Work under this item will consist of furnishing, assembling, and installing pathway control cabinets in the locations shown on the drawings.
- B. Materials: Each cabinet shall meet the following minimum requirements:
1. Enclosure shall be aluminum, freestanding, with a minimum seven individual sections. Enclosure shall be minimum 60 inches high by 44 inches wide by 24 inches deep with sloped roof, be powder coated black, and be rated NEMA 3R. Enclosure shall have isolated sections dedicated for utility metering and service entrance conductor lugs. All welds shall be ground smooth.
  2. Provide a single door per cabinet section, stainless steel door handle with 3-point latch and hasp, and staple for padlocking.
  3. Door seal shall have a continuous closed-cell neoprene gasket around the entire perimeter.
  4. Cabinet shall be as manufactured by Milbank, Four-Door D-Size, or equal.
  5. All mounting and external hardware shall be stainless steel.
  6. The cabinet shall have a minimum short circuit interrupting capacity of 22,000 A.
  7. Lighting control devices shall be mounted within the enclosure. Control and switching devices shall be NEMA rated when applicable. Devices shall be mounted on a painted steel back panel. Back panel shall be white in color. Backpanel shall be grounded to enclosure. Provide rack mounting brackets as required to mount the back panel in the cabinet. Devices shall be provided as specified below and in Controls and Instrumentation.
    - a. Panelboards: Provide two panelboards as shown on the Drawings.
    - b. Provide 30A, electrically held lighting and power contactors; quantity and number of poles shall be as required to control the circuits as specified herein plus 25% spare circuit space.
    - c. Accessories:
      - (1) Provide one GFI receptacle for power distribution unit. Coordinate location with video surveillance equipment. (See Wiring Devices).
      - (2) LED Panel light and door switch.
      - (3) Wiring troughs to route wiring between devices, maximum 60% fill.
      - (4) Two three-position, 30 mm, NEMA-type 13 selector switch control stations (H-O-A) (See Wiring Devices). Provide one H-O-A selector switch for lighting circuits and one for receptacle power circuits. Refer to Controls and Instrumentation for additional requirements.
      - (5) Terminal strips to land all field wiring and branch circuits within the cabinet.
      - (6) Relays as required.
      - (7) SPD unit (see Surge Protective Devices (SPD)).
      - (8) Control power fusing as required. Provide indicating type fuse holders.
      - (9) Anti-condensation heater(s) and thermostat, sized as required, Hoffman DAH Series, or equal.
      - (10) Provide a generator receptacle located on the cabinet exterior as manufactured by Hubbell Model HBL7968. Receptacle shall be wired with an automatic break before make bypass switch.
      - (11) Dimming switch for control of 24th Street Overlook canopy lighting (PCC-5 only). Coordinate dimming switch with light fixture manufacturer.
      - (12) Battery backup system for network and video surveillance equipment. System shall include two 120 VDC batteries and Alpha Novus FXM power module, or equal, minimum two hours of operation for all network and video surveillance equipment.



8. Concrete base shall be provided as part of this item. Refer to controller base detail as shown on the Drawings.
9. Refer to Controls and Instrumentation and Video Surveillance System for additional equipment to be mounted in the control cabinets.
10. The cabinet shall include standard 19 inch rack, sized as required for mounting video surveillance equipment. Coordinate with Video Surveillance System for equipment requirements.

#### 2.4 AMPHITHEATER POWER CENTER

- A. Description: Power control cabinet, base, and accessories shall be provided as specified herein. The Work under this item shall consist of furnishing, assembling, and installing the Amphitheater Power Center where shown on the drawings.
- B. Materials: The cabinet shall meet the following minimum requirements:
  1. Enclosure shall be NEMA 3R, aluminum, and powder coated black.
  2. The door shall have a continuous neoprene gasket, stainless-steel door handle with 3-point latch, and hasp and staple for padlocking.
  3. All mounting and external hardware shall be stainless steel.
  4. The cabinet shall have a minimum short circuit interrupting capacity of 22,000 A.
  5. The concrete base shall be provided as part of this item.
  6. The cabinet shall be as manufactured by Milbank CP3B Series, or equal.
  7. Devices shall be mounted on a white-painted steel back panel within the enclosure and be NEMA rated when applicable. Back panel shall be grounded to the enclosure. Devices shall be provided as specified below:
    - a. Panelboards: Provide two panelboards as shown on the Drawings.
    - b. Receptacles: Provide two 50A, 125/250V, NEMA 5-50R receptacles and six GFI, 20A receptacles. Each receptacle shall be powered from a separate circuit breaker in the cabinet (See Wiring Devices).
    - c. LED panel light and door switch.
    - d. Wiring troughs to route wiring between devices, maximum 60% fill.
    - e. Anti-condensation heater(s) and thermostat, sized as required, Hoffman DAH Series, or equal.

#### 2.5 CONTROL RELAYS AND CONTACTORS

- A. Relays and contactors shall meet the following requirements:
  1. Interposing/isolation relays in accordance with Motor Control.
  2. Lighting and Receptacle Contactors:
    - a. Configuration: Electrically held, 2-12 poles.
    - b. Mounting: DIN rail.
    - c. Voltage: 120VAC with 120VAC coil.
    - d. Contact rating: 30A continuous.
    - e. UL listed.
    - f. NEMA rated.
    - g. Manufacturer: Square D, Class 8903, Allen-Bradley, 700-PK or equal.

#### 2.6 ARC FLASH HAZARD WARNING LABELS FOR NEW EQUIPMENT

- A. Equipment specified herein shall be provided with arc flash hazard warning labels based on an arc flash hazard analysis performed by the equipment manufacturer. Labels and label placement shall meet the requirements of NFPA 70E, shall be bilingual, and shall clearly identify and mark electrical equipment to warn workers from shock, arc flash and electrocution hazards.

- B. Warning labels shall be self-adhesive vinyl, 4 inches by 6 inches, and be as manufactured by Conney Safety products, or equal.

## 2.7 FABRICATION

- A. Shop-assembled enclosures and cabinets housing terminal blocks or electrical components in accordance with ANSI/NEMA ICS 6.
- B. Provide conduit hubs on all enclosures.
- C. Provide protective pockets inside front cover with schematic diagram, connection diagram, and layout drawing of control wiring and components within enclosure.
- D. Provide gasketed surfaces for all enclosure and cabinet doors and covers.

## 2.8 ENCLOSURE RATING

- A. Cabinets and enclosures shall be rated NEMA 4X, stainless steel, unless noted otherwise on the drawings.

## PART 3-EXECUTION

### 3.1 INSTALLATION

- A. Install cabinets and enclosures plumb. Anchor securely to wall and structural supports at each corner minimum.
- B. All cabinets and enclosures shall be labeled with permanent labels (not adhesive type). Permanent labels shall include painted, stencil-type labels or engraved laminated nameplates (4 inches by 4 inches minimum size).
- C. Provide accessory feet for free-standing equipment enclosures.
- D. All cabinets and enclosures attached to building surfaces which may be damp shall be spaced out to avoid rust and/or corrosion. All boxes in damp locations shall be on 1 inch standoffs. Damp locations shall include, but not be limited to, exterior locations, all wet wells, and all areas below grade.

## WIRING DEVICES

PART 1–GENERAL

## 1.1 SUMMARY

- A. Work Included:
  - 1. Receptacles.
  - 2. Cover plates.
  - 3. Control stations.

## 1.2 REFERENCES

- A. NEMA WD 1–General-Color Requirements for Wiring Devices.
- B. Drawings–Bill of Materials.

## 1.3 QUALITY ASSURANCE

- A. Manufacturers of switches, outlets, boxes, lamps, fuses, lugs, etc.: Firms regularly engaged in the manufacture of these products, of the types and ratings required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer: A firm with at least 5 years of successful installation experience on projects with electrical wiring installation work similar to that in this project.
- C. Code Compliance: Comply with National Electrical Code (NFPA 70) and any and all local codes as applicable to construction and installation of electrical wiring devices, material, and equipment herein specified.
- D. UL Labels: Provide electrical cable, raceways, wire, connectors, outlets, switches, etc., which have been listed and labeled by Underwriters Laboratories.
- E. NECA Standard: Comply with applicable portions of National Electrical Contractor's Association's "Standard of Installation."

## 1.4 SUBMITTALS

- A. Submit shop drawings and product data in accordance with provisions of Submittals section.
- B. Provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.

## 1.5 MEASUREMENT AND PAYMENT

- A. All Work of this Special Provision is incidental to the lump sum Electrical bid item.

PART 2–PRODUCTS

## 2.1 RECEPTACLES

- A. GFCI Receptacle: Pass and Seymour 2095, Cooper TRVGF20 receptacle with integral

ground fault current interrupter. Receptacles shall be mounted vertically. GFCI receptacles shall not be series wired. Provide ivory color.

## 2.2 COVER PLATES

- A. While in use receptacle covers for exterior use shall be Leviton M5979, or equal.

## 2.3 CONTROL STATIONS

- A. Heavy-duty, oil-tight, 30 mm operators in NEMA 4X enclosures, unless otherwise noted. Control stations shall be Square D, Class 9001, Type SKY, Allen-Bradley Bulletin 800T, or equal, with operators as specified herein.

## PART 3-EXECUTION

### 3.1 INSTALLATION

- A. Convenience Receptacles: Specification grade self-grounding.
- B. Install devices and cover plates flush and level.
- C. Back-wiring is not allowed for receptacles. Wires shall be terminated with the device screw terminal.
- D. Individual labels shall be placed on the back of all receptacle faceplates indicating the pathway control cabinet, lighting panel, and circuit from which the switch or receptacle is fed. Labels shall be White background with Black lettering no smaller than 12-point font. Provide Pan Net permanently attached self-adhesive type, machine fed, and self-laminating labels, or equal. All labels must be by the same manufacturer, same size, and same font. Handwritten labels are not acceptable.

## OVERCURRENT PROTECTIVE DEVICES

PART 1–GENERAL

## 1.1 SUMMARY

- A. Work Included: Provide overcurrent protective devices as shown on the drawings, as specified herein, and as needed for a complete and proper installation.

## 1.2 SUBMITTALS

- A. Submit shop drawings and product data in accordance with provisions of Submittals section, including electrical ratings, physical size, interrupt ratings, trip curves,  $I^2t$  curves, and manufacturer's detailed specifications.

## 1.3 QUALITY ASSURANCE

- A. Comply with the following requirements:
  - 1. NFPA 70 National Electrical Code (NEC).
  - 2. Local codes and ordinances.
  - 3. Provide overcurrent protective devices by same manufacturer for each type of device.

## 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Comply with pertinent provisions of Materials and Equipment.
- B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

## 1.5 MEASUREMENT AND PAYMENT

- A. All Work of this Special Provision is incidental to the lump sum Electrical bid item.

PART 2–PRODUCTS

## 2.1 CIRCUIT BREAKERS

- A. General:
  - 1. Comply with UL 489 and NEMA AB1 requirements.
  - 2. Provide thermal and magnetic protection unless noted otherwise.
- B. Main and Feeder Breakers:
  - 1. Circuit breakers shall have a short-circuit interrupting rating as indicated on the Drawings.
  - 2. Field-Adjustable Thermal-Magnetic Trip Circuit Breaker: NEMA AB1. Provide circuit breakers with frame sizes 400 amperes and less with mechanism for adjusting instantaneous pickup setting for automatic operation. Range of adjustment shall be three to ten times the trip rating.

- C. All lugs shall be rated to accept copper conductors.

### PART 3-EXECUTION

#### 3.1 INSTALLATION

- A. Install overcurrent protective devices in accordance with manufacturer's recommendations.

#### 3.2 ADJUSTMENT

- A. Set and record adjustable settings on circuit breakers to provide selective coordination and proper operation.

## SURGE PROTECTIVE DEVICES (SPD)

PART 1–GENERAL

## 1.1 SUMMARY

- A. Work Included: Service entrance devices.

## 1.2 REFERENCES

- A. ANSI/IEEE C62.41 and C62.45.
- B. NFPA 70, and 75.
- C. UL 1449, most recent issue.

## 1.3 QUALITY ASSURANCE

- A. Manufacturers of surge protective devices. Firms regularly engaged in the manufacture of these products of the types and ratings whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer: A firm with at least 5 years of successful installation experience on projects with electrical wiring installation work similar to that in this project.
- C. Code Compliance: Comply with National Electrical Code (NFPA 70) and any and all local codes as applicable to construction and installation of electrical wiring devices, material, and equipment herein specified.
- D. UL Labels: Provide surge protective devices which have been listed and labeled by Underwriters Laboratories.
- E. NECA Standard: Comply with applicable portions of National Electrical Contractor's Association's "Standard of Installation."

## 1.4 SUBMITTALS

- A. Submit shop drawings and product data in accordance with provisions of Submittals section.
- B. Shop Drawings for Equipment Panels: Include wiring schematic diagram, wiring diagram, outline drawing, and construction diagram as described in ANSI/NEMA ICS 1. Test reports certified by the manufacturer shall be provided to Engineer upon request for each model submitted.

## 1.5 WARRANTIES

- A. Manufacturer shall provide a minimum 20-year warranty from the date of substantial completion to cover repair or replacement of the device. This warranty shall include the field replaceable plug-in modules and coordinated fuses.

## 1.6 MEASUREMENT AND PAYMENT

- A. All Work of this Special Provision is incidental to the lump sum Electrical bid item.

## PART 2—PRODUCTS

### 2.1 GENERAL

- A. These specifications describe the electrical and mechanical requirements for high energy transient voltage (service entrance panels) surge suppressors. The specified surge protective device shall provide effective energy surge diversion for application in ANSI/IEEE C62.41-2002 location Category C3 (service entrance). Testing shall be per ANSI/IEEE C62.45–2002 using ANSI/IEEE C62.41 Category C3 waveforms and amplitudes.
- B. The system individual units shall be UL listed under UL1449, latest edition, Standard for Surge Protective Devices (SPD). Surge ratings shall be permanently affixed to the SPD.
- C. Operating Temperature: Operating temperature range shall be -40°F to 131°F.
- D. Storage Temperature: Storage temperature range shall be -40°F to +185° F.
- E. Relative Humidity: Operation shall be reliable in an environment with 0% to 95% noncondensing relative humidity.
- F. Operating Altitude: The system shall be capable of operation up to an altitude of 13,000 feet above sea level.
- G. Design Life: >15 years.
- H. Operating Voltage: Maximum continuous operating voltage shall be no less than 115% of the nominal rated line voltage.
- I. Power Frequency: SPD power frequency shall be rated for use on 50 and 60 Hertz power systems.
- J. All SPDs shall be MOV type. Noise filtering capabilities shall be provided as an option for the devices specified herein.
- K. SPD shall be suitable for use in Type 2 locations.
- L. Unit shall provide maximum ANSI/UL 1449 VPRs for 240/120-volt, single-phase.
  1. L-N = 800 V.
  2. L-G = 900 V.
  3. N-G = 700 V.
  4. L-L = 1500 V.

