

UNION

PACIFIC

RAILROAD

ELECTRICAL DESIGN MANUAL

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SECTION I
DESIGN REQUIREMENTS

I. DESIGN REQUIREMENTS

A. GENERAL

1. **Deviations from Manual:** The Union Pacific Railroad has standardized methods of workmanship and quality of material, which are included herein. Changes and deviations from the Manual should not be made unless prior written permission is received from the Manager of Electrical Design.
2. **Coordination:** Coordinate the design of the electrical system with the design of other disciplines. Coordinate the design to allow for normal train operations during construction. Disruptions include fouling any tracks due to installation of wiring, or equipment, power stoppages, etc. Note: All work within 25 feet of a track may be subject to track closure or require a flagman.
3. **Standard Material:** Design all installations with standard Union Pacific material, where standards exist. For non-standard material submit catalog cuts of major items of equipment to the Manager of Electrical Design, for review and approval.
4. **Utility Service:** Coordinate with the local electrical utility to ensure the design meets requirements for metering. Provide the Manager of Electrical Design, copies of all correspondence with local utilities.
5. **Specification Deviations:** Proposed changes to equipment required for the project require written approval from the Manager of Electrical Design. Standards: All designs shall be in accordance with the current AREMA and FRA Standards.
6. **Material Provided By Others:** Coordinate with the Manager of Electrical Design, for material to be provided by the Railroad; include the information on the drawings.
7. **Work Included:** Provide a complete set of stamped reproducible drawings, as indicated in Subsection I.B of the design guide. Also include copies of all drawings on electronic media. Specifications may not be required on certain projects; the Manager of Electrical Design, will provide direction. A Professional Electrical Engineer registered in the state, in which the project will be constructed, is required to stamp the Electrical Drawings. All projects requiring foundations shall be reviewed and stamped by a registered professional structural engineer. Demolition work shall be shown on the drawings.
8. **Selected Suppliers and Manufacturers:** A list of required suppliers and manufacturers is located in Division 16 of the specifications.
9. Provide estimates comparable to degree of completion of design. Include line items for demolition.
10. **Power System Study:** Include requirements to provide power system study for electrical apparatus included as part of this project. Analysis shall be undertaken from the last overcurrent device in this project to the utility service. Include all generator services and motor contributions. Accomplish the analysis using SKM Power Tools software or ETAP Power System software compatible with the software owned by Union Pacific. The actual study shall be accomplished by one of the firms Union Pacific has pre-approved for completing such an analysis.
 - a. Output of the analysis shall include: hard copies of the one line diagrams, hard copies of the final report, electronic copies of the one-line diagrams and final report and Arc Flash Hazard labels affixed to equipment analyzed as part of the study.

- b. The firm completing the analysis shall comply with the UPRR Power System Study Specification. A copy of the complete UPRR Power System Study specification shall be provided on request.

B. DRAWINGS

1. **General:** All drawings shall be drafted on Bentley Microstation Computer Aided Design (CAD) systems. The drawings shall include the Symbols and Legend sheet. Include graphic scales for all scales used on each drawing. All plan drawings shall include a North arrow.
2. **CAD Information:** Each CAD drawing shall be drawn to adhere to the Levels shown in Appendix "E." Title blocks shall be as shown in Appendix "E". The title block is for the standard 24x36 Union Pacific drawing sheet, including: Border, Title Block, and General Director - Design, Approval Line and Revision Block.
3. **General Drawing Arrangement:** The general drawing shall include and be arranged as follows: .
 - a. **Title Sheet:** The Title Sheet shall be used for stand-alone electrical projects. If used, the sheet shall include a list of Electrical Drawing Numbers and Titles. If space permits, all symbols and abbreviations shall be included on the Title Sheet.
 - b. **Symbols and Abbreviations Sheet:** The symbols and abbreviations sheet shall include a complete listing of all symbols and abbreviations used on the drawings.
 - c. **Location Plan:** A Location Plan shall include city and local street names. Also include a North arrow on the plan.
 - d. **Site Plan:** The Site Plan shall indicate the location of the "Facility" within the Railroad Yard. Also include a North arrow on the plan.
 - e. **Floor Plan(s):** Lighting and Power designs shall be on separate plans. If the plans for a single floor occupy more than a single sheet, each partial plan shall include a small-scale key plan to indicate the location of the partial plan with respect to the whole floor plan. Match lines shall be shown. Floor plans shall be arranged in order starting with the basement and proceeding upward to the top floor, and a roof plan if required.
 - f. **Lighting Floor Plans:** Lighting floor plans shall indicate the relative location of all light fixtures (include the fixture designation), methods of control, conduit location (i.e. concealed, surface, or underfloor) circuiting and location of the panelboard serving the lighting loads. Room names and/or numbers, location of windows and doors (including door swings), and wiring shall be shown.
 - g. **Power Floor Plans:** Power floor plans shall indicate the relative location of all receptacles, telephone receptacles, disconnect switches, panelboards, conduits and other non-lighting devices that require circuiting. In addition, each "load," shall indicate the circuit designation, number and sizes of wires, and conduit sizes, if other than #12, 1/2"C.
 - h. **Grounding Plan:** Provide detailed Grounding Plans for all buildings; the plan(s), shall include:

- (1) **Service Entrance Grounding details.**
 - (2) **All transformer grounding details.**
 - (3) **Special Grounding Grids:** Provide grounding details for Computer or specialized Control Rooms. (This includes details of all grounding connections within the room, i.e. raised floor connections, ground windows, etc.)
- i. **Elevations and Sections (if necessary):** Elevations and sections shall be included as necessary to make a complete description of the work.
 - j. **Details:** Enough details shall be shown to permit the job to be completed without additional engineering.
 - k. **One Line Diagrams:** Provide a one line diagram for all facilities. One line diagrams shall include ratings of equipment with impedance of transformers and generator sizes and ratings of buses and conductors, current, voltage and interrupting ratings of circuit protective devices.
 - l. **Elementary Diagrams:** Show all the elements of power and control circuits.
 - m. **Wiring Diagrams:** Show terminal to terminal connections.
 - n. **Schedules:**
 - (1) **Lighting Fixture Schedule:** Provide a lighting fixture schedule which includes the requirements shown in Appendix "B." The preferred location for the schedule is the same plan as the Lighting Floor Plan, (if space permits); otherwise, the lighting fixture schedule may be included with other schedules.
 - (2) **Equipment Schedule:** Provide Equipment schedules which includes the requirements shown in Appendix "B". The schedule may be located on the plan which has most of the referenced equipment shown, or included with the other schedules.
 - (3) **Pole Schedules:** Provide Pole Schedules which indicate Pole ID, Size, Class of pole, and Construction Details.
 - (4) **Panel Schedules:** Provide panel schedules which includes the requirements shown in Appendix "B". The schedule(s) may be shown on a floor plan or One Line Diagram if space permits.
 - (5) **Wire and/or Conduit Schedule:** Provide a wire or conduit schedule. This schedule shall which includes the requirements shown in Appendix "B". Include on a floor plan if space is available; otherwise, include it with the other schedules.
 - (6) **Transformer Schedule:** Provide a transformer schedule when there is more than one transformer specified. Locate the schedule as required.
 - (7) **Other schedules:** Provide additional schedules as required or as deemed necessary by the Designer.

C. LIGHTING DESIGN

1. **General:** All lighting shall be designed to conform to the recommended lighting levels stated in this Design Manual, or as recommended by the Illuminating Engineering Society. (Notify the Manager Electrical Design for discrepancies between this Manual and the IES standards.)
 - a. Coordinate with the Manager Electrical Design, if the Railroad, will supply any standard material.
 - b. All lighting fixtures must bear a UL label, unless written approval is received from the Manager of Electrical Design.
 - c. All lighting design shall meet local lighting requirements. All lighting shall be directed and controlled to avoid lighting spill onto surrounding properties.
2. **Recommended Lighting Levels:** Design the lighting system(s) based on foot-candle (fc) values shown, for the following facilities:

<u>Facility/Area</u>	<u>Table</u>
Office Bldgs. Areas	C.2-1
Shops/Warehouses.....	C.2-2
Building Exteriors.....	C.2-3
Railroad Yards.....	C.2-4
Intermodal Facilities.....	C.2-5
Automobile Facilities	C.2-6
Fueling Facilities	C.2-7

Table C.2-1 Office Bldgs/Areas

<u>Room or Area</u>	<u>fc</u>
Offices - Private.....	50
Offices - Open	50
Offices - Cubicles with task lighting	30
Conference Rooms (1).....	30 - 50
Corridors.....	10
Locker Rooms	20 - 30
Lunch Rooms (2).....	30
Restrooms.....	20 - 30
Mechanical Rooms	20 - 30

- (1) Provide two level switching and / or dimming. Dimming shall only be used for Conference Rooms in office facilities, not Lunchroom / Conference Rooms.
- (2) Some Lunch rooms, may also be utilized as Conference Rooms, if so utilize two level switching at approximately 30 and 50 foot-candles.

Table C.2-2 Shops/Warehouses

<u>Room or Area</u>	<u>fc</u>
Shop Area - Heavy repair	50
Shop Area - Fine repair	75
Paint Shops (Not including booths).....	50
Part Storage - Inactive (1).....	10

Part Storage - Bulky items	20 - 30
Part Storage - Small items	50
Fueling stations - Interior (2).....	30 - 50
Stairways	10 - 20
Toilets and Wash Rooms.....	20 - 30

- (1) Occupancy sensors may be required in certain parts storage areas; verify with the Engineer if required.
- (2) Higher lighting levels are required for day operations, and lower lighting levels for night operations.

Table C.2-3 Building Exteriors

<u>Area</u>	<u>fc</u>	<u>Uniformity</u>	
		<u>Ave/Min</u>	<u>Max/Min</u>
Entrances	1		
Parking areas	1	4:1	8:1
Surrounding areas	1		

Table C.2-4 Railroad Yards

<u>Area</u>	<u>fc</u>	<u>Uniformity</u>	
		<u>Ave/Min</u>	<u>Max/Min</u>
Switch Points	2		
Hump Area - Horizontal	5		
Hump Area - Vertical	20		
Retarder Area - Vertical.....	10		
Flat Switching Yards - Vertical	5		
Flat Switching Yards - Horizontal	2		
Classification Yards.....	1	5:1	10:1
Receiving Yards	1	5:1	10:1
Departure Yards.....	1	5:1	10:1

Table C.2-5 Intermodal Facilities

<u>Area</u>	<u>fc</u>	<u>Uniformity</u>	
		<u>Ave/Min</u>	<u>Max/Min</u>
Unloading - Horizontal.....	3		
Unloading - Vertical.....	3		
Trailer Parking.....	2	3:1	8:1
Perimeter Fence	1		

Table C.2-6 Automobile Facilities

<u>Area</u>	<u>fc</u>	<u>Uniformity</u>	
		<u>Ave/Min</u>	<u>Max/Min</u>
Unloading / Loading (Rail Cars)	5	3:1	6:1
Unloading / Loading (Transports)	5	3:1	6:1
Parking.....	3	5:1	10:1
Perimeter Fence	1		

Table C.2-7 Fueling Facilities

<u>Area</u>	<u>fc</u>	<u>Uniformity</u>	
		<u>Ave/Min</u>	<u>Max/Min</u>
Fuel Dispensing Islands.....	3	3:1	6:1

Truck Unloading..... 3..... 5:1..... 10:1

3. **Interior:**

- a. **Lighting Calculations:** Lighting calculations shall be made for each room (identical rooms of the same size do not need to be duplicated). Incandescent lighting fixtures shall not be used.
- b. **Office Switching:** Rooms larger than 200 square feet must have dual level switching. Relay switching for large rooms shall be used; in addition, large rooms shall be zoned to allow utilization of occupancy sensors and photoelectric controls. Occupancy sensors shall be designed to allow for the use of moveable office partitions, without degradation of the control sensing system - two cubicles one sensor.
- c. **Shop Switching:** Switches shall be used for controlling most lights within large shops.
- d. **Office Lighting Fixtures:** Lighting fixtures in offices shall be specification grade three lamp fluorescent, 2x4 troffers with electronic ballasts and cool white lamps. Parabolic type louvers or .125 prismatic acrylic lenses shall also be utilized. Direct/Indirect fixtures may be proposed.
- e. **Shop Lighting Fixtures:** High bay metal halide (MH) light fixtures shall be utilized in shop areas. Heavy duty industrial fluorescent fixtures shall be utilized in areas with low ceiling, i.e. locker rooms, storage rooms, etc.
- f. **Exit and Emergency Lighting:** Provide and install emergency lighting, as required by the appropriate building code. Use battery backup lights for emergency lighting for facilities. Use LED exit signs when appropriate.

4. **Exterior Lighting Design:**

- a. **General:** Utilize a lighting contactor with an H-O-A switch and photo cell, for installations consisting of six or more lights.
 - (1) Site lighting related to part night operations shall be controlled by UP standard radio control panel that includes timed lighting shut-off as well as on and off radio control. Information for procuring the control panel will be provided to the successful proposer.
- b. **Exterior Building Lighting:** Design in conjunction with existing Railroad site lighting. Wall pack luminaires shall be used on buildings with no overhangs, or eaves. Where possible install recessed luminaires in overhangs. All exterior lighting shall be metal halide. All wall mount fixtures shall have cut-off type distribution.
- c. **Site lighting:** Design shall be designed based on the area being illuminated. In all lighting projects, consideration shall be given to the effects of 1.) Light pollution, 2.) Light glare, and 3.) Light trespass. Photometric calculations and foot-candle layout shall be provided for all exterior site lighting.

- d. **Roadways:** Utilize the standard 400W HPS cut-off luminaire, mounted on Class 3 wood poles. Fixtures should be mounted no more than 40 feet above grade, nor less than 30 feet, unless directed to otherwise.
- e. **Track switches:** Utilize the standard 400W HPS cut-off luminaire, on Class 3 wood poles. Typically poles should be spaced not greater than 140 ft on center. Fixtures should be mounted no more than 40 feet above grade, nor less than 30 feet, unless directed to otherwise. Consideration will need to be given to ease of installation and maintenance; coordinate with Manager of Electrical Design.
- f. **Automobile Loading/Unloading Facilities:** Utilize 70-120 foot high-mast light towers, for area lighting, combined with roadway (and if required floodlights), on the perimeter. Utilize UPRR approved manufacturer.
- g. **Intermodal Facilities:** Utilize the 70-120 foot High-mast lighting towers for area lighting, combined with roadway luminaires around the perimeter. (Facilities smaller than 350 feet in any direction, should only require a combination of roadway luminaires and floodlights, on the same poles.) The average to minimum ratio should not exceed 5:1. Utilize UPRR approved manufacturer.
- h. **Fueling Facilities:** Coordinate the lighting design with facility design.
- i. **Departure / Receiving Tracks:** Design the lighting system based on the IES recommended levels.

D. POWER DESIGN

- 1. **General:** All power distribution design shall conform to all applicable local, state and federal codes, including the National Electrical Code (NEC) and the National Electrical Safety Code (NESC).
- 2. **Voltages:** For 600 Volt and under installations, the following voltages shall be used for distribution, and calculations:

Voltage*	Phase
120/240.....	1
120/208.....	3
120/240**.....	3
240.....	3
277/480.....	3
240/480**.....	3
480**.....	3
600***.....	3

* Services larger than 200A at 120/208 Volts should be 277/480 Volts.

** Note: These distribution voltages are to be used only if approved by the Manager Electrical Design.

*** For distribution systems exceeding 600 Volts, the preferred distribution class is 15 kV; with the distribution voltage equal to the local utility company's voltage; Voltage distribution systems in the 5 kV class, or higher than 15 kV, must have prior approval.

3. **Panelboards and Schedules:** Panelboards shall be sized to allow for a minimum of 25% electrical growth, and allow for 25% additional breaker space. Panelboard bus shall be sized for maximum number of spaces allowed based on ampacity of panel and shall be 24 spaces minimum.
 - a. Each panelboard shall have a schedule; load calculations shall be performed on the standard form, or an approved equal.
4. **Transformers and Schedules:** Each transformer shall be sized based on the estimated demand load plus 25%. No oil filled transformer smaller than 10 kVA will be utilized.
 - a. Designer shall require Contractor to supply a list of installed and spare transformers new for this project. List shall include Transformer number, Manufacturer, Serial Number, Location or Pole Number, KVA, Primary Voltage, Secondary Voltage, Tap information and PCB content.
5. **Outlets:**
 - a. **Convenience Outlets:** Provide convenience outlets in all offices, shops, warehouses, etc. . In offices, install a minimum of one duplex outlet on each wall of private offices, and a minimum of one outlet near each desk in open offices. Load calculations shall be based on the actual load of equipment to be connected, or 180 VA per duplex receptacle, whichever is greater. Connect a maximum of eight (8) duplex outlets, per 20 amp circuit.
 - b. **GFCI Outlets:** Provide GFCI (Ground Fault circuit Interrupter) receptacles in all Bathrooms, near sinks, exterior locations, and other areas as may be required by codes. Ground fault receptacles shall incorporate the self test feature. Unless otherwise directed do not use GFCI circuit breakers in lieu of GFCI receptacles. Do not use a feed through circuit for downstream receptacles.
 - c. **Telephone and Data Outlets:** Unless otherwise directed, telephone and data outlets shall be planned for and shown on the plans by the Designer. Provide one set of Telephone and Data Outlets for each desk, and elsewhere as directed. See the Specifications, for outlet box requirements.
 - d. **Welding Outlets:** Provide and install Siemens 60A 3P disconnect switch and receptacle combination, fuse block enclosures and receptacle thread lubrication as noted below: All material with the exception of the lubrication shall be purchased through Echo Electric, Alan Devereaux, 402-330-9995 for UPRR National Contract Pricing.
 - (1) Siemens 60A 3P disconnect switch and receptacle combination, Catalog number HNF362JCH.
 - (2) Killark cord cap for each welder, VP6485 60A.
 - (3) Provide and apply Killark "LUB-G" type lubrications or equal to receptacle thread surfaces to prevent galling between the receptacle and locking ring threads.
 - (4) Custom fuse boxes shall be installed near panelboards where welding receptacle circuits originate. Fuse box shall be installed in series with all welding receptacle circuits

- i. Single circuit version: Cat No. A1412CHQR-UPRR-CUSTOM#1
 - 1. Sample Part List: Hoffman A1412CHQR Enclosure, Hoffman A1412 Din Rail, (1) 3 phase Class J Fuse Block, (3) 60A Class J Fuses
- ii. Double circuit version: Cat No. A1412CHQR-UPRR-CUSTOM#2
 - 1. Sample Part List: Hoffman A1412CHQR Enclosure, Hoffman A1412 Din Rail, (2) 3 phase Class J Fuse Block, (6) 60A Class J Fuses
- iii. Single circuit version: Cat No. A1412CHQR-UPRR-CUSTOM#3
 - 1. Sample Part List: Hoffman A1412CHQR Enclosure, Hoffman A1412 Din Rail, (3) 3 phase Class J Fuse Block, (9) 60A Class J Fuses

6. **Overhead Distribution:**

- a. **General:** Utilize the standard pole line details which will be provided.
- b. **Pole Construction:** Locations where wires cross tracks and designated roadways, double crossarm construction and 55 foot poles are required for primary voltages.
- c. **Control:** Design the power distribution system to allow for installation of a power line recloser at the source of power from the Electric Utility; additional reclosers may be required, depending on the size of the distribution system. Coordinate all applications, with the Manger Electrical Design. Utilize the Cooper Kyle Type W Recloser unless other reclosers are required to coordinate with utility.
- d. **Clearances:** Following are the minimum clearances for wires crossing railroad branch lines, main lines, and possible electrified main lines.

WIRE CLEARANCE CHART

Voltage (to ground)	Potential Electrified	Minimum Clearance Required Above Top of Rail Other Lines	Minimum Clearance Required Above Communication and Signal Line Including Static Wires
			Aux. Tracks
0 to 750	35.0'	27.5	4.0'
751 to 15 kV	36.0'	29.5	4.0'

7. **Underground Distribution:**

- a. **Conduit System Design:** Conduits shall be as specified in Section 16111, of the Electrical Specifications. Conduits shall be sized based on RHW type wire with outer covering.
- b. **Hand Holes and Man Holes:**
 - (1) Hand Holes may be used for pulling cables in underground duct bank distribution. Do not splice cables in hand holes. Hand holes shall be AASHTO H-20 rated.

- (2) Man holes shall be used only with agreement of the Manager of Electrical Design.
8. **Wires and Cables:** Wires and cables shall be installed according to the latest NEC. Wires and cables shall be as specified in Section 16120 of the Electrical Specifications. Under no circumstances shall the current carrying neutrals be sized less than the phase conductors.
9. **Grounding System:** Design for the grounding system shall meet the requirements of the National Electrical Code.
10. **Building Grounding:** Bond system ground and lightning protection ground outside building in a ground inspection enclosure. The complete grounding system consists of external to the building grounding, internal building grounding, and building electrical distribution systems.
- a. **External Building Grounding:** Bond all grounding electrode conductors at the service entrance panelboard only. This includes all ground rods, water pipes, building steel, microwave towers, and other ground electrodes. The size of all grounding electrode conductors shall be in accordance with the NEC, or minimum #2 AWG.
- b. **Internal Building Grounding:** Ground every separately derived system in accordance with the NEC. Provide details for each type of separately derived system, indicating ground electrode conductor sizes, and point of attachment to ground.
- c. **Computer Room Grounding:** Establish a separately derived source (isolated transformer, UPS, etc.) for the room, and locate these as close to the room as possible; preferred method is to locate these systems within the Computer Room. Locate a panelboard immediately downstream from the separately derived source and from this establish a “ground window” for the room. Bond all equipment racks, raised floor systems, and any other metal object to the ground window. The purpose is to create a virtual zero potential difference between different “grounds” within the room. This ground window must not be bonded to any external ground source, as this can create ground loops within the building or a potential difference between grounds. This also minimizes the effect of external sources of voltages, being cleared through the critical areas.
11. **Surge Protective Devices:** All service entrances shall be protected with a surge protective device. Surge protection, shall also be installed on all panelboards serving: office areas, programmable logic controllers, communication equipment, and all other electronic equipment.
12. **Control Panels:** Every control panel shall comply with the latest published edition of the National Electric Code, specifically Article 409, Industrial Control Panels. In addition, all control panels shall be UL listed. If compliant, OEM control panels supplied with OEM equipment shall be allowed. All other control panels shall be provided by one of the firms Union Pacific has pre-approved for control panel fabrication. Those firms are listed in the electrical specification.

E. INSTRUMENTATION AND CONTROL

1. **General:** Provide a complete set of control drawings indicated in Paragraph “B”, of this document. Coordinate with the Manager Electrical Design whether the project requires a Programmable Logic Controller (PLC), and if so, which model.

2. **Manufacturers:** When programmable logic controllers are required, utilize the Allen Bradley series of PLC's.

F. REMODELING

1. **Service Entrance:** For all service entrances the following shall apply:
 - a. Field verify the connected load for each panelboard and calculate the new estimated demand loads per the National Electrical Code. Show all calculations on the Load Analysis Forms.
 - b. Develop a One Line Diagram of the facility, based on information in Subsection I.F.1.a above.
 - c. Provide and install surge protective devices as outlined in Subsection I.D.12 above.
2. **Light Fixtures:** Design the lighting system in accordance with the provisions of SECTION "C" - LIGHTING DESIGN. Provide new light fixtures in all areas unless directed to do otherwise. Do not re-use fluorescent fixtures with T-12 lamps. If light fixtures are directed to be re-used, the fixtures shall be cleaned before being re-installed; in addition, all broken lenses, and damaged ballasts shall be replaced, and paint nicks shall be repainted. All lamps shall be new.
3. **Panelboards:** Panelboards shall be replaced if spare, or new, circuit breakers of the same manufacturer cannot be obtained. Replace panelboards in order to run arc flash analysis without using assumptions regarding maintenance or interrupting ability. All new panelboards shall be sized in accordance with Subsection I.D.3.
4. **Outlets:** Provide devices in accordance with Subsection I.D.5 herein. Existing devices in walls may be re-used if the wiring meets all local, state and national codes, and are grounded outlets.
5. **Grounding:** Design the grounding system in accordance with Subsection I.D.10 above.
6. **Equipment:** Coordinate with the Manager Electrical Design, if programmable logic controllers are to be used. The Manufacturer of PLC's shall be Allen Bradley.

G. COMMUNICATIONS ENTRANCE

1. See communications and IT service entrance directions.

SECTION II
SUBMITTALS

SUBMITTAL REQUIREMENTS

NOT ALL SUBMITTAL REQUIREMENTS ARE SHOWN HERE. SEE SPECIFICATIONS FOR ADDITIONAL INFORMATION.

SECTION NUMBER	SECTION NAME	SHOP DRAWINGS	PRODUCT DATA	O & M MANUAL	TEST REPORTS
----	LOAD BALANCE				X
16010	ARC FLASH REPORT				X
16120	MEDIUM VOLTAGE CABLES		X		
16131	INGROUND BOXES		X		
16140	WIRING DEVICES		X		
16150	MOTORS		X		
16155	MOTOR STARTERS		X	X	
16156	CONTROL PANELS	X	X	X	
16160	PANELBOARDS	X	X	X	
16170	DISCONNECT SWITCHES		X		
16181	FUSES	X	X		
16231	GENERATORS	X	X	X	X
16415	TRANSFER SWITCHES	X	X	X	
16460	TRANSFORMERS	X	X	X	
16510	INTERIOR LIGHT FIXTURES		X	X	
16520	EXTERIOR LIGHT FIXTURES		X	X	
16530	LIGHTING CONTACTORS		X	X	
16540	RADIO OPERATED LIGHTING CONTROL		X		
16611	UPS SYSTEMS	X	X	X	
16900	PROGRAMMABLE LOGIC CONTROLLERS	X	X	X	
16401	POLES		X		
16401	TERMINATION KITS		X		
16401	LIGHTNING ARRESTORS		X		
16402	UG TERMINATION KITS		X		
16402	LOAD-BREAK ELBOWS		X		
16402	UG SPLICES		X		
16402	NEUTRAL GROUNDING KIT		X		
16403	SECTIONALIZING ENCLOSURE		X		
16403	PADMOUNTED SWITCHES		X		

SECTