

SECTION 13856

INSTRUMENTATION AND CONTROL SYSTEMS – ELECTRICAL WORK

PART 1 GENERAL

1.1 SUMMARY

- A. Description Of Systems
 - 1. Control Power System: 120 volts, 2 phase, 60 hertz and 24 V DC.
 - 2. Furnish all labor, materials, equipment, technical supervision, and incidental services required to complete, test and leave ready for operation the electrical systems as specified in the 13800 Series Sections or as indicated.
- B. Related Work Specified In Other Sections Or Packages
 - 1. Operating tests on mechanical and electrical equipment installed under other Sections to prove capability of such equipment to perform as specified in the Section covering specific equipment.

1.2 RELATED WORK SPECIFIED UNDER OTHER SECTIONS

- A. Instrumentation and Control System – General – Section 13855.
- B. Control Systems Equipment – Section 13865.
- C. Automatic Control Valves – Section 13865 App A.
- D. Flow Meters – Section 13865 App B.
- E. I&C Systems Start-Up and Final Acceptance Testing Section 13875.

1.3 QUALITY ASSURANCE

- A. Source Quality Control
 - 1. Furnish equipment and materials listed in the current, latest issue having a date prior to issue date of Specifications, of Equipment Publications and Underwriters' Laboratories, Inc., and bearing the UL Label whenever standards have been established and label service is regularly furnished. Furnish equipment and materials conforming to electrical standards requirements and the requirements of the contract documents.
- B. Field Quality Control
 - 1. Install equipment and material in compliance with the regulations of Local, State and Governmental laws governing electrical installation, the latest edition of the electrical standards requirements and the requirements of the Contract Documents.

1.4 SUBMITTALS

- A. Furnish submittals per Section 01300 and as supplemented herein. Include complete data on each item. Coordinate the items as they relate to the Work prior to submittal.
- B. Submit a Letter of Compliance for all items listed under Part 2.
- C. Test Reports: Submit, including complete data on actual readings taken and corrected values, to the Consultant for approval after each test period. Have all test reports signed by the authorized witnesses present at tests prior to submission. Do not energize any equipment or material for operating tests until test data has been approved.

1.5 RECORD DOCUMENTS

- A. Submit three copies of final approved test reports to Consultant at the completion of the Work, per requirements of Section 01300.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Conduit
 - 1. As specified in Division 16 specifications.
- B. Conduit Fittings
 - 1. As specified in Division 16 specifications.
- C. Outlet Boxes
 - 1. As specified in Division 16 specifications.
- D. Pull And Junction Boxes
 - 1. As specified in Section Division 16 specifications.
- E. Conduit Boxes For Hazardous Areas
 - 1. As specified in Division 16 specifications.
- F. Wireways
 - 1. As specified in Division 16 specifications.
- G. Cable Tray
 - 1. As specified in Division 16 specifications.
- H. Miscellaneous
 - 1. As specified in Division 16 specifications.

- I. Fuses
 - 1. Fuses in General: One-time high interrupting capacity, UL Class RK5 dual element type.
 - a. Bussmann “Fusetron”
 - b. Gould-Shawmut “Trionic”
 - c. Littelfuse

- J. Wire And Cable
 - 1. As specified in Section 16050, Part 2, and as modified and supplemented herein.
 - 2. Wire for General Interior and Exterior Use: Stranded conductor, annealed copper, NEC Type THWN/THHN rated 75 degC, 600 volts, for conductor sizes No. 14 AWG and larger.
 - 3. Multi-Conductor Instrumentation Cables: Copper, not less than No. 18 AWG. Cables shall be twisted with 100% shield and drain wire. If multiconductor cables are proposed, provide twisted pairs, each with shield and drain wire with minimum 10% spares.
 - a. Belden
 - b. Alpha
 - c. Carol (General Cable)
 - 4. Terminate shields at I/O card and tape field end, except as specified by equipment manufacturer.
 - 5. ControlNet co-axial cable Allen Bradley ControlNet, Beldon 3093A Type RG-6/U suited to cable length.

- K. Connectors For Splicing Copper Conductors
 - 1. Connectors for Straight Splicing Conductors Up To and Including No. 8 AWG: Solderless compression type.
 - a. Wago
 - 2. ControlNet connectors Allen Bradley 1786-BNC/B.

- L. Lugs For Terminating Copper Conductors
 - 1. Lugs for Terminating Control Wiring: Solderless compression type with tinned tongue connector.
 - a. Burndy “Hydent”
 - b. Thomas & Betts “Sta-Kon”
 - c. Wago
 - 2. Lugs for terminating Power Conductors up to and including No. 8 AWG: Solderless type, manufacturer’s standard unless otherwise specified.

- M. Wire Labels
 - 1. As specified in Division 16 specifications.

- N. Insulating Tape
 - 1. As specified in Division 16 specifications.

- O. Miscellaneous
 - 1. As specified in Division 16 specifications.

P. Control Devices

1. Push Buttons and Selector Switches: Heavy duty, NEMA 13 and NEMA 4 type, with contacts rated 10 amperes continuous, 600 volts AC, with legend plate operation and color as indicated.
 - a. Allen-Bradley Bulletin 800T (NEMA 13), 800H (NEMA 4)
 - b. Square D Class 9001, Type K (NEMA 13), 9001, Type SK (NEMA 4)
 - c. Cutler Hammer Eaton HT800
2. Indicating Lights: Heavy duty, NEMA 13 and NEMA 4 type with LED bulb, integral 120-transformer, push-to-test feature, color cap and legend plate as indicated.
 - a. Allen-Bradley Bulletin 800T (NEMA 13), 800H (NEMA 4)
 - b. Square D Class 9001, Type K (NEMA13), 9001, Type SK (NEMA 4)
 - c. Cutler Hammer
3. Control Relays: Heavy duty industrial type with convertible contacts rated 10 amperes continuous, 600 volts AC. Provide coils for operation on 120 volts AC unless other requirements are indicated. Provide number and type of contacts as indicated. Provide with power indication Flag & Light.
 - a. Allen-Bradley Bulletin 700, Type P.
 - b. Square D Class 8501, Type X
 - c. Cutler Hammer
4. Enclosures: As indicated in Section 13855.
5. Limit Switches: Oil-tight type with operator to provide required function.
 - a. Allen-Bradley
 - b. Square D
 - c. General Electric
6. Control Transformers: 480/120 volt, size as indicated, complete with fuses. Open type or in NEMA 1 enclosure as required.
 - a. Allen-Bradley
 - b. Square D
 - c. Cutler Hammer
7. Isolating Transformers: 120/120V, size as indicated, complete with fuses. Open type or in NEMA 1 enclosure as required.
 - a. Sola
 - b. Allen Bradley
 - c. Cutler Hammer
8. Terminal Blocks: 300 volt class terminals with wire clamps.
 - a. Allen Bradley Bulletin 1492
 - b. Square D Class 9080
 - c. Weidmuller

Q. Grounding Conductors

1. Insulated Grounding Conductors: As specified in Division 16 specifications.

R. Grounding Connections

1. As specified in Division 16 specifications.

- S. Receptacles
 - 1. 20 Ampere Duplex Convenience Receptacle, with ground fault circuit interrupter for 120V, single phase service, straight blade, 2 pole, 3 wire, NEMA configuration 5-20R rated 20A 125V, NEMA performance standard, specification grade for back and side wiring, brown color.
 - a. Arrow Hart GF5342
 - b. Byrant GFR53FT
 - c. Hubble GF-5362

- T. Horn
 - 1. Signal Horn: 24 V DC, producing minimum sound intensity level of 90 dB at 10 feet.
 - a. Federal Signal Corp.
 - b. Edwards
 - c. Allen Bradley

- U. Beacon
 - 1. 24 V DC, strobe, 15 J energy, 1 Hz, 40,000 hours MTBF.
 - a. Federal Signal
 - b. Edwards
 - c. Allen-Bradley

PART 3 EXECUTION

3.1 CONDUIT AND WIREWAY INSTALLATION

- A. Conduit Systems
 - 1. As specified in Division 16 specifications and as supplemented herein.
 - 2. Identify conduits by color bands or character labels at intervals not greater than 130 feet and at each outlet or termination into equipment as follows.
 - 3. 208 Volt Systems - 2 bands (color to be determined by Owner)
 - 4. 120 Volt Systems - 1 band (color to be determined by Owner)
 - 5. Identify cable trays by character labels at intervals not greater than 130 feet and at equipment terminations in accordance with the class designation for service.
 - 6. Conduit and fittings between field mounted equipment and wall or building mounted pull boxes shall be rigid. Home runs between local pull boxes, wall mounted panels and/or pull boxes may be EMT conduit 10'-0" Above Finished Floor.

- B. Outlet, Switch, Junction And Pull Boxes
 - 1. As specified in Division 16 specifications.

- C. Wireways
 - 1. As specified in Division 16 specifications.

- D. Cable Trays
 - 1. As specified in Division 16 specifications.

3.2 WIRE AND CABLE INSTALLATION

A. General

1. Install as specified in Division 16 specifications and as supplemented herein.
2. Splicing of instrumentation cable is not allowed. Where required because of length of runs, use approved terminal cabinets. Mount cabinets no higher than 6'-0" above finished floor or platform.
3. Route RTD, 4-20 mA analog and low level D.C. signal wiring in conduits separate from all other wiring unless otherwise indicated. Wiring shall be minimum No. 18 AWG shielded; 2, 3 or 4 conductor as required. Where multi-conductor cables are used, use twisted pair cable with each pair shielded.
4. Provide a minimum of 20% spare conductors (no less than 2) between main conduit runs. Roll up spares at each end within pull boxes or cabinets and label as spare, i.e., SP-1, SP-2, SP-3, etc.
5. All 120 VAC service to equipment shall include a ground wire sized per NEC for the load being served.

B. Color Coding And Conductor Identification

1. 120 VAC control wiring within a control panel deriving its power from an outside source shall be yellow and DC power wiring shall be blue.
2. Identify individual phase conductors of branch power as to phase and system voltage by means of color coding. Color scheme for each different voltage system shall be as directed by the Consultant. Provide conductor color coding by means of colored insulating materials or by means of colored wire labels attached to individual conductors in all outlet, pull or junction boxes and at all terminations.
3. Identify each control circuit wire at each termination by means of wire labels. Provide identification as indicated. Mark the white marking strip of all control terminal blocks with the same identification as the connecting wire in permanent black ink.

C. In Underground Duct Systems

1. In accordance with Division 16 specifications.

D. In Cable Tray

1. Install cables in tray at locations indicated with spaces left clear for the addition of future cables, and allow sufficient slack to permit expansion or contraction of cables. Clamp cables to tray at intervals of not more than ten feet in horizontal runs and two feet in vertical or sloping runs.

E. Splices And Terminations

1. Splice and terminate conductors with connectors and lugs as specified for the specific size and type of conductor. Indent all compression type connectors and lugs with tools as recommended by the connector or lug manufacturer.
2. Thoroughly clean wire ends before connectors or lugs are applied. Install the connector or lug immediately after wire brushing the conductor.
3. Insulate all bare surfaces of conductors with a minimum of four layers (half lap in two directions) of electrical insulating tape.

4. Splices in instrument signal cables, i.e. 4-20 maDC, 1-10V DC, RTD, Thermocouple, etc. are not allowed. In those cases where continuous runs are not possible, provide approved terminal cabinets. Mount cabinets no higher than 6'-0" above finished floor or platform.

F. Cable Identification

1. Identify cable groups and conduit at entering and leaving locations in manholes and handholes by means of 1/8 inch thick lead die-stamped tags with punched ears or stainless steel tags. Fasten tags around the cable group or conduit with No. 12 AWG copper wire.
2. Identify cables in cable tray at intervals of 130 feet, at each side of walls, and at terminations and splices by means of strip aluminum with raised letters.
3. Designate source and load, or feeder or cable identification on tags. Submit identification for the approval of the Consultant.

3.3 DISTRIBUTION EQUIPMENT SUPPORTS AND IDENTIFICATION

- A. Anchor all self-supporting equipment securely to floors and to supporting steel where such supports are required.
- B. Provide identification on all control panels installed in accordance with the following:
 1. On surfaces 4 inches by 4 inches and greater, hand paint or stencil with bright yellow paint, or provide good quality decal, with bright yellow letters.

3.4 GROUNDING

- A. Where installed conductors are used, thoroughly tape all exposed connections.
- B. Carry an equipment ground wire with all branch circuit conductors.
- C. Where metallic conduit is used for mechanical protection of a ground conductor, bond conductor to the conduit at each end.

3.5 ELECTRICAL ACCEPTANCE TESTS

- A. Description Of System
 1. Preliminary inspections and tests: Visual inspections of electrical equipment, wire checks of factory wiring and any other preliminary work required to prevent delays during performance of electrical acceptance tests.
 2. Electrical acceptance tests: Those inspections and tests required to show that the workmanship, methods, inspections, and materials used in erection and installation of electrical equipment conform with accepted engineering practices, IEEE Standards, IPCEA-NEMA Standards, electrical standards requirements, manufacturers instructions, and this Section, and to determine that the equipment involved may be energized for operational tests.
 3. Operating tests: Those tests performed on all electrical equipment installed under this Section, and under other Sections, to show that the electrical equipment will perform the functions for which it was designed.

4. Furnish all labor, materials, test equipment, and technical supervision to perform and record the electrical tests as specified, and perform and record all electrical tests as required, including tests on 600 volt wire and cable and control devices, unless otherwise specified.

3.6 FINAL ACCEPTANCE

- A. In accordance with Division 16 specifications.

3.7 SCHEDULING OF TESTS

- A. In accordance with Division 16 specifications.

3.8 GENERAL TESTING REQUIREMENTS

A. Preliminary Work

1. Perform preliminary inspections and tests immediately prior to performing acceptance tests. Fuses and fusing devices, such as cable limiters, shall be omitted from cable tests and tests involving cables.

B. Continuity Tests

1. In accordance with Division 16 specifications.

3.9 TESTS ON CONTROL WIRING

A. General

1. Give each single conductor and multi-conductor control wire or cable a continuity test and megger test. Verify identification of conductors.

B. Connections

1. Disconnect and fan out conductors to be tested.

C. Acceptance

1. Wires must pass all tests.

D. Records

1. Include the following information in test report on each wire group.
 - a. Wire and group identification.
 - b. Approximate average cable temperature.

3.10 TESTS ON WIRE AND CABLE IN 480 VOLT AND LOWER SERVICE

A. General

1. In accordance with Division 16 specifications.

3.11 TESTS ON CONTROL DEVICES

- A. In accordance with Division 16 specifications as modified herein.
- B. Perform operating tests on all control or indicating devices installed under this Contract.

END OF SECTION

Revision History	
Date	Rev. No.
A	0
B	0
C	0
D	0
E	0
F	0
02-19-09	0

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