### 2.2 SERVICE ENTRANCE DEVICES

- A. The maximum surge current capacity of the specified system, based on the standard IEEE 8/20 microsecond waveform, shall be at least 160 kA per phase. The surge life (8/20) shall be at least 6 kA for 10,000 occurrences or 10 kA at 20 kV for 16,000



occurrences. The transient suppression capability shall be bidirectional and suppress both positive and negative impulses. SPD shall have a nominal discharge rating ( $I_n$ ) of 10 kA.

- B. The SPD shall have a minimum Short Circuit Rating (SCCR) of 100 KAIC. The interrupt capability must be confirmed and documented by a recognized independent testing laboratory.
- C. The suppressor shall be designed so as to minimize the internal surge path impedance. Direct point-to-point internal wiring is inherently inductive and not acceptable. Connection to the power service shall be constructed as shown in the manufacturer's installation notes for best performance.
- D. The system shall be constructed using field replaceable plug-in modules. The module shall consist of multiple fuse protected metal oxide varistors. The status of each module shall be locally monitored with a red LED that will illuminate if the module protection is reduced. Protector shall provide redundant protection within each phase module with multiple surge rated fuses per module or one fuse per MOV.
- E. Red and green solid-state LED indicators shall be provided on the hinged front cover to indicate protection status. An illuminated green LED indicates power is present at the protector on all phases, and an illuminated red LED shall indicate that one or more of the modules have reduced protection. Both front panel and internal LEDs are required to provide power and fault indications. Relay operation shall be in a failsafe operating mode, i.e., continuously energized so that power failure, reduced protection, or a break in the remote monitoring line will cause a fault indication at the remote monitor. Neon indicators are not permitted.
- F. Relay alarm contacts shall be provided for remote alarm monitoring capability of unit status. Surge protected normally open and normally closed contacts shall be provided.
- G. The system shall be equipped with an audible alarm which shall be activated when any one or more of the modules has a reduced protection condition. A mute switch shall be provided for the audible alarm.
- H. A 14 gauge, NEMA Type 4, steel enclosure, with corrosion-resistant hardware shall be provided for the unit.
- I. Service entrance devices shall be as manufactured by MCG, 160M Series, Liebert LM, or equal.

## PART 3-EXECUTION

### 3.1 INSTALLATION

- A. The installation and testing of the system shall be in full accordance with the manufacturer's installation and maintenance instructions and all national and local codes.
- B. Each installed device shall be fed by an appropriately sized circuit breaker, per the manufacturer's installation notes, in the protected panel. No SPD shall be installed without an upstream overcurrent device.
- C. Units shall be installed as close as practical to the electrical panel. Low impedance

cabling furnished by the manufacturer shall be utilized for installations with lead lengths greater than, or equal to, 5 feet. Low impedance cabling furnished by the manufacturer or appropriately-sized standard cable, may be utilized for installations with lead lengths less than 5 feet. SPD leads shall be as short as possible for best performance.

- D. Manufacturer shall provide protection modules and coordinated fuses under a no-cost lifetime replacement warranty.

## EXTERIOR LIGHTING

PART 1–GENERAL

## 1.1 SUMMARY

- A. Work Included: Exterior lighting fixture work as shown on the drawings and in schedules.

## 1.2 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of exterior lighting fixtures of the types and rating for the project, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer: A firm with at least 5 years of successful installation experience on projects with exterior lighting fixture work similar to that in this project.
- C. NFPA Compliance: Comply with National Electrical Code as applicable to installation and construction of exterior lighting fixtures.
- D. NEMA Compliance: Comply with applicable portions of National Electrical Manufacturers Association Standards pertaining to outdoor lighting equipment.
- E. ANSI Compliance: Comply with applicable American National Standards pertaining to lamp materials and lighting ballasts.
- F. UL Labels: Provide exterior lighting fixtures which have been listed and labeled by Underwriters Laboratories.

## 1.3 SUBMITTALS

- A. Submit shop drawings and product data in accordance with provisions of Submittals section.
- B. Shop Drawings–Exterior Lighting Fixtures: Submit dimensioned drawings of installed exterior lighting fixtures, including, but not necessarily limited to, layout, conduit, wiring, etc. Submit fixture shop drawings in booklet form with a separate sheet for each fixture, assembled in luminary-type alphabetical order, with the proposed fixture and accessories clearly indicated on each sheet.

## 1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Deliver exterior lighting fixtures individually wrapped in factory-fabricated fiberboard-type containers.
- B. Handle exterior lighting fixtures carefully to prevent breakage, denting, and scoring the fixture finish. Do not install damaged lighting fixtures; replace and return damaged units to equipment manufacturer.
- C. Store exterior lighting fixtures in a clean, dry space. Store in original cartons and protect from dirt, physical damage, weather, and construction traffic.

## 1.5 MEASUREMENT AND PAYMENT

- A. All Work of this Special Provision is incidental to the lump sum Electrical bid item.

## PART 2–PRODUCTS

### 2.1 MATERIALS

- A. Furnish all labor and material necessary to install exterior lighting as indicated on the drawings and specified herein.
- B. Concrete foundations for poles shall be round, as shown on the drawings.
- C. Fixture schedule shows style of fixture, pole heights where poles are required, and basic IES distribution pattern. Contractor shall include all fittings, brackets, mounting plates, etc., for a proper installation. Contractor shall verify finish color with Engineer prior to releasing fixtures for fabrication.

## PART 3–EXECUTION

### 3.1 LIGHTING CONTROLS

- A. Light fixtures shall be controlled as specified herein and as shown on the Drawings. See Controls and Instrumentation for pathway lighting controls.

### 3.2 INSPECTION

- A. Examine the areas and conditions under which exterior lighting fixtures are to be installed, and notify Engineer of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

### 3.3 INSTALLATION

- A. Provide exterior lighting fixtures of the types indicated, where shown on the drawings and at the indicated heights, in accordance with the fixture manufacturer's written instructions and with recognized industry practices, to ensure that the fixtures comply with the requirements and serve the intended purposes. Comply with NEMA Standards and requirements of the National Electrical Code pertaining to installation of exterior lighting fixtures, and with applicable portions of NECA's "Standard of Installation."
- B. Entire exterior lighting assembly, including fixtures and poles, shall be capable of withstanding sustained winds of 100 mph.
- C. Fasten fixtures securely to indicated structural support, and check to ensure that fixtures are plumb.
- D. All bases for fixtures shall be provided by Contractor. Where square or rectangular poles or fixture heads are used, Contractor shall verify with Engineer the orientation of fixture heads and poles.

- E. Provide fixtures, poles, hardware, etc., for complete system.
- F. Ground all pole-mounted fixtures.

3.4 ADJUST AND CLEAN

- A. Clean exterior lighting fixtures of dirt and debris upon completion of installation.
- B. Protect installed fixtures from damage during the remainder of the construction period.

3.5 FIELD QUALITY CONTROL

- A. Upon completion of installation of exterior lighting fixtures and after branch supply circuitry has been energized, apply electrical energy to demonstrate capability and compliance with requirements. When possible, correct malfunctioning units at the site, then retest to demonstrate compliance; otherwise, remove and replace with new units and proceed with retesting. All testing shall take place at night.

## CONTROLS AND INSTRUMENTATION

### PART 1—GENERAL

#### 1.1 SUMMARY

- A. Related Sections:
  - 1. Controls and Instrumentation Drawings.

#### 1.2 SYSTEM DESCRIPTION

- A. The work includes furnishing, delivering, installing all items furnished, and modifying the existing Dubuque W&RRC Supervisory Control and Data Acquisition system (SCADA) to include the Bee Branch Creek Pathway lighting controls, creek level monitoring, and video surveillance. The SCADA System HMI configuration will be provided by others.
- B. System Supplier shall be defined as the fabricator, assembler, and supplier of all system components. This shall include, but not be limited to, all instrumentation as specified, all PLC cabinets and required interface hardware and internal wiring, the SCADA System computer, hardware, system drawings, and system software. See paragraph 1.08 for other System Supplier requirements.
- C. Contractor shall inspect all work. The Bid shall include everything necessary to obtain a complete installation operating in accordance with these specifications and the Bidder's proposal, whether necessary items and equipment are contained in, or are remote from the enclosures furnished under this Contract. All responsibility for this system ultimately lies with Contractor.
- D. Contractor shall be responsible for the placing of circuits and making of electrical connections in accordance with System Supplier-furnished drawings, instructions, and field supervision to ensure proper connection. Contractor shall include the services of a System Supplier factory engineer to supervise making of connections to power supplies, communication circuits, existing control equipment, and any other connections external to the new control equipment; adjust the equipment; initiate and check operation; instruct Contracting Authority's electrician on operation and maintenance of the equipment; and place the equipment in operation in a manner fully satisfactory to Engineer. This will include on-site review of software/hardware controls from the central control point.
- E. Any auxiliary interface relays and controls needed for completion of this project, if not specifically called for, shall be by System Supplier. All switches and control and indicating lights associated with the control panels shall be new and installed in the starter panels.

#### 1.3 QUALITY ASSURANCE

- A. System Suppliers: Firms regularly engaged in the design and manufacture of SCADA systems of the size and complexity specified herein, and whose systems have been in satisfactory use in similar service for not less than 10 years.
- B. Installer: A firm with at least 10 years of successful installation experience on projects with SCADA system design and installation work similar to that required for the project.

- C. Code Compliance: Comply with National Electrical Code (NFPA 70) and any and all local codes as applicable to construction and installation of electrical wiring devices, material, and equipment herein specified.
- D. UL Labels: Provide control panels, power supplies, controllers, relays, wire, and connectors that have been listed and labeled by Underwriters Laboratories.
- E. NECA Standards: Comply with applicable portions of National Electrical Contractor's Association's Standard of Installation.

#### 1.4 SUBMITTALS

- A. Manufacturer's Data: Submit manufacturer's data, specifications, and installation recommendations for each item specified herein.
- B. Submit shop drawings and product data in accordance with provisions of Submittals section.
- C. Provide product data on all equipment and devices specified herein as well as wiring schematics for all systems.
- D. Shop drawing submittals shall include the following information provided in booklet form:
  1. Detailed catalog information, descriptive literature, and specifications of hardware. All items being provided must be specifically noted on this literature.
  2. All field devices and instruments.
  3. Project implementation plan, including information on project organization, project management, engineering, programming, configuration, training, startup, and maintenance services. Plan shall include key personnel on project, point of contact, and communication protocol.
  4. Overall network schematic showing all controllers, and hardware addresses applicable to the system.
  5. Wiring diagrams for all pathway control cabinets.
  6. PLC I/O Listing.
  7. Database with PLC addresses.

#### 1.5 MEASUREMENT AND PAYMENT

- A. All Work of this Special Provision is incidental to the lump sum Electrical bid item.

#### 1.6 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provision of Submittals.
- B. Include spare parts data listing, source and current prices of replacement parts and supplies, and recommended maintenance procedures and intervals.
- C. Submit Operation and Maintenance Manuals. The following additional information shall apply:
  1. Manuals shall contain, but not be limited to, the following:
    - a. System Hardware.
    - b. System Software.
  2. Hardware section shall include:
    - a. Safety precautions, physical description, functional description, operating procedures, theory of operation, maintenance instructions, checkout

- procedures, troubleshooting procedures, servicing, and removal and replacement procedures.
  - b. Wiring schematic and logic diagrams, parts list, and point-to-point wiring.
  - c. Listing of all hardware timers installed, as well as the ranges set on each timer. Listing shall also include actual timer setting after completion of startup.
3. Software section shall include:
- a. Software manual shall describe system techniques, general philosophies, list, and description of all standard software.
  - b. Program documentation (i.e., PLCs) shall include programs, documentation files, database and configuration as installed. Provide two copies of backup disks of this information. Passwords for all programmable devices (i.e., PLCs, OIPs) shall be turned over to Contracting Authority at the time of final completion.

#### 1.7 DELIVERY, STORAGE, AND HOLDING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to PCC components, enclosure, and finish.

#### 1.8 DESCRIPTION OF THE UPPER BEE BRANCH CREEK PATHWAY

- A. The Upper Bee Branch Creek Pathway consists of five (three existing) combination lighting and security pathway control cabinets and one existing SCC that will be used to control lighting, receptacles, and security cameras along the new pathway.
- B. System Supplier shall be responsible for the development of all required process control functions based on the algorithms described in this specification. Many systems encompass several algorithms for system components. A listing of major process areas that will need software development for operation is as follows. The location for these areas as affected by the algorithm is included:
  - 1. Storm Water Pumping Station (SCC-200).
  - 2. Pathway Control Cabinets (PCC-1 and PCC-2).
- C. All process equipment shall be monitored and alarmed as described herein and listed in the I/O tables shown in the SCADA System I/O Listing. All analog and process equipment shall be monitored, totalized, indicated, recorded, and stored for reports and historical data.
- D. The individual station SCCs and the listing of control and monitoring functions are shown in the I/O Listing in the SCADA System I/O Listing. With the exception of the items listed as existing, all equipment shall be provided in this Contract.

#### 1.9 CONTRACTOR AND SYSTEM SUPPLIER GENERAL REQUIREMENTS

- A. This specification, along with the plans, defines the requirements of a PLC-based process monitoring and control system. System Supplier shall construct a process monitoring and control system specifically for the demanding requirements of a real-time municipal pumping station.



- B. It is the intent of this specification to define a fully integrated open-type process monitoring and control system, factory-tested, delivered to the site, ready to function upon connection of power source and field instrument wiring. Components, peripherals, interconnections, cabling, power supplies, software, and services necessary to form a complete, integrated system shall be identified and provided by Contractor. Contractor shall be responsible for reviewing the wiring diagrams and control sequences for equipment provided under other Special Provisions and coordinating all interface requirements. Contractor shall submit to Engineer, in writing, any deficiencies noted during this review. Any changes required by Contractor because of failure to complete this review shall be the responsibility of Contractor, at no increase in cost to Contracting Authority.
- C. Contractor shall be responsible for complete coordination in providing all equipment, sensors, and meters supplied with input and output signals, and contacts that are compatible with the systems as specified herein. Contractor shall also be responsible for complete coordination with manufacturers of other systems specified in other Special Provisions with which an interface is required. The Contract drawings and I/O Listing are symbolic representatives of the required work. It is not intended that the drawings show all appurtenances. Contractor shall provide a complete and working system according to the true intent and meaning of the drawings, specifications, and standard industry practices.
- D. To ensure a complete and totally integrated system, a single manufacturer who has experience in furnishing similar networked PLC-based monitoring and control systems of the same complexity and size for municipal pumping station facilities shall provide specified equipment and services. The system proposed to meet this specification shall be of field-proven design, incorporating manufacturer's standard equipment and software. Service of all peripheral devices shall be provided by the manufacturer of the process monitoring and control system.
- E. Design and specification of devices and completed system shall conform to applicable portions of the latest edition of the National Electrical Code (NEC).
- F. Control panels shall bear a serialized UL label indicating that it is UL approved as an assembled unit. Panels that have individual components that are UL labeled, but do not have UL approval as an assembled unit are not acceptable.
- G. Training Program:
1. Submit training plan including course syllabus, personnel who will be conducting the training, and schedule.
  2. Provide materials, instructors, and workbooks to complete the training.
  3. Training courses shall include:
    - a. Operator training. Course length minimum 4 hours. Training shall utilize equipment specified herein following installation and field testing.
    - b. Maintenance training. Course length minimum 4 hours. It should be assumed that maintenance training will occur a minimum of 2 weeks after the operator training described above.
  4. Manufacturer's training shall be directed to system and equipment operation, maintenance, troubleshooting, and equipment and system-related areas other than the process itself.
- H. System Supplier shall meet the following minimum requirements:
1. System Supplier shall have a full-time staff of qualified programmers who are knowledgeable in the configuration of networked computer systems and the PLCs being provided.
  2. System Supplier shall have a minimum of one Microsoft-certified engineer.

3. System Supplier shall have training capabilities and shall have conducted training courses in programming and maintenance.
  4. System Supplier shall have an adequate inventory of spare parts.
  5. System Supplier shall have a full-time staff of qualified service technicians.
  6. System Supplier shall be responsible for the programming and documentation of the system.
  7. System Supplier shall be responsible for all details that may be necessary to properly install, wire, adjust, and place in operation a complete and working system.
  8. System Supplier shall be responsible for all coordination between the system and the field devices, instrumentation equipment, motor control centers, and equipment furnished with other Special Provisions. This shall include interface with existing equipment.
- I. All components are to be standard make acceptable to Engineer, with one manufacturer to provide all similar components. The Base Bid Supervisory System System Supplier shall be L.W. Allen-Altronex, (608) 222-8622, Frakes Engineering, (317) 577-3000, Automatic Systems Company, (651) 631-9005, Integrated Process Solutions, (608) 849-4375, or Instrument Control Systems, (763) 559-0568. See General Conditions and Supplementary Conditions regarding substitutions to the Base Bid system suppliers.

#### 1.10 SYSTEM STARTUP AND SUPPORT SERVICES

- A. System Supplier shall be responsible for development of a formal address listing associated with each PLC and shall provide Engineer with an organized spreadsheet of all addresses to be used for programming of the HMI software specified herein. Point listing shall be provided in Microsoft Excel format, grouped individually for each PLC, and neatly organized into groups such as discrete I/O, analog I/O, setpoints, alarms, historical data, and dialer configuration. Points not used with the HMI software or for internal PLC logic shall be removed or hidden from the listing. Spreadsheet shall be sent to Engineer a minimum of 6 weeks prior to on-site startup and checkout. Any revisions made to the original spreadsheet shall be clearly identified by highlighting, colored text, or notes within the documents. Electronic files shall be named with the date and revision number.
- B. After being notified by Contractor that the equipment has been installed and is in full operating condition and ready for test, Engineer will make a one day trip to check operation. If the equipment does not operate according to the specifications, there will be deducted from payments due Contractor the amount of \$1,500 a day for Engineer's time plus travel and expenses, for all additional field and office time spent by Engineer checking equipment. Contracting Authority will deduct the amount of these charges from payments made to Contractor and will make payment to Engineer.
- C. Final acceptance and payment will not be made until the system has operated satisfactorily for a minimum of 30 consecutive days. Contractor shall include in Bid field follow-up to ensure proper adjustments and operation during the first year following project final completion. Prior to beginning the 30 day test, the following criteria shall be met:
1. Satisfactory operation of I/O control loops.
  2. Satisfactory operation of software.
  3. Satisfactory operation of control program.
  4. Satisfactory operation of peripheral equipment.
  5. The necessary debugging programs have been performed.
  6. Data output is reliable.
  7. Control loops are operational.

8. Checking and calibrating of systems have been completed.
- D. Contractor, through System Supplier, shall provide the following support services:
1. Field Service Engineer: Field service engineer shall be responsible for programming of system PLCs in the factory and at the site. Field service engineer shall be present for startup of all systems and available throughout the entire construction process until final completion. Service technicians sent for system startup will not be acceptable. Support shall include on-site time. Services shall include, but not be limited to:
    - a. Commissioning, installation, startup, and testing of equipment.
    - b. Revising or rewriting manuals to incorporate an installed and accepted system.
    - c. On-site training.
    - d. Software modifications.
  2. In-factory support shall include consultation following the acceptance testing and shipment. Services shall include, but not be limited to:
    - a. Researching and answering questions related to the system operation, documentation, and system use and functions.
    - b. Program modifications.
    - c. Revising or rewriting manuals.
  3. Post-startup support shall include follow-up services during the 1 year period following final acceptance. Service shall include follow-up recalibration and replacement of defective equipment, as well as additional training, software modifications, and control configurations as requested by Contracting Authority. This shall include 16 hours for work on-site other than warranty repair or replacement of defective equipment. This time shall be used for software enhancements and modifications to improve the operation of the system. It shall be assumed that this 16 hours includes two trips to the site.

#### 1.11 EQUIPMENT ENCLOSURES

- A. Plastic wiring troughs shall have removable covers. Maximum fill for wiring troughs shall be 60%. All wiring in supervisory enclosures and control panels not in wiring troughs shall be bound with continuous-type spiral windings. Terminal strips located adjacent to wiring troughs shall have a minimum of 1 1/2 inches between terminal strip and wiring trough.
- B. All wiring for new panels shall be done in the factory, Class II, Type C with master terminal strips for exterior connections. Terminal strips shall be located either at the bottom or on the side of the enclosure, depending on where the I/O conduits penetrate the enclosure. Splices are not allowed within enclosures or wireways. All enclosures must pass through doors to point of installation, and if enclosures are shipped in sections, all wiring and connections between sections shall be done by Contractor. All wiring shall be labeled at each end with corresponding numbers. This numbering shall be shown on the shop and record drawings.
- C. All components within the enclosures shall be identified with interior-mounted engraved labels. Labels shall be installed on the enclosure back panel and not on the device or wireway. Devices shall be grouped for each device or unit being controlled.
- D. All panels with DIN rail-mounted equipment shall include a minimum of 25% spare DIN rail space.
- E. In addition to spare I/O specified herein, provide a minimum of 25% spare hot and neutral terminals wired to terminal strips. Spares shall be provided for all voltage

sources within the panel (e.g., 120 V, 24 V).

#### 1.12 COMMON REQUIREMENTS ALL EQUIPMENT

- A. All indicating and recording devices shall be electric or electronic.
- B. All control power shall be 120 volts with suitable circuit protection (fuses or breakers). Fuse holders shall be provided with integral LEDs to indicate when the fuse is blown.
- C. Devices powered at 120 volts from pathway control cabinets shall be fused. This shall include, but not be limited to transducers.
- D. Provide lightning protection, isolation transformers, and fused disconnects at each end of each power circuit, supervisory circuit, and local supervisory circuit with transformers and relays, if necessary, to obtain supervisory power. 120 volt power shall be available at all control points. Lightning protection shall be completely solid-state and self-healing and shall not require the use of fuses. Provide a single switch with an indicating light to deenergize the control power for each location. Each panel shall have a GFI, duplex, 20 ampere, 120 volt receptacle.
- E. If enclosure and panel space is needed for future installation of devices and lights, the enclosure and panel shall be constructed for such installation. Supports shall be provided for future equipment, and panel openings shall be made and covered with neat cover plates matching the panel.
- F. Where equipment is necessary to perform a function as called for in one part of this specification, it shall be provided, even though the detailed enumeration at various control points may omit listing that equipment.
- G. Where a certain accuracy of sensing and transmitting levels and controlling operations are called for, means must be provided to read or determine that the levels are within the limits or accuracy specified of the sensing, transmitting, and controlling devices. Where no accuracy is specified, but a knowledge of levels is necessary to set operating points, an indicating device of accuracy consistent with the operation of the system is required.
- H. All control and auxiliary relays shall have indicating LEDs. All timing relays shall have On and timing Out LEDs.
- I. A condensation heater shall be provided in all control panels located outdoors. Condensation heater shall be as manufactured by Hoffman Model DAHX001, or equal, sized based on control panel and exterior temperature.

#### 1.13 GENERAL CONTROL ALGORITHMS

- A. Programming algorithms described herein and in Part 3–Execution shall reside within the PLC associated with that equipment and not in the master PLC.
- B. All alarm contacts or system changes following a command must exist or not change for 0 to 5 seconds to activate the SCADA System to the alarm state.
- C. All analog and digital inputs shall be monitored and totalized in the PLC. This shall include, but not be limited to levels. The PLC shall calculate maximum, minimum, and running average for all analog inputs. Instantaneous values, totals, maximum,

minimum, and average values shall be read by the HMI software and be reset on a daily basis as described below. Minimum, maximum, and average values shall be stored in the PLC for the current day and previous day.

- D. System Supplier shall provide addressing for all PLC fault codes so that the error number and associated description can be displayed at the SCADA system.
- E. The operator shall be able to set the processor clock and processor date in the master PLC from the HMI software. Clock and date setting shall be transmitted via the fiber-optic network from the master PLC to set the processor clock and date in the remote PLCs based on the setting in the master PLC. Coordinate communication with the master PLC to retrieve date and time data with Contractor.
- F. All analog signals shall be scaled to engineering units in the PLC with implied decimal to allow storage in integer registers. System Supplier shall provide all analog ranges, PLC register values, and associated scaling factors to Engineer for use with the HMI software. This shall include upper and lower limits of PLC registers (i.e., -32768 to 32767 or 0 to 65535), as well as upper and lower limits for the associated device (i.e., 0 to 150 psi). Analog values specified to be displayed with decimal points shall be scaled by the HMI software.
- G. For all level sensing devices, provide a Transducer Fail alarm at the SCADA system for each transducer. Transducer fail shall be defined as the signal from the transducer being out of range.
- H. Provide "Out of Service" indication for each piece of equipment when that equipment's PCC or SCADA H-O-A is not in the Auto position.
- I. All analog signals shall have associated high and low setpoints and alarms. Alarms shall be tied in to the existing dialer system.
- J. PLCs shall be set up so that the ranges of all analog input signals to the PLC I/O cards can be configured from the HMI software. Provide two operator-adjustable setpoints for each analog input, one corresponding to 4 mA and the other corresponding to 20 mA. This feature is intended to be used for startup and calibration purposes.
- K. All controlled equipment as described herein shall have the capability of manual control from the HMI software through the manipulation of analog or digital variables. This shall be through the use of a "SCADA H-O-A" switch or by forcing a single I/O point as a manual start command. All analog and digital outputs shall be capable of being manually set from the HMI software.
- L. Provide an analog PLC register for each piece of equipment with a SCADA H-O-A switch. Register shall be used for color animation associated with that equipment's HMI graphic object. Analog register value shall be as follows: 0 = Off/Out of Service, 1 = In Auto at MCC, 2 = PLC Call-to-Run, 3 = Running, 4 = Failed (Call-to-Run, Starter Overload, etc.). Precedence shall be given to the higher number conditions; for example, if a pump is In Auto but has failed, the register value shall be 4.
- M. The SCADA system shall allow the operator to change all setpoints and operating parameters within the PLCs as described herein. All control algorithms and alarms for equipment shall be programmed in the associated PLC and not in the master. There shall be no control algorithms or alarms in the computers. Control of each piece of equipment shall be accomplished as described herein and in Part 3–Execution of this section.

- N. The master PLC shall monitor the status of each remote and an alarm shall be generated at the SCADA system if communication is not received from the remote PLC within an operator-adjustable time period.
- O. Each PLC shall be set up so that the master PLC will monitor the scan cycle of each remote PLC. This shall be accomplished by the master PLC setting and resetting a bit internal to the master PLC program every 60 seconds. This bit shall then be sent to each remote PLC. Once this bit is received by the remote PLC, the remote PLC shall copy the value of this bit to a second bit internal to the remote PLC program. This second bit will be read by the master PLC. If the master does not see a change in status of the second bit, a remote PLC scan fail alarm shall be generated. The master PLC shall provide indication of which remote PLC is in alarm.
- P. Battery status of each remote PLC shall be monitored by the SCADA system. In the event of a low battery condition, an alarm shall be generated at the SCADA system.
- Q. Alarm functions shall be capable of being printed out listing both time and date of their occurrence, as well as acknowledgment, the operator that acknowledged the alarm, and the current state of the alarm. Any change in alarm state shall also be capable of being printed. These alarms shall list both station and type of alarm that has occurred. Again, based on demand, a log or record of 24 hour/30 day records shall be kept and stored both by hard copy as well as hard disk, CD, or tape backup. All alarm points shown on the I/O list, as well as those developed in PLC software, shall each be indicated individually at the SCADA system (i.e., no common alarms).

## PART 2-PRODUCTS

### 2.1 INDUSTRIAL CONTROL AND POWER RELAYS

- A. Industrial control and power relays shall be installed in supervisory control centers, motor control centers, industrial control panels, and where required by System Supplier. Relays used to interface with PLC I/O shall be terminal style, interposing/isolation relays. Relays for motor control circuits, hardwired control logic, and for loads less than 10 amps shall be general purpose, industrial, square base relays. Relays for lighting circuits and small motor loads shall be industrial, electrically held power relays.
- B. Relays shall meet the following requirements:
  - 1. Interposing/isolation relays:
    - a. Configuration: SPDT or DPDT as required by System Supplier.
    - b. Mounting: DIN rail with screw terminal base socket.
    - c. Voltage: 120 Vac, or as required by System Supplier.
    - d. Contact rating: 8 A (DPDT), 16 A (SPDT).
    - e. Operating life: 10 million cycles.
    - f. Status: On-Off flag-type or LED indicator.
    - g. UL listed.
    - h. Manufacturer: Allen-Bradley, 700-HK, or equal.
  - 2. General purpose relays:
    - a. Configuration: DPDT or 3PDT as required by System Supplier.
    - b. Mounting: DIN rail with screw terminal base socket.
    - c. Voltage: 120 Vac.
    - d. Contact rating: 15 A, minimum; 3/4 hp.
    - e. Operating life: 10 million cycles.

- f. Status: On-Off flag-type or LED indicator.
  - g. UL listed.
  - h. Manufacturer: Allen-Bradley, 700-HB, or equal.
3. Power relays:
- a. Configuration: Electrically held, 2-12 poles.
  - b. Mounting: DIN rail, square base.
  - c. Voltage: 120 Vac.
  - d. Contact rating: 20 A continuous; 1 hp.
  - e. Operating life: 10 million cycles.
  - f. UL listed.
  - g. NEMA rated.
  - h. Manufacturer: Allen-Bradley, 700-PK, or equal.

## 2.2 PLC TELEMETRY SYSTEMS AND PLC SOFTWARE

- A. All control signals, status signals, alarm, and variable analog data shall be transmitted and received between the existing master data gathering site (SCC-Main) at the W&RRC and the remote pathway control cabinets and Storm Water Pumping Station using the fiber-optic network.
- B. It shall be the responsibility of System Supplier to ascertain that all field devices are compatible and consistent with the new system design. This includes reviewing drawings and data to ascertain the compatibility and consistency of the system with the field devices on such considerations as:
  - 1. Power levels.
  - 2. Power sources.
  - 3. Logic schemes.
  - 4. Signal types and levels.
  - 5. Interface devices where required.
  - 6. All other aspects of field devices impacting on the design of the system.
- C. PLC Systems:
  - 1. System Supplier shall provide all the equipment necessary for data gathering, monitoring, and control as required to meet this specification and in accordance with the drawings. The PLC system equipment shall include, but not necessarily be limited to, the following:
    - a. PLC consisting of CPUs with adequate memory and instructions, local and remote I/O mounting racks, power supplies, I/O modules, communications modules and hardware, and all other components required to make the PLCs perform all the functions required in this specification. The PLCs shall be mounted in NEMA 12 or NEMA 4X enclosures as specified herein or as shown on the drawings; see Equipment Enclosures. The new PLC enclosures shall be completely assembled, prewired, and tested at System Supplier's factory.
    - b. Fiber-optic data highway cable system terminated to interconnecting hardware such as station connectors at the various SCC and pathway control cabinet system locations.
  - 2. PLC Programming and PLC Software: System Supplier shall provide all the PLC programming and PLC software required to meet this specification and shall be in accordance with the system configuration. The software shall include, but not necessarily be limited to, the following:
    - a. PLC logic programs to be written by System Supplier for the PLC systems to accomplish the monitoring and control functions as specified elsewhere in this specification. The supplier shall document and annotate the

- programs, update them as required after startup, and then turn the programs over to Contracting Authority in the form of compact disks; two copies are required.
- b. System Supplier shall coordinate the I/O database in each PLC with the Programmer of the HMI Software. All I/O addressing that is to be viewed or manipulated by the HMI Software shall be organized into contiguous blocks of integer registers to facilitate block data transfer between computers and PLCs. The I/O addressing shall be made available to Contracting Authority during shop drawing review (see item 2.01-SCADA System Computers and Software).
3. Engineering:
    - a. System Supplier shall provide all engineering necessary to accomplish and document the requirements of this specification and in accordance with the system configuration. The engineering to be performed by System Supplier on this project shall include, but not be limited to, the following categories:
      - (1) PLC system layouts.
      - (2) Panel layouts.
      - (3) I/O configuration and wiring drawings.
      - (4) PLC programming.
      - (5) Fiber-optics communication layout.
      - (6) Network layout.
    - b. Submittals: In addition to submittals previously described provide:
      - (1) Shop drawing and product data.
      - (2) PLC logic programs.
      - (3) Recommended spare parts lists.
    - c. Installation: Contractor shall install all the system equipment including PLCs and local I/O enclosures, and interconnecting cabling as required. This work shall include all interconnection wiring from new and existing equipment as required for completion of the system.
  4. The PLC shall be a microprocessor-based controller.
  5. The PLC processor shall meet the following minimum general specifications:
    - a. Voltage: 100 to 130 Vac.
    - b. Frequency: 47 to 63 Hz.
    - c. Temperature: 0 to 60°C.
    - d. Humidity: 5 to 95% noncondensing.
    - e. RFI: MIL-STD-461B.
    - f. EMI: IEEE 472-1974.
  6. The PLC processor shall have the following minimum features:
    - a. 1 MB of battery-backed static RAM.
    - b. 1 GB nonvolatile memory (Secure Digital).
    - c. Utilize 32-Bit Architecture.
    - d. Solve 1K words of logic in 0.9 milliseconds.
    - e. I/O scan time of 0.225 milliseconds per I/O rack.
    - f. Real-time clock.
    - g. Selectable timed interrupts.
    - h. Local I/O capability of 30 modules.
    - i. Memory protection.
    - j. Two Ethernet communications ports for fiber-optic data communications.
    - k. Remote I/O capability.
    - l. Status indicators.
  7. The PLC must be capable of performing the necessary logic to control the system. PLC capabilities shall include, but not be limited to, the following:



- a. Discrete I/O (120 Vac, isolated, or 24 Vdc with DC battery controller, as required).
  - b. Isolated analog input (4-20 mA).
  - c. Isolated analog output (4-20 mA).
  - d. Timers.
  - e. Latch/unlatch relays.
  - f. Counters.
  - g. Comparators (setpoints for analog level).
  - h. Relay ladder logic.
8. The PLC must be capable of self-diagnosing the following error conditions resulting in orderly shutdown of the unit and annunciation of an error condition.
    - a. Memory parity error.
    - b. Loss of signal communication between master and I/O.
    - c. Loss of logic power.
    - d. Halt or interrupt of memory scan.
    - e. Detection of incomplete relay ladder rungs in memory.
  9. The PLCs shall be of the modular hardware style as manufactured by Allen-Bradley CompactLogix, or equal to match Contracting Authority's existing equipment, with all accessories required to perform the operations described herein and to communicate with the fiber-optic data highway system.
  10. Environmental ratings for all components of the PLC system shall meet or exceed the following requirements:
    - a. Humidity rating of 0% to 95% relative humidity.
    - b. Ambient temperature rating 32° to 131°C.
  11. The vendor shall be able to attest that the PLC system has been designed and tested to operate in an industrial environment with all its associated electrical noise.
  12. All components comprising the PLC system shall be manufactured by a company regularly engaged in the manufacture of programmable controllers.
  13. The power supply shall be protected against short circuits.
  14. The power supply shall contain its own overcurrent and overvoltage protection.
  15. In the event of power loss, register or ladder information shall be retentive.
  16. To allow monitoring of a malfunctioning machine or process, it shall be possible to connect or disconnect programming equipment at all times, even when the system is running.
  17. Each PLC enclosure shall include, but not be limited to, the following equipment:
    - a. Main PLC processor.
    - b. Main power supply.
    - c. I/O modules and housing.
    - d. Computer-grade transient and spike suppressor.
    - e. Rail mounted terminal blocks for field wiring terminations.
    - f. Plastic wiring ducts.
    - g. General purpose duplex GFCI receptacle.
    - h. 15 A, 120/240 Vac, branch circuit breakers to feed to the main PLC controller and the I/O controlled field devices.
    - i. Other accessories required to provide a complete and working PLC system.
    - j. True on-line UPS backup for the SCC.
    - k. Slot fillers for any unused I/O module slots.
  18. The main PLC processor shall receive power from their individual power supplies, which shall be fed from dedicated 15 ampere circuit breakers through transient and spike suppressors.
- D. System Supplier shall provide a complete list of spare parts required and where they may be obtained for operating the system for 3 years from startup.

- E. The equipment mounted within the enclosures shall be mounted on the enclosure back panel, neatly organized, and shall be in accordance with the manufacturer's recommendations.
  - 1. All wiring within the enclosure shall be through the plastic wiring ducts. All wiring not in ducts shall be in plastic spiral bindings. All I/O devices shall be wired to rail mounted terminal blocks.
  - 2. All field wiring shall terminate at the rail mounted terminal blocks that shall be mounted either at the bottom or on the side of the enclosure back panel depending on where the I/O conduits penetrate the enclosure.
  - 3. The field wiring terminals shall be clearly identified as to which I/O terminals they are wired.
  - 4. Jumpers between adjacent terminal blocks shall be copper jumper bars supplied by the terminal block manufacturer.
  
- F. The color code for panel and field wiring shall be as follows:
  - 1. Discrete 120 Vac Input:
    - a. Hot Wire: Red.
    - b. Neutral Wire: White.
    - c. Switched Wire: Brown.
  - 2. Discrete 120 Vac Output:
    - a. Hot Wire: Red.
    - b. Switched Wire: Dark Blue.
  - 3. 120 Vac Panel Power:
    - a. Hot Wire: Red.
    - b. Neutral Wire: White.
    - c. Ground Wire: Green.
  - 4. Intrinsically Safe: Light Blue.
  
- G. 24 Vdc power supplies shall be provided and installed in the enclosures for powering all analog input signals where required.
  
- H. Current-to-current isolators shall be provided and installed in remote-mounted enclosures for isolating all existing analog input signals. NEMA rating of enclosures shall be as required for the area where installed.
  
- I. Manufacturer of Accessories:
  - 1. The plastic wiring duct shall be Electrovert "Electro-Duct," Panduit, or equal.
  - 2. Terminal blocks shall be Phoenix Contact UK 5 N, or equal.
  - 3. Wire markers shall meet the requirements of Electrical Identification.
  - 4. Circuit breakers shall be Square D Type QO with mounting bases, or equal. Circuit breakers can be of the rail mounted type such as Square D, Class 9080, Type GCB-150, or equal.
  - 5. Power supplies shall be Sola, rail mount, SPD or SDN Series, or equal.
  - 6. Signal conditioners shall be Action Instruments, DIN rail mount, or equal.
  
- J. System Supplier shall provide for the design and layout of the fiber-optic communication system between the SCC and lighting control cabinets being provided. Spare runs of fiber-optic cable shall have connectors provided and be run to each terminating location.
  
- K. System Supplier shall provide the necessary communication modules within the systems to allow the systems to communicate with the fiber-optic cabling.

- L. System Supplier shall provide the necessary fiber-optic cable, fiber-optic termination units, connector kits, and terminator sets, as specified herein, to provide complete and working communication between the existing SCCs and new SCC and pathway control cabinets. The installation of the fiber-optic cable shall be by Contractor, with supervision by System Supplier.

### 2.3 TVSS DEVICES FOR CONTROL PANELS AND INSTRUMENTATION EQUIPMENT

- A. The incoming power supply of each lighting control cabinet or supervisory control center shall be protected with a transient voltage surge suppression (TVSS) device. TVSS unit shall be as manufactured by Citel Model DS4xS, or equal.
- B. Each analog signal entering or leaving a supervisory control center or pathway control cabinet and leaving a building shall be provided with a DIN-rail mounted surge protection device as manufactured by Citel, Model DLA-24D3, or equal. Each transmitter shall be provided with a surge protection device as manufactured by Citel Model TSP15M, or equal, on the output and Citel Model DS4xS, or equal, on the power supply.

## PART 3-EXECUTION

### 3.1 PATHWAY CONTROL CABINET (PCC)-GENERAL

- A. UPSs installed in pathway control cabinets shall be provided as specified herein with a relay IO module that provides a dry contact output to the PLC in the event that the UPS batteries need replacement. Indication of "Replace UPS Battery" shall be provided at the SCADA System.
- B. Control descriptions described herein are specific in nature to equipment associated with the SCCs. Contractor shall refer to Section 1.13-General Control Algorithms for additional programming requirements.
- C. Provide a power fail relay in each pathway control cabinet that shall be used for control power fail alarm as well as indication that operation is from the UPS. Control power fail wiring shall be hardwired and not through the PLC.
- D. All control algorithms and alarms described herein shall be programmed into the PLC for the associated I/O interfaces. Refer to the I/O listing for all required I/O that shall interface with each PLC. A minimum of 25% spares shall be provided for each type of input and output used.

### 3.2 EXISTING SUPERVISORY CONTROL PANEL 200 MODIFICATIONS (SCC-200, STORM WATER PUMPING STATION)

- A. This SCC contains an Allen-Bradley CompactLogix PLC which includes a digital input from an exterior photocell. This PLC shall send a photocell status signal over the fiber-optic Ethernet/IP network to each remote PLC for control of light fixtures and receptacles associated with each pathway control cabinet (PCC-1 through PCC-5).

### 3.3 PCC-1 (UPPER BEE BRANCH CREEK PATHWAY CONTROL CABINET)

- A. Contractor shall provide a new back panel-mounted (maximum 16 inches wide by 20 inches high) PLC, contactors, and auxiliary devices specified herein in a section of this

pathway control cabinet and all work required to incorporate the database as specified herein. Provide terminal blocks on the back panel for termination of all field wiring. The PCC is provided as specified in Cabinets and Enclosures and will be located where shown on the Drawings. Refer to the I/O listing for all required I/O that shall interface with this PLC.

- B. The Inlet Structure ultrasonic level transmitter (LIT-03) shall be installed in a stainless steel enclosure and mounted on the side of this PCC. Provide stainless steel unistrut supports as required.
- C. This PLC shall receive a photocell status signal via the fiber-optic Ethernet/IP network from the existing SCC-200 for control of light fixtures and receptacles powered through this PCC.
- D. The exterior light fixtures shall be controlled from this PLC as described below.
  - 1. There shall be four groups setup as follows:
    - a. Group A-Pathway Lighting.
    - b. Group B-Street Lighting.
    - c. Group C-Flagpole Lighting.
    - d. Group D-Underdeck Bridge Lighting.
  - 2. Each group shall have a SCADA H-O-A selector switch which shall function as follows:
    - a. In SCADA "Hand", the lights shall be energized.
    - b. In SCADA "Auto", there shall be three control options for each group setup in the PLC, and the operator shall have the ability to select one of the following for each group:
      - (1) Option 1—Time clock. Provide two operator adjustable time-of-day "On-Time" and "Off-Time" (hour and minute) setpoints per day to energize and de-energize the light fixtures.
      - (2) Option 2—Photocell. Fixtures shall be energized and de-energized based on the state of the photocell, which is wired to this PLC.
      - (3) Option 3—Time clock and photocell. Fixtures shall be energized by the photocell and de-energized by the time clock. An operator adjustable "Off-time" setpoint (hour and minute) shall be setup in this PLC. Setpoint shall be separate from that described above for Option 1.
  - 3. The state of each lighting group shall be monitored at the SCADA System.
  - 4. Provide three two-pole and one four-pole lighting contactors in this PCC that shall be wired to the associated circuits in LP-1A for control of the light fixtures.
- E. The exterior receptacles shall be controlled from this PLC as described below.
  - 1. There shall be two groups setup as follows:
    - a. Group A-Pathway Pole Receptacles
    - b. Group B-Street Pole Receptacles
  - 2. Each group shall have a SCADA H-O-A selector switch which shall function as follows:
    - a. In SCADA "Hand", the receptacles shall be energized.
    - b. In SCADA "Auto", there shall be three control options for each group setup in the PLC, and the operator shall have the ability to select one of the following for each group:
      - (1) Option 1—Time clock. Provide two operator adjustable time-of-day "On-Time" and "Off-Time" (hour and minute) setpoints per day to energize and de-energize the receptacles.
      - (2) Option 2—Photocell. Receptacles shall be energized and de-energized based on the state of the photocell, which is wired to this PLC.
      - (3) Option 3—Time clock and photocell. Receptacles shall be energized by

the photocell and de-energized by the time clock. An operator adjustable "Off-time" setpoint (hour and minute) shall be setup in this PLC. Setpoint shall be separate from that described above for Option 1.

3. The state of each receptacle group shall be monitored at the SCADA System.
  4. Provide one two-pole and one six-pole receptacle power contactors in this PCC that shall be wired to the associated circuits in LP-1B for control of exterior receptacles.
- F. The high water level warning light powered from this PCC shall be controlled from this PLC based on the channel level (LIT-03 through LIT-06) as follows: When the level of the channel measured by any of the level transducers rises above an operator-adjustable level setpoint (0.00 to 20.00 feet), the warning light shall be activated. The light shall deactivate when the channel level measured by all transducers falls below the level setpoint.

### 3.4 PCC-2 (UPPER BEE BRANCH CREEK PATHWAY CONTROL CABINET)

- A. Contractor shall provide a new back panel-mounted (maximum 16 inches wide by 20 inches high) PLC, contactors, and auxiliary devices specified herein in a section of this pathway control cabinet and all work required to incorporate the database as specified herein. Provide terminal blocks on the back panel for termination of all field wiring. The PCC is provided as specified in Cabinets and Enclosures and will be located where shown on the Drawings. Refer to the I/O listing for all required I/O that shall interface with this PLC.
- B. This PLC shall receive a photocell status signal via the fiber-optic Ethernet/IP network from the existing SCC-200 for control of light fixtures and receptacles powered through this PCC.
- C. The exterior light fixtures shall be controlled from this PLC as described below.
  1. There shall be two groups setup as follows:
    - a. Group A-Pathway Lighting.
    - b. Group B-Street Lighting.
  2. Each group shall have a SCADA H-O-A selector switch which shall function as follows:
    - a. In SCADA "Hand", the lights shall be energized.
    - b. In SCADA "Auto", there shall be three control options for each group setup in the PLC, and the operator shall have the ability to select one of the following for each group:
      - (1) Option 1–Time clock. Provide two operator adjustable time-of-day "On-Time" and "Off-Time" (hour and minute) setpoints per day to energize and de-energize the light fixtures.
      - (2) Option 2–Photocell. Fixtures shall be energized and de-energized based on the state of the photocell, which is wired to this PLC.
      - (3) Option 3–Time clock and photocell. Fixtures shall be energized by the photocell and de-energized by the time clock. An operator adjustable "Off-time" setpoint (hour and minute) shall be setup in this PLC. Setpoint shall be separate from that described above for Option 1.
  3. The state of each lighting group shall be monitored at the SCADA System.
  4. Provide one two-pole and one four-pole lighting contactors in this PCC that shall be wired to the associated circuits in LP-2A for control of the light fixtures.
- D. The exterior receptacles shall be controlled from this PLC as described below.
  1. There shall be two groups setup as follows:
    - a. Group A-Pathway Pole Receptacles
    - b. Group B-Street Pole Receptacles

2. Each group shall have a SCADA H-O-A selector switch which shall function as follows:
    - a. In SCADA "Hand", the receptacles shall be energized.
    - b. In SCADA "Auto", there shall be three control options for each group setup in the PLC, and the operator shall have the ability to select one of the following for each group:
      - (1) Option 1—Time clock. Provide two operator adjustable time-of-day "On-Time" and "Off-Time" (hour and minute) setpoints per day to energize and de-energize the receptacles.
      - (2) Option 2—Photocell. Receptacles shall be energized and de-energized based on the state of the photocell, which is wired to this PLC.
      - (3) Option 3—Time clock and photocell. Receptacles shall be energized by the photocell and de-energized by the time clock. An operator adjustable "Off-time" setpoint (hour and minute) shall be setup in this PLC. Setpoint shall be separate from that described above for Option 1.
  3. The state of each receptacle group shall be monitored at the SCADA System.
  4. Provide one two-pole and one six-pole receptacle power contactors in this PCC that shall be wired to the associated circuits in LP-2B for control of exterior receptacles.
- E. The high water level warning lights powered from this PCC shall be controlled from this PLC based on the channel level (LIT-03 through LIT-06) as follows: When the level of the channel measured by any of the level transducers rises above an operator-adjustable level setpoint (0.00 to 20.00 feet), the warning lights shall be activated. The light shall deactivate when the channel level measured by all transducers falls below the level setpoint.

### 3.5 EXISTING PCC-3 MODIFICATIONS (UPPER BEE BRANCH CREEK PATHWAY CONTROL CABINET)

- A. This PCC contains an Allen-Bradley CompactLogix PLC which shall receive a photocell status signal via the fiber-optic Ethernet/IP network from SCC-200 for control of exterior light fixtures and exterior receptacles powered from this PCC.
- B. The existing PLC program contains four groups of exterior light fixtures and two groups of exterior receptacles with controls as described under PCC-1. Upon connection of the fiber-optic network to this PCC, verify functionality of all existing exterior light fixture and exterior receptacle groups using Option 2 and Option 3 in SCADA "Auto". Provide programming modifications as required to match functionality of each option as described herein.
- C. The existing PLC program contains high water level warning light controls as described under PCC-1. Upon connection of the fiber-optic network to this PCC, verify functionality of existing high water level warning light controls when either LIT-03 or LIT-04 measures a channel level above the level setpoint. Provide programming modifications as required to match functionality described herein.

### 3.6 EXISTING PCC-4 MODIFICATIONS (UPPER BEE BRANCH CREEK PATHWAY CONTROL CABINET)

- A. This PCC contains an Allen-Bradley CompactLogix PLC which shall receive a photocell status signal via the fiber-optic Ethernet/IP network from SCC-200 for control of exterior light fixtures and exterior receptacles powered from this PCC.
- B. The existing PLC program contains three groups of exterior light fixtures and two groups of exterior receptacles with controls as described under PCC-1. Upon connection of

the fiber-optic network to this PCC, verify functionality of all existing exterior light fixture and exterior receptacle groups using Option 2 and Option 3 in SCADA "Auto". Provide programming modifications as required to match functionality of each option as described herein.

#### 3.4 EXISTING PCC-5 MODIFICATIONS (UPPER BEE BRANCH CREEK PATHWAY CONTROL CABINET)

- A. This PCC contains an Allen-Bradley CompactLogix PLC which shall receive a photocell status signal via the fiber-optic Ethernet/IP network from SCC-200 for control of exterior light fixtures and exterior receptacles powered from this PCC.
- B. The existing PLC program contains five groups of exterior light fixtures and three groups of exterior receptacles with controls as described under PCC-1. Upon connection of the fiber-optic network to this PCC, verify functionality of all existing exterior light fixture and exterior receptacle groups using Option 2 and Option 3 in SCADA "Auto". Provide programming modifications as required to match functionality of each option as described herein.
- C. The existing PLC program contains high water level warning light controls as described under PCC-1. Upon connection of the fiber-optic network to this PCC, verify functionality of existing high water level warning light controls when either LIT-03 or LIT-04 measures a channel level above the level setpoint. Provide programming modifications as required to match functionality described herein.

## CONTROLS AND INSTRUMENTATION DRAWINGS

### PART 1-GENERAL

#### 1.1 SUBMITTALS

- A. Submit drawings in accordance with provisions of Submittals section.

#### 1.2 COORDINATION

- A. The requirements set forth in this section are intended to apply to the drawings provided as specified in Controls and Instrumentation.

#### 1.3 MEASUREMENT AND PAYMENT

- A. All Work of this Special Provision is incidental to the lump sum Electrical bid item.

### PART 2-PRODUCTS

NOT APPLICABLE

### PART 3-EXECUTION

#### 3.1 GENERAL REQUIREMENTS

- A. All drawings shall have the following information:
  1. Project information, including name of Contracting Authority and specific project name.
  2. Drawing title, accurately representing what is on the drawing.
  3. Unique drawing identifier, consisting of a unique drawing number or drawing number with individual sheet number. If sheet numbers are used, total number of sheets must be identified on each sheet.
  4. System Supplier company name, address, and phone number.
  5. Original design information, including person responsible for design, date of original design, person responsible for checking of design, and date of design check.
  6. Revision block indicating revision number, date, description of revision, and person responsible for revision.
- B. All drawings shall have line numbers that can be uniquely referenced from other drawings.
- C. All drawings showing wiring shall include unique wire numbers assigned to wiring that is installed between devices in the panel. The wire number shall be shown on the drawings.
- D. All drawings showing relays shall include reference to the drawings where the relay contacts are shown. Spare relay contacts that are not used shall be identified.

#### 3.2 DRAWINGS REQUIRED

- A. Index of Drawings: Index of Drawings shall list drawing number, sheet number (if applicable), and drawing title for each drawing in drawing package.



- B. Symbol Sheet: Symbol Sheet shall include:
1. Explanation of all symbols used on the drawings, including, but not limited to, normally open/normally closed contacts, flow switches, selector switches, pushbuttons, timers, control relays, fuses, circuit breakers, terminal blocks, and contactors. Symbol sheet does not need to be specific to project, but must contain explanation of all symbols used on the drawings (i.e., special symbols used for a particular project must be added to standard symbol sheets).
  2. List of abbreviations used on the drawings.
  3. Explanation of continuation method for circuits that cannot be shown on a single sheet.
- C. Exterior Enclosure Layout Drawing: Exterior layout drawing shall show location of all externally-mounted equipment. Exterior layout drawing shall include:
1. Enclosure dimensions, enclosure NEMA rating (i.e., NEMA 12, NEMA 4X stainless steel, etc.), and enclosure color or finish.
  2. Location and actual depiction of panel latches, hinges, mounting holes and lifting eyes.
  3. Location and accurate representation of equipment mounted on enclosure (i.e., switches should look like actual switches being installed; indicating lights should look like actual lights being installed).
  4. Equipment nameplate location.
  5. Description for each piece of equipment or unique identifier and parts list, or bill of materials.
  6. Nameplate list including nameplate wording, size, construction (i.e., lamicoid with Black background and White letters), and mounting method (i.e., stainless steel screws). Label size must include size in inches or reference to standard sizes included on symbol sheet, or elsewhere in drawing package.
  7. Identification of area reserved for equipment located inside enclosure, but not actually mounted on enclosure back panel, such as UPSs, fiber optic patch panels, and lighting packages.
- D. Interior Enclosure Layout Drawing: Interior layout drawing shall show location of all internally-mounted equipment. Interior layout drawing shall include:
1. Back panel dimensions and finish.
  2. Location and accurate representation of equipment (i.e., terminal blocks should look like actual terminal blocks; receptacle should look like actual receptacle, etc.).
  3. Dimensions of internally-mounted equipment are not necessary, but equipment should be drawn to scale such that an accurate representation of the way equipment will be mounted is shown on the drawing.
  4. Description for each piece of equipment or unique identifier and parts list, or bill of materials.
- E. Interconnection Diagram, Network Diagram or Block Diagram: Interconnection diagram, Network Diagram or Block Diagram shall show all cabling between system components and identify any station addressing or node numbers that are assigned to equipment. All cables shall be identified by cable type, including specific manufacturer and model/part number. Party responsible for furnishing and installing cable shall also be included. Some examples of cables that must be shown are:
1. Communications cables between system components (fiber and/or copper). This includes fiber optic jumpers between fiber patch panels and equipment, and Ethernet patch cables between switches and devices.
  2. Communications cables (fiber and/or copper) between PLCs, controllers, operator interface equipment and security devices (e.g., card readers, electric strikes) that are not shown on the elementary schematics.

- F. Elementary Schematic: Elementary schematics shall be developed for each motor or supplied equipment and shall include:
  - 1. Nominal voltage, AC or DC designation, number of phases (if AC), and frequency in hertz (if AC) for each source of electrical supply to the enclosure.
  - 2. Prospective short-circuit current available at the point of electrical supply to the enclosure.
  - 3. Type of power supply system grounding (e.g., wye phase midpoint grounded, delta phases corner grounded, wye phases ungrounded, delta phases ungrounded, etc.).
  - 4. Complete documentation of electrical circuit from supply to motor or supplied equipment. Documentation shall include disconnecting means, main overcurrent protection (when supplied), branch overcurrent protection (when supplied), control circuit and special purpose control protection, motor control, overload protection, local disconnect (when supplied) and motor horsepower, and full load amps from nameplate or supplied equipment full load amps.
  - 5. Documentation of PLC or controller inputs and outputs.
  - 6. Documentation of all circuit breaker/motor protector ratings, fuse sizes, control power transformer VA ratings, dip switch settings, etc.
  
- G. Wiring Diagram: Wiring diagrams shall show all terminations for all cables external to the enclosure. Terminations may be shown on the elementary schematics as long as the termination information is concise and easily understood by the personnel installing the field wiring. Termination information shall be shown for all devices, including devices that are not part of System Supplier's scope of supply. A box with two dots or continuation arrows indicating continuation to a piece of equipment are not acceptable.
  
- H. Functional Testing Recommendations: Testing recommendations shall include description of functional tests that must be performed by operators. Functional test description shall be included for UPS, indicating lights, and other devices whose condition can only be determined by testing.

### 3.3 SAMPLE DRAWINGS

- A. Sample drawings showing an acceptable format are included in the appendix. The samples included in the appendix do not represent the only acceptable method of showing the required information.

BEE BRANCH: MISSISSIPPI RIVER TRAIL  
 SB-IA-2100(675)--7T-31  
 CITY OF DUBUQUE  
 SCADA SYSTEM I/O LISTING - PATHWAY CONTROL CABINET-1

SCC	EQUIPMENT NAME	NUMBER	DI	D	AI	A	WIRE	COMMENTS
PCC-1	REPLACE UPS BATTERY		1	0	0	0	2-#14	FROM UPS IN THIS PCC
PCC-1	CONTROL POWER FAIL		1	0	0	0	2-#14	FROM CONTROL POWER RELAY IN THIS PCC
PCC-1	PLC BATTERY FAIL		0	0	0	0	--	FROM LOGIC WITHIN THIS PLC
PCC-1	EXTERIOR LIGHTING - GROUP A		0	1	0	0	2-#14	TO GROUP A LIGHTING CONTACTOR IN THIS PCC
PCC-1	EXTERIOR LIGHTING - GROUP B		0	1	0	0	2-#14	TO GROUP B LIGHTING CONTACTOR IN THIS PCC
PCC-1	EXTERIOR LIGHTING - GROUP C		0	1	0	0	2-#14	TO GROUP C LIGHTING CONTACTOR IN THIS PCC
PCC-1	EXTERIOR LIGHTING - GROUP D		0	1	0	0	2-#14	TO GROUP D LIGHTING CONTACTOR IN THIS PCC
PCC-1	EXTERIOR LIGHTING STATUS - GROUP A		1	0	0	0	2-#14	FROM AUX CONTACT ON GROUP A CONTACTOR IN
PCC-1	EXTERIOR LIGHTING STATUS - GROUP B		1	0	0	0	2-#14	FROM AUX CONTACT ON GROUP B CONTACTOR IN
PCC-1	EXTERIOR LIGHTING STATUS - GROUP C		1	0	0	0	2-#14	FROM AUX CONTACT ON GROUP C CONTACTOR IN
PCC-1	EXTERIOR LIGHTING STATUS - GROUP D		1	0	0	0	2-#14	FROM AUX CONTACT ON GROUP D CONTACTOR IN
PCC-1	EXTERIOR RECEPTACLES - GROUP A		0	1	0	0	2-#14	TO GROUP A RECEPTACLE CONTACTOR IN THIS PCC
PCC-1	EXTERIOR RECEPTACLES - GROUP B		0	1	0	0	2-#14	TO GROUP B RECEPTACLE CONTACTOR IN THIS PCC
PCC-1	EXTERIOR RECEPTACLES STATUS -		1	0	0	0	2-#14	FROM AUX CONTACT ON GROUP A CONTACTOR IN
PCC-1	EXTERIOR RECEPTACLES STATUS -		1	0	0	0	2-#14	FROM AUX CONTACT ON GROUP B CONTACTOR IN
PCC-1	CHANNEL LEVEL AT GARFIELD AVE INLET	LIT-03	0	0	1	0	SH. PR.	FROM ULTRASONIC LEVEL TRANSMITTER ON THIS PCC
PCC-1	HIGH WATER LEVEL WARNING LIGHTS		0	1	0	0	2-#14	TO HWL WARNING LIGHTS LIGHTING CONTACTOR IN
PCC-1	HIGH WATER LEVEL WARNING LIGHTS STATUS		1	0	0	0	2-#14	FROM AUX CONTACT ON HWL WARNING LIGHTS CONTACTOR IN THIS PCC.
	***TOTALS***		9	7	1	0		

BEE BRANCH: MISSISSIPPI RIVER TRAIL  
 SB-IA-2100(675)--7T-31  
 CITY OF DUBUQUE  
 SCADA SYSTEM I/O LISTING - PATHWAY CONTROL CABINET-2

SCC	EQUIPMENT NAME	NUMBER	DI	D	AI	A	WIRE	COMMENTS
PCC-2	REPLACE UPS BATTERY		1	0	0	0	2-#14	FROM UPS IN THIS PCC
PCC-2	CONTROL POWER FAIL		1	0	0	0	2-#14	FROM CONTROL POWER RELAY IN THIS PCC
PCC-2	PLC BATTERY FAIL		0	0	0	0	--	FROM LOGIC WITHIN THIS PLC
PCC-2	EXTERIOR LIGHTING - GROUP A		0	1	0	0	2-#14	TO GROUP A LIGHTING CONTACTOR IN THIS PCC
PCC-2	EXTERIOR LIGHTING - GROUP B		0	1	0	0	2-#14	TO GROUP B LIGHTING CONTACTOR IN THIS PCC
PCC-2	EXTERIOR LIGHTING - GROUP C		0	1	0	0	2-#14	TO GROUP C LIGHTING CONTACTOR IN THIS PCC
PCC-2	EXTERIOR LIGHTING - GROUP D		0	1	0	0	2-#14	TO GROUP D LIGHTING CONTACTOR IN THIS PCC
PCC-2	EXTERIOR LIGHTING STATUS - GROUP A		1	0	0	0	2-#14	FROM AUX CONTACT ON GROUP A CONTACTOR IN
PCC-2	EXTERIOR LIGHTING STATUS - GROUP B		1	0	0	0	2-#14	FROM AUX CONTACT ON GROUP B CONTACTOR IN
PCC-2	EXTERIOR LIGHTING STATUS - GROUP C		1	0	0	0	2-#14	FROM AUX CONTACT ON GROUP C CONTACTOR IN
PCC-2	EXTERIOR LIGHTING STATUS - GROUP D		1	0	0	0	2-#14	FROM AUX CONTACT ON GROUP D CONTACTOR IN
PCC-2	EXTERIOR RECEPTACLES - GROUP A		0	1	0	0	2-#14	TO GROUP A RECEPTACLE CONTACTOR IN THIS PCC
PCC-2	EXTERIOR RECEPTACLES - GROUP B		0	1	0	0	2-#14	TO GROUP B RECEPTACLE CONTACTOR IN THIS PCC
PCC-2	EXTERIOR RECEPTACLES STATUS -		1	0	0	0	2-#14	FROM AUX CONTACT ON GROUP A CONTACTOR IN
PCC-2	EXTERIOR RECEPTACLES STATUS -		1	0	0	0	2-#14	FROM AUX CONTACT ON GROUP B CONTACTOR IN
PCC-2	CHANNEL LEVEL AT RHOMBERG AVE	LIT-04	0	0	1	0		FUTURE
PCC-2	HIGH WATER LEVEL WARNING LIGHTS		0	1	0	0	2-#14	TO HWL WARNING LIGHTS LIGHTING CONTACTOR IN
PCC-2	HIGH WATER LEVEL WARNING LIGHTS STATUS		1	0	0	0	2-#14	FROM AUX CONTACT ON HWL WARNING LIGHTS CONTACTOR IN THIS PCC
	***TOTALS***		9	7	1	0		

## INSTRUMENT AND COMMUNICATION WIRE AND CABLE

### PART 1-GENERAL

#### 1.1 SUMMARY

- A. Work Included: This specification contains the requirements for instrument wire and cable.

#### 1.2 QUALITY ASSURANCE

- A. Qualifications of Installers: Use skilled workers who are thoroughly trained and experienced in the necessary crafts, and who are completely familiar with the specified requirements and the methods needed for proper performance of the work.

#### 1.3 PRODUCT HANDLING

- A. Instrument cable shall be furnished in lengths as necessary.
- B. Reels, coils, or package rolls of instrument cable shall be identified with the project name and other tagging identification as called for.

#### 1.4 SUBMITTALS

- A. Submit shop drawings and product data in accordance with provisions of Submittals section.

#### 1.5 MEASUREMENT AND PAYMENT

- A. All Work of this Special Provision is incidental to the lump sum Electrical bid item.

### PART 2-PRODUCTS

#### 2.1 GENERAL

- A. All materials of construction for cable and wire shall be compatible and noncontaminating.
- B. Unless otherwise noted in these specifications, the requirements herein listed shall be strictly adhered to.

#### 2.2 SHIELDED PAIR CABLING FOR ELECTRONIC INSTRUMENTS

- A. Shielded pair cabling shall have stranded, tinned-copper conductors, No. 16 AWG, twisted with 2-inch lay.
- B. Insulation of conductors shall be 15 mil, 90°C minimum PVC, rated for 300 volts. Materials shall equal or exceed UL 13 requirements for physical properties.
- C. Color coding shall be manufacturer's standard or as stated.
- D. The outer jacket shall be flame-retardant and weather- and ultraviolet-resistant PVC, 35 mils thick, and 80°C minimum rating. The outer jacket shall contain a ripcord and shall

equal or exceed the requirements of UL 1277. Cable shall be UL labeled as power-limited circuit cable.

- E. If the cabling is not installed in steel conduits, a 100% coverage shield shall be applied over the insulated conductors. The shield shall consist of a 0.85 mil minimum thickness aluminum mylar tape. A No. 18 AWG, seven-strand, tinned-copper drain wire shall be furnished in continuous electrical contact with the shield.
- F. Single-pair shielded cables shall be Belden 9316, or equal.

## 2.3 INDUSTRIAL ETHERNET CABLE

- A. For video surveillance cameras, communication with the SCADA System and equipment in supervisory control centers, motor control centers, control panels, etc., and areas with 480-volt power, provide 600 V-rated, 4-pair shielded twisted-pair cabling meeting EIA/TIA Category 6 requirements. Transmission characteristics of the cables shall meet full Category 6 performance criteria as defined by the referenced TIA/EIA documents and this specification. Jacket color shall be teal.
- B. Industrial Ethernet cable shall be minimum No. 23 AWG with PE jacket and foil and braided shield. The cable outer jacket shall be sunlight- and weather-resistant industrial-grade PE with a nominal overall cable diameter of 0.39 inches. Cable shall be Superior Essex Model BBDN6, or equal.
- C. Patch cables shall be provided premanufactured by the cable manufacturer or connector manufacturer in sufficient length to connect associated equipment to any port on the patch panel or switch. Field-attached plugs shall be insulation displacement type and be by the same manufacturer as the cable or connector.

## PART 3-EXECUTION

### 3.1 INSTALLATION REQUIREMENTS AND SPECIAL CONSIDERATIONS

- A. Shielded pair and industrial Ethernet specified in this section shall be installed in conduit, and may not be run free-air or in nonmetallic tubing such as innerduct.
- B. Although twisted conductors effectively reduce magnetic noise, where additional magnetic shield is necessary to minimize interference from stray magnetic fields armored cable shall be provided.
- C. Since magnetic interference is produced by currents flowing through conductors and electrical equipment, any instrument wire run near electric motors, transformers, circuit breakers, motor starters, power lines, or AC power and control cables may need additional magnetic shielding.
- D. Armor may be necessary on instrument cables installed in nonmagnetic electrical ducts:
  - 1. Electronic instrument wiring, pairs and triplets, and thermocouple lead extension wire, single pair. There shall be a steel wire armor of 24 gauge AISI 1006 soft annealed steel wire covering the inner jacket.
  - 2. The armor shall be covered by a flame-retardant and weather- and ultraviolet-resistant PVC, outer jacket 35 mil minimum thickness and 80°C minimum rating. The outer jacket shall contain a ripcord and shall equal or exceed the physical characteristics of UL 1277. Cable shall be UL labeled as power limited

cables.

### 3.2 GROUNDING

- A. Shielded cabling shall be installed in accordance with manufacturer's instructions and to minimize electrical noise and interference to associated instruments. Refer to instrument manufacturer's instructions for additional requirements.
- B. Ends of signal wires shall be sealed to prevent the migration of moisture into the cable and to prevent unintentional grounding of the shield at the open end. Seal signal wires using a minimum 1-inch piece of heat-shrink tubing installed over PVC jacket and individual wires, and heat-shrink to a watertight fit.
- C. All shields must be grounded.
- D. Shields shall be grounded at one point only. Shielded cabling shall be isolated and left open at the instrument.
- E. Cable shield grounds shall be isolated from control system signal grounds, except at instrument system grounding electrodes.
- F. The control room instrument ground shall be separate and isolated from the electrical power grounding system.

## FIBER-OPTIC CABLING

### PART 1–GENERAL

#### 1.1 SUMMARY

- A. Work included: This section includes providing, and placing into successful operation, fiber-optic cabling of the size shown on the Drawings, including all required connectors and equipment.

#### 1.2 QUALITY ASSURANCE

- A. Qualifications of Installers: Use skilled workers who are thoroughly trained and experienced in the necessary crafts, and who are completely familiar with the specified requirements and the methods needed for proper performance of the Work. Upon request of Engineer, Contractor shall provide documentation of qualifications and experience for fiber-optic equipment installations. Engineer shall determine if Contractor is qualified to perform the Work.
- B. All optical fibers shall be 100% attenuation tested at the manufacturer. The attenuation of each fiber shall be provided with each cable reel. The measured attenuation shall be for both 850 and 1300 frequency for multimode and 1310 or 1550 frequency for single mode. This documentation shall be provided with each spool. Contractor shall designate on the Drawings documentation the location where each spool has been installed and provide this data to Engineer.

#### 1.3 SUBMITTALS

- A. Manufacturer's Data: Submit manufacturer's data, specifications, and installation recommendations for each item specified herein.
- B. Submit shop drawings and product data in accordance with provisions of Submittals section.

#### 1.4 DELIVERY, STORAGE, AND HOLDING

- A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

#### 1.5 MEASUREMENT AND PAYMENT

- A. All Work of this Special Provision is incidental to the lump sum Electrical bid item.

### PART 2–PRODUCTS

#### 2.1 FIBER-OPTIC CABLING

- A. Fiber-optic cabling shall be as manufactured by OFS, Corning, or equal. Fibers shall be terminated with connectors recommended by the cable manufacturer. Connectors shall be provided on all fibers of each fiber-optic cable.



- B. All fibers in the cable shall be usable fibers and meet required specifications. Fiber shall consist of a dry water block coupled with a dry tube construction.
  - 1. Single-Mode Fiber:
    - a. Typical core diameter: 8.3um.
    - b. Cladding diameter: 125 +1.0um by fiber end measurement.
    - c. Core-to-cladding offset: <1.0um.
    - d. Coating diameter: 250 +15um.
    - e. Attenuation uniformity: No point discontinuity shall be greater than 0.1 dB, except terminations or patch cords, at either 1310nm or 1550nm. The coating shall be a layered UV cured acrylate applied by the fiber manufacturer. The coating shall be mechanically or chemically removable without damaging the fiber.
- C. Factory cable rating shall be 0.35 dB/KM at 1310 nM and 0.30 dB/KM at 1550 nM. Installed tolerance shall be less than 0.44 dB/KM at 1310 nM and less than 0.33 dB/KM at 1550 nM, testing tolerance.
- D. All fibers in the cable shall meet the requirements of this specification. The testing tolerance attenuation specification shall be a maximum attenuation for each fiber over the entire operating temperature range of the cable when installed.
- E. The change in attenuation at extreme operational temperatures for single-mode fibers shall not be greater than 0.20 dB/km at 1550 nm, with 80 percent of the measured values no greater than 0.10 dB/km at 1550 nm.
- F. Optical fibers shall be placed inside a loose buffer tube, minimum six fibers per tube, normally twelve fibers per tube. Actual number of fibers per tube shall be twelve fibers per tube unless specified differently on the Drawings.
  - 1. Single-mode only—each buffer tube shall contain twelve or six fibers.
- G. The buffer tubes shall meet EIA/TIA-598, "Color coding of fiber-optic cables."
- H. Fiber count, tubes of fiber, shall be as shown on the Drawings.
- I. Fillers shall be included in the cable core to lend symmetry to the cable cross-section where needed.
- J. The central anti-buckling member shall consist of a glass reinforced plastic rod. The purpose of the central member is to prevent buckling of the cable.
- K. Each buffer tube shall be filled with materials that expand when contacted by moisture such as water blocking tape or fibers. Water blocking gel shall be acceptable for in buffer tube filler; however gel [jicky-pic] for filler between buffer tubes shall not be acceptable.
- L. Buffer tubes shall be stranded around a central member. Acceptable techniques include the use of the reverse oscillation, or "SZ", stranding process.
- M. All dielectric cables (with no armoring) shall be sheathed with medium density polyethylene. The minimum nominal jacket thickness shall be 1.4 mm. Jacketing material shall be applied directly over the tensile strength members and flooding compound. Cable jacketing shall utilize the newer designs to provide maximum flexibility without loss or appreciable dB attenuation. Cable diameter shall not exceed 0.50 inch.

- N. The jacket or sheath shall be marked with the manufacturer’s name, the words “optical cable”, the year of manufacture, number of fibers, type of fiber and sequential feet or meter marks. The markings shall be repeated every one-meter or three feet. The actual length of the cable shall be within –0/+1% of the length marking. The marking shall be in a contrasting color to the cable jacket. The height of the marking shall be approximately 2.5 mm. A copy of the manufacturer fiber definition and shipping sheet identifying all tests, results and fiber indexes shall be provided to Engineer on delivery of cable to Contracting Authority or shall be included with a listing of place(s) of installation when installed by Contractor.
- O. Where ever possible, six buffer tubes with twelve fibers each, or subsets specified, shall be provided and designated as follows:

Buffer Tube/Fiber	Tube/Fiber Color
#1, 1 <sup>st</sup> tube or fiber	blue
#2, 2 <sup>nd</sup> tube or fiber	orange
#3, 3 <sup>rd</sup> tube or fiber	green
#4, 4 <sup>th</sup> tube or fiber	brown
#5, 5 <sup>th</sup> tube or fiber	slate
#6, 6 <sup>th</sup> tube or fiber	white
#7, 7 <sup>th</sup> tube or fiber	red
#8, 8 <sup>th</sup> tube or fiber	black
#9, 9 <sup>th</sup> tube or fiber	yellow
#10, 10 <sup>th</sup> tube or fiber	violet
#11, 11 <sup>th</sup> tube or fiber	rose
#12, 12 <sup>th</sup> tube or fiber	aqua

- P. Breakout Kits: The breakout kits or termination boxes used to terminate each fiber cable in the cabinet shall provide for the separation and protection of the individual fibers with the buffer tubing and jacketing materials. The termination housing shall be installed within a wall or shelf mountable interconnect housing which shall provide for storing fibers, ample room for feed through cable, strain relief for multiple cables within unit, and accommodate LC compatible connectors. All fiber pigtailed shall be terminated through LC connectors on the wall or shelf mounted interconnect panel. All terminations shall be LC type, ceramic core (outdoor connections), and plug into the provided controller unit internal fiber-optic modem. Acceptable enclosures for combination termination/splice points shall be FDC-CMP-072 enclosures or pre-approved equal. Splices to pigtail fiber, where used, shall utilize fan out kit protection to the fiber, heat shrink tubing with metal bar reinforcement and 900 micron rated pigtail insulation. Splices to factory pigtailed shall use pigtailed that are rated for a minimum temperature range of 0°F to 150°F. In the absence of pigtailed meeting this temperature rating, fibers shall utilize loose tube fiber in fanout kit tubes and LC connectors. These splices, fiber cable to pigtailed, may be external to splice trays mounted internally to the enclosure, when shown on the wiring diagrams. All other splices, not specified to be installed external to the fiber splice tray, shall be installed in splice trays and be supported with heat shrink tubing.
- Q. Connectors: Connectors shall be LC (ceramic ferrule-outdoor connections) compatible, field installable, and self-aligning and centering or factory fabricated pigtailed. Connectors to the special devices used for Ethernet network connections shall utilize a fusion splice with a pre-terminated pigtail patch cord. Fiber-optic equipment, used for terminating fibers, shall be rated for the type of connectors used. Connectors shall be Siecor CamLite, UniCam, or NEMA temperature rated epoxy type, or equal.

## PART 3-EXECUTION

### 3.1 INSTALLATION REQUIREMENTS

#### A. Cable Installed in Ducts and Conduits:

1. A suitable cable feeder guide shall be used between the cable reel and the face of the duct and conduit to protect the cable and guide it into the duct off the reel. It shall be carefully inspected for jacket defects. If defects are noticed, the pulling operation shall be stopped immediately and Engineer notified. Precautions shall be taken during installation to prevent the cable from being "kinked" or "crushed." A pulling eye shall be attached to the cable and used to pull the cable through the duct and conduit system. A pulling swivel shall be used to eliminate twisting of the cable. As the cable is played off the reel into the cable feeder guide, it shall be sufficiently lubricated with a type of lubricant recommended by the cable manufacturer. Dynamometers or breakaway pulling swing shall be used to ensure that the pulling line tension does not exceed the installation tension value specified by the cable manufacturer. The mechanical stress placed on a cable during installation shall not be such that the cable is twisted or stretched. The pulling of cable shall be hand assisted at each controller cabinet. The cable shall not be crushed kinked or forced around a sharp corner. If a lubricant is used it shall be of water based type and approved by the cable manufacturer. Sufficient slack shall be left at each end of the cable to allow proper cable termination, minimum 50 feet, this slack shall be in addition to installation slack as hereinafter specified. Additional slack cable, as defined in the drawings, shall be left in each hub cabinet, handhole, and at the top of each conduit riser. Excess slack at hub cabinets shall be re-pulled into the nearest handhole to provide a neat and orderly installation.
2. Storage of minimum slack cable in controller cabinets and additional slack at pull boxes shall be coiled. If multiple fiber cables are pulled through the same duct, this fiber should be coiled separately from one another. The slack coils shall be bound at a minimum of 3 points around the coil parameter and supported in their static storage positions. If stored in a vault, fiber shall be stored along the outermost wall to allow unabated ingress and egress. The binding material and installation shall not bind or kink the cable. Storage of additional slack cable adjacent to conduit risers and support poles shall be as visibly marked/tagged as "CAUTION-FIBER-OPTIC CABLE." Maximum length of cable pulling tensions shall not exceed the cable manufacturer's recommendations. Along with the fiber-optic cable, one No.10 AWG THHN, 600 volt single conductor cable (identifier conductor), orange in color, shall be pulled with 10 feet slack in each pull box. All fiber cables shall be marked with a metallic identifier in the handhole adjacent to the control cabinet and on the cable in the control cabinet at the point of termination. The identifier, both in the cabinet and in the handhole, shall indicate the direction the cable is going, cable contents, and the abbreviated location for the other end destination. Fiber cabling between control cabinets and adjacent vault locations shall be outdoor rated, loose tube fiber.

- B. Minimum Bend Radius: For static storage, the cable shall not be bent at any location to less than ten times the diameter of the cable outside diameter or as recommended by the manufacturer. During installation, the cable shall not be bent at any location to less than twenty times the diameter of the cable outside diameter or as recommended by the manufacturer.

#### C. Post-Installation:

1. Each section of the cable shall be tested for continuity and attenuation as a minimum. If the attenuation is found not to be within the acceptable nominal values, Contractor shall

use an optical time domain reflectometer (OTDR) to locate points of localized loss caused by bends or kinks. If this is not successful Contractor shall replace the damaged cable with no additional payment. Splices will not be allowed to repair the damaged section. After all fiber cable is installed between control cabinets and fiber links between fiber distribution points (FDP) complete links, all fibers, whether terminated or non-terminated, shall be tested for continuity (flash light). All terminated fiber shall be tested with an OTDR and Power Meter. Contractor may jumper termination points at control cabinets to minimize the number of tests and run a single OTDR test between several control cabinets, subject to the range of the OTDR. Links between FDPs shall be tested separately. Each OTDR trace, for documented test result submittal, shall be displayed individually and not be combined with other fiber traces as overlays. Single mode fiber shall be tested at 1310 nM. The results of the OTDR test shall be provided on an electronic media (disk) and paper printout. The OTDR wave, pictorial diagram of dB loss over the length of fiber tested, shall be provided along with the measured data values. The printout shall contain the manufacturer's fiber-optic Index of Refraction to the third decimal point for the fiber provided. Contractor shall provide Engineer with a written report showing all the values measured compared to the calculated values for length and coupler/connector losses at the completion of these tests. Outdoor patch cords between FDP and controller units less than 151 feet do not need be OTDR tested.

2. Documentation provided to Engineer shall include a written indication of every splice, termination, patch cord, etc. for cable being measured. Power meter measurement recordings shall indicate the exact measured distance [OTDR or field measurement with cross reference for oscillation multiplier] on the sheet showing the power meter readings. Any deviations between fiber readings in the same tube shall be notated for OTDR graphs as well as deviations greater than 5% on power meter readings. Rated values for acceptable installation shall be based on the following parameters:
  - a. Patch cords/Pigtails: 60 MM & .15 SM dB each.
  - b. Unicam/Hotmelt Terminations: 1.0 dB set of 2 (In and Out).
  - c. Splices: 0.08 each.
  - d. 1 KM = 0.3077 KF where KF is 1000 feet.
3. Data documentation shall include for each test between cabinets or between FDP sites, the length of fiber as measured by OTDR, frequency used in test on OTDR by each fiber type, distance to each splice, termination or patch cord jumper, dB loss rating by manufacture from spool documentation, index of refraction by type of fiber in section, and the dB loss of each section as measured in the final test for each fiber. A special test shall be made on all continuous spliced fiber from start to end that includes the total dB loss measured and the OTDR plot on electronic disk. Splice points shall be identified on the trace.
4. Light Source—An LED light source with a wavelength that is the system wavelength, 1310 and 1550 nm for single mode, shall be used. The LED shall be stable within 0.1 dB in intensity over a time period sufficiently long to perform the measurement. The output of the LED shall overfill the input end of the launch fiber/cable in both numerical apertures (NA) and core diameter. The accuracy of the combined light source and power meter shall be less than .05 dB and be temperature compensated stabilized to 0.01 dB over the operating range of the meter(s).
5. Power Meter -The detector in the power meter shall have an effective numerical aperture and active region that is larger than the receive reference cable and/or the fiber under test. The power meter shall have a minimum range from +3 DBMS to -40 DBMS. The power meter shall have an accuracy of  $\pm 0.5$  dB through the operating temperature and minimum resolution of 0.1 dB.

D. Testing:

1. General: Contractor shall provide all personnel, equipment, instrumentation and supplies necessary to perform all testing. All testing shall be performed in an accepted manner and in accordance with the testing equipment manufacturer's recommendations. All data shall

- be recorded and submitted to Engineer as hereinbefore specified. Contractor shall provide one copy of operating software to read and view all OTDR traces.
2. Attenuation: The end-to-end attenuation shall be measured for each fiber for each link after installation and termination. A patch cord jumper cable shall be connected to both the light source and the receive cable to the power meter by the use of a connector (barrel). The two reference cables shall then be connected via a termination coupler and the power meter "zeroed" to eliminate the line loss. This process results in a reading of the actual line loss (dB) of the input connector, fiber cable, exiting connector and any other splices or jumpers installed in the measured test link. The calculated "loss" shall not include the input or departing cables in the loss calculation. The calculated fiber loss measured shall list the number of terminations, including the input and departing connectors, the number of splices and the number of patch cords used to jumper the link(s) into the measured final link. The measured values for each terminated fiber in each tube shall include the Tube number, fiber number, number of feet in the link, the number of splices, the number of patch cords and the number of connectors, if any. The length of optical cable shall be as measured by the OTDR rather than the fiber cable jacket as the fiber is a reverse oscillation process resulting in a greater optical distance than the fiber cable jacket. The value for both the OTDR length and the cable jacket shall be provided in the recorded documentation for each link distance. All distances shall be recorded in feet rather than meters for both recorded lengths.
  3. Fibers that are not continuous from beginning of the link to the end of the link shall be noted in the documentation; otherwise, all fibers in a single tube may be listed with a single data entry for all required data listed above for all fibers in the tube. The fiber documentation for each fiber shall identify the fiber being tested by either fiber number or fiber coating color and be recorded by complete tube, Tube 1 through Tube 6, fiber 1 through fiber 12. The OTDR to be performed in both directions of the test shall be recorded for information purposes only to resolve discrepancies in replicating the test during inspections of the final installation. The power meter reading recordings shall log total dB loss over the length of the fiber measured, equivalent to a dB loss budget.
  4. Each tube of a cable shall be in the same file divider where the tube cover OTDR page shows the overview of all splices, patch cords, terminations from start to end. The second section shall include all Power Meter readings and the mandated documentation to show the calculated line loss (losses). The third section shall contain all OTDR traces, one trace per screen. The fourth section shall include the spool sheet for the fiber installed on the test section. An "explanation" sheet may be included where required to clarify an unusual reading that is valid but difficult to be explained through traditional data presentation, such as a video feed fiber that is attached to a jumper to provide continuous feed from the start to end of the tube length where other fibers in the same tube are simply spliced. The above format shall be repeated for each tube of a cable.
  5. Documentation: The result of all testing shall be recorded along with date of test, name of person performing test, brand name, model number, serial number of equipment used during test, and any other pertinent information and data. Contractor shall be responsible to provide input to Engineer reviewing the recorded data documentation to resolve all questions or data discrepancies.
- E. Cable Termination: Terminations shall be made using the method recommended by the connector manufacturer. All fibers shall utilize a fan-out kit of the size and type recommended by the manufacturer and of the number of fibers provided in each fiber tube. All fibers terminated shall utilize a ceramic ferrule (outdoor connections), ST, mechanical termination equal to Siecor UniCam connectors, or be a wide temperature (-40°F to 170°F) epoxy. Heat cured or epoxy type connections meeting the full temperature ratings are acceptable for this Project, including factory manufactured pigtails. Contractor shall be required to provide proof of purchase of sufficient quantities of ceramic terminations for outdoor terminations to verify ceramic connector usage or temperature ratings on epoxy or heat cured processes prior to terminating any fibers. Contractor may terminate fibers by splicing factory

pigtails to the fiber ends and then connecting the pigtail to the fiber coupler in the fiber tray. When splicing pigtails to terminate, all splices shall be provided with the metal reinforced shrink tube protector. Contractor may terminate fibers by the use of UniCam mechanical termination connectors. All termination LC couplers shall be rated for dual fiber application, MM and SM.

- F. Splices: The fiber cable shall be installed in continuous runs between cabinets. No splices shall be allowed, unless shown on the Drawings or for testing. Splices, where specified, shall be by fusion splice and shall be installed using an automatic fusion splicer. Splices between two fibers leaving the cabinet shall be supported in splice trays installed in splice enclosures. All splices shall be re-enterable splice capsules, gas or gel filled only and shall be protected by heat shrink tubing designed for fiber-optic splicing applications. Fibers being terminated in two separate termination or splice enclosures shall be supported between enclosures by the use of buffer tubing or approved equal support material or shall be pigtail patch cords. Termination/splice enclosures shall be separated by less than 12 inches unless a conduit is installed between enclosures. All splices shall be performed by an automated splicer device that verifies the final splice termination quality. All splices shall be nominally 0.03 to 0.05 dB loss but shall be less than a 0.08 dB loss.
- G. Launch Reference Attenuator:
1. The launch attenuator, for single mode fiber testing, shall be utilized for all OTDR tests such that one launch cable shall be at the beginning of the fiber being tested. The launch attenuator(s) shall be of the same fiber core size and type as the fiber under test. The attenuator shall emulate the minimum distance specified by the OTDR manufacturer for stabilization of the pulse generation. LC connectors shall be utilized with each attenuator to connect the device to the test device, OTDR. One launch cable shall be installed on the start of the fiber being tested.
  2. The OTDR shall have the Threshold Loss set at a value to show each splice or termination junction of a single fiber in each tube without showing the extraneous noise caused by handhole coils or turns into the cabinets. This level is normally a value (Threshold Loss) between 0.3 and 0.8 on the OTDR. This trace shall be provided for one fiber in each tube tested and each "event" shall be marked as to splice, jumper or patch cord. The Threshold Loss shall then be set to a value of 0.10 for single mode fiber tests. The test of each fiber installed shall be conducted and any recorded events above this threshold shall be identified, such as jumper or patch cord. Events that are in excess the provided values shall be corrected prior to documentation submittal, such as terminations in excess of the rated value or bends in the fiber at the point of a splice entering or leaving the splice tray (See Testing). For measured values recorded in excess of the above (0.10 SM) listed values, refer to the paragraph 12.2 specification as hereinbefore defined. Engineer reserves the right to spot test fiber terminations, splices, or re-testing of all fibers in a section to insure proper quality assurance both during and after installation and testing. Deviations from testing and report documentation shall be reviewed and Contractor shall be able to retest any or all challenged measurements to verify a valid test. Inconsistent test results, in the sole opinion of Engineer, shall be cause for Contractor to retest the entire fiber installation.

## VIDEO SURVEILLANCE SYSTEM

PART 1—GENERAL

## 1.1 SUMMARY

- A. Work Included: This section includes a complete and operational Video Surveillance System (VSS).
- B. Allowances: System Supplier shall include in the Bid the cost of the following items specified in this section. Refer to the individual sections listed below for a complete description of the work required. Computer Allowance, item 2.1—Video Surveillance System Server.

## 1.2 SYSTEM DESCRIPTION

- A. Provide a complete Operating Video Surveillance System (VSS). The system shall include fixed, Pan, Tilt, Zoom (PTZ), and thermal cameras, protective housings, network switches, and all other equipment necessary for a complete and operational Video Surveillance System.
- B. Contractor shall be responsible for providing final working drawings to be approved by Engineer, based on the information described herein and shown on the drawings as well as by field observations. System design provided is not intended and does not show all details required for a complete system.
- C. Contractor shall inspect all work. The Bid shall include everything necessary to obtain a complete installation operating in accordance with these specifications. All responsibility for these systems ultimately lies with Contractor.
- D. Contractor shall be responsible for the placing of circuits and making of electrical connections in accordance with the manufacturer-furnished drawings, instructions, and field supervision to ensure proper connection. The Contract shall include the services of the manufacturer's factory engineer to supervise making of connections to power supplies, communication circuits, and any other connections external to the new Video Surveillance equipment; to adjust the equipment; initiate and check operation; instruction of Contracting Authority's staff on operation and maintenance of the equipment, and place the equipment in operation in a manner fully satisfactory to Engineer.

## 1.3 QUALITY ASSURANCE

- A. Manufacturers: Firms regularly engaged in the manufacture of electrical equipment, cable and wire products of the types and ratings necessary, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Installer: A firm with at least 5 years of successful installation experience on projects with electrical wiring installation work similar to that in this project.
- C. Code Compliance: Comply with National Electrical Code (NFPA 70) as applicable to construction and installation of electrical equipment, cable, wire, and connectors.
- D. UL Labels: All electrical equipment and material shall be listed and labeled by Underwriters Laboratories, except where UL does not include the equipment in their

listing procedures.

- E. NEMA/ANSI Compliance: Comply with National Electrical Manufacturers Association, American National Standards Institute and other standards pertaining to material, construction and testing, where applicable.
- F. Installer: A qualified security system contractor shall be one which has a minimum of 5 years experience with security systems of size and complexity as specified herein, and meets the following:
  - 1. Milestone certified.
  - 2. Axis trained.
  - 3. Located a maximum of 100 miles from the project location.
  - 4. Have a maximum response time of two hours.

#### 1.4 SUBMITTALS

- A. Submit shop drawings and product data in accordance with provisions of Submittals section.
- B. Provide wiring diagrams, equipment ratings, dimensions and finishes for all proposed devices and equipment.
- C. Provide a complete Surveillance System riser diagram including: Point of origin of each camera circuit, circuit type and labeling, area covered by each camera, wire/cable type and size, and locations of patch panels where primary system video feed enters the fiber loop.

#### 1.5 MEASUREMENT AND PAYMENT

- A. All Work of this Special Provision is incidental to the lump sum Electrical bid item.

#### 1.6 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Submittals section.
- B. Include source and current prices of replacement parts and supplies and recommended maintenance procedures and intervals.

#### 1.7 DELIVERY, STORAGE, AND HOLDING

- A. Store in a clean, dry space. Maintain factory wrapping or provide additional plastic cover to protect units from dirt, water, construction debris, and traffic.
- B. Handle in accordance with manufacturer's written instructions.

### PART 2-PRODUCTS

#### 2.1 VIDEO SURVEILLANCE SYSTEM

- A. Contractor shall provide fixed cameras, pan-tilt-zoom cameras, thermal cameras, camera housings, camera mounting hardware, surge suppression devices, and network switches where shown on the drawings and specified herein. Contractor shall include in the Lump Sum Base Bid all labor necessary to install the video surveillance system equipment as



described herein and shown on the drawings. Purchase of video surveillance system hardware shall be held until approved by Engineer to ensure the system is of current technology at project completion. Final selection of the video surveillance system shall be made at the time of actual purchase based on latest available technologies.

- B. Provide a Milestone license and Milestone Software Upgrade Plan (SUP) for all cameras installed, including those furnished by Contracting Authority. Pro-rated SUP shall be provided through November 26 of the year plan is purchased. If purchased after November 26, SUP shall be provided through November 26 of the following year.

## 2.2 VIDEO SURVEILLANCE SYSTEM SERVER

- A. All components of the computers shall be supplied by System Supplier. The server shall perform monitoring and operating of video surveillance cameras.
- B. System Supplier shall include an allowance of \$25,000 in the Lump Sum Base Bid for one server computer and monitor. These items shall be included in the Bid. System Supplier shall include in the Lump Sum Base Bid (not part of the allowance) all labor necessary to set up the desktop computer. Purchase of computer hardware and software shall be held until approved by Engineer to ensure system is of current technology at project completion. Contractor shall not use any computer hardware or software supplied as part of the Contract. Final selection of each system's components shall be made at the time of actual purchase based on latest available technologies. Final cost for this equipment will be adjusted by change order based on actual system costs.
- C. The computer hardware shall be installed in the Traffic Control Center at Dubuque City Hall and herein specified complete with all power cabling and interface cabling. Provide APC, or equal, four-port surge protector for each computer. Surge protectors shall include protection for one telephone line. Provide a true on-line UPS for each computer that will provide 30 minutes of operation during a power failure. UPSs shall match those being provided for the PLCs specified herein.

## 2.3 SURGE PROTECTIVE DEVICES

- A. Each camera shall be protected with a surge protective device (SPD) at the camera and at the control cabinet.
- B. An SPD as manufactured by Nitek Model IPPWR1, or equal, shall be provided with each camera. The SPD shall provide surge protection for one 10/100/1000Base-TX Ethernet port and include standard RJ45 network ports. The SPD shall pass Power over Ethernet Plus (PoE Plus) power and support Category 5/5e and Category 6a standards. PoE Plus Ethernet clamping shall be 58 Vp-p and the transient response time shall be 1-picosecond. The SPD shall be rated for a temperature range of -40°F to 185°F and include a lifetime warranty. The SPD shall be mounted inside the light pole that each camera is mounted on, unless otherwise noted.
- C. Each camera shall be protected by a surge protector as manufactured by Nitek Model IPPWR16, or equal. The surge protector shall provide 16 channels of surge protection for PoE Plus 10/100/1000Base-TX Ethernet equipment. PoE Plus Ethernet clamping shall be 58 Vp-p and the transient response time shall be 1-picosecond. The surge protector shall be rated for a temperature range of -40°F to 185°F. The surge protector shall be rack mountable in a standard 19 inch rack and be provided inside the pathway control cabinets where shown on the Drawings.

## 2.4 POWER OVER ETHERNET (POE) NETWORK SWITCHES

- A. A 28-port managed network switch shall be provided inside the pathway control cabinets where shown on the Drawings. The switch shall include 24 10/100Base-TX RJ-45 ports with PoE injector, four 10/100/1000Base-TX RJ-45 ports, and four 1000Base-SX/LX/LHX.XD/ZX Gigabit fiber SFP. The switch shall have LED indicators for Ring Status, DC Power, PSU Status, System Status, Alarm, Ethernet Port Link/Activity Status, and PoE Status. The switch shall be rack mountable in a standard 19 inch rack. Switches shall be as manufactured by Comtrol Model RocketLinx ES7528, or equal.
- B. An 8-port or 16-port Layer 2 Ethernet switch and PoE Plus extender shall be provided inside the pathway control cabinets where shown on the Drawings. The switch shall support IP cameras and include two RJ-45 Gigabit network output ports and eight or sixteen RJ-45 link ports capable of transmitting up to distances of 2000 feet. The switch shall have LED indicators for Link Status, Power, and PoE Out. The switch shall be rack mountable in a standard 19 inch rack. Switches shall be as manufactured by Nitek Model ER8500U, or equal.
- C. For all Ethernet cable runs over 400 feet to cameras, provide a PoE extender transmitter inside the light pole that the camera is mounted on. The extender shall be as manufactured by Nitek Model ET1500U, or equal. The transmitter shall support IP cameras utilizing 10/100Base-TX and PoE up to a distance of 1960 feet. The transmitter shall have LED indicators for Link Status and Power.
- D. Network switches shall be plug connected to a single-phase, Switched Power Distribution Unit (PDU). The PDU shall include 16 switched NEMA 5-15/20R receptacles (eight front and eight rear) and shall be rack-mountable in a standard 19 inch rack. A digital display on the unit shall continuously display the total output load in amps. The PDU shall support power-on, power-off, and reboot of each receptacle on a real-time or programmable basis. A network interface shall allow remote monitoring of data and alerts. The PDU shall be as manufactured by Tripp-Lite Model PDUMH20NET, or equal.

## 2.5 FIBER PATCH PANELS

- A. Fiber-optic patch panels shall be installed inside the pathway control cabinets where shown on the Drawings and shall be used to terminate incoming fiber-optic cable. Patch panels shall be as manufactured by Corning, Closet Connector Housing with Housing Panels and CCH Cassettes as required. Each patch panel shall include the following:
  - 1. 4U, 19 inch rack-mounting enclosure.
  - 2. Provide high density LC modules as required for all terminations shown on the Drawings.
  - 3. Splice trays as required.
  - 4. LC connectors shall have the required fiber terminating connectors and accept multi-mode or single-mode fiber as required.
  - 5. UL-Listed and meet ANSI/TIA/EIA-568A and 606.

## 2.6 FIXED CAMERAS

- A. Fixed cameras shall have the following minimum requirements:
  - 1. Minimum 2 MP/HDTV 1080P indoor/outdoor.
  - 2. Minimum Illumination—color: 0.18 lux, B/W: 0.04 Lux, F1.3; HDTV 1080p 50/60 fps: Color: 0.36 lux, B/W: 0.08 lux, F1.3.
  - 3. Shutter time: 1/143000 to 2 s.

4. Video compression: Minimum H.264.
5. Power: Power over Ethernet IEEE 802.3af/802.3at Type 1 Class 3, max. 12.95 W or High Poe max 25.5 W for enclosure and camera.
6. 3 year warranty.
7. Shall be compatible with Milestone Video Management most current version and have its own driver.
8. Cameras shall be compatible with Theia SL940P F1.5, or equal. 50% of all fixed cameras provided shall have the standard lens replaced with this lens.
9. Cameras shall be compatible with Skybracket drawing #49702.
10. Cameras shall be as manufactured by Axis Model Q1615E, or equal.

## 2.7 PAN-TILT-ZOOM (PTZ) CAMERAS

- A. PTZ cameras shall have the following minimum requirements:
  1. Video Compression: Minimum H.264.
  2. Minimum 2.0 MP.
  3. 4.7–94mm, F1.6 Lens with 20X zoom.
  4. Minimum Illumination: 0.4 lux(f1.6) in color mode; 0.04 lux(f1.6) in monochrome mode.
  5. Image Rate: 30 FPS.
  6. Tilt: 186 degrees, E-flip, 0.05-360 degrees / sec.
  7. Pan: 360 degrees, endless, 0.05-450 degrees / sec.
  8. Power: Power over Ethernet, 24 VAC or 24 VDC
  9. Shall be compatible with Milestone Video Management most current version and have its own driver.
  10. Cameras shall be as manufactured by Avigilon Model 2.0 Megapixel Day/Night 20x HD Pendant Dome Camera.

## 2.8 THERMAL CAMERAS

- A. Thermal cameras shall have the following minimum requirements.
  1. Array Format: 640 X480.
  2. Field of View: 32 X 26 degrees (FC-632R; 19mm).
  3. Zoom: Continuous E-zoom, up to 4X.
  4. Focus Range: Athermalized, Focus Free.
  5. Measurement Range: -10°C to 110°C.
  6. Measurement Accuracy: ±5°C or 5% of reading.
  7. Video Compression: H.264.
  8. Power: Power over Ethernet IEEE 802.3AF-2003 .
  9. Cameras shall be as manufactured by Flir Model FC-Series R.

## PART 3–EXECUTION

### 3.1 VIDEO SURVEILLANCE SYSTEM

- A. Prior to installation, Contractor shall turn over all video surveillance equipment to Contracting Authority for initial setup. Contractor shall install all video surveillance equipment after completion of the initial setup.
- B. Contractor shall be responsible for installing all video surveillance equipment in each pathway control cabinet.

### 3.2 CAMERA MOUNTING

- A. Pole-Mounted Camera:
  - 1. The pole mount shall be designed specifically for mounting a camera on a pole. Provide 1/2 inch hole at specified mounting height. Hole shall have rubber grommet to prevent cable damage. Camera cables shall be mounted inside the pole.
  - 2. The camera mount shall be a manually adjustable tilt table extending up from the horizontal arm. The mount shall be supplied with a manually adjustable tilt table capable of unlimited 360 degrees pan adjustment and  $\pm 90$  degrees tilt adjustment.
  - 3. Camera mount shall be banded to the pole using stainless steel banding and hardware. Banding shall be powder coated black to match the light pole.
  - 4. Provide 6 inch camera cable drip loop to prevent water seepage into camera housing and pole.

### 3.3 WIRING AND INSTALLATION

- A. All wiring shall be in conduit.
- B. All wire and cable passing through metal work shall be sleeved by an approved grommet or bushing.
- C. Identify all wire and cable at terminations. Identification shall be made as specified in previous sections.
- D. Inspect areas to receive camera to ensure suitability of application. Contact Engineer for any conflict that may present itself. Camera mounts shall be rigidly attached to light poles. All cameras are to be installed per the manufacturer's requirements.
- E. All camera views shall be reviewed with Contracting Authority and adjusted as requested.

### 3.4 TESTS

- A. Completely test and adjust all camera locations to ensure complete operation of the system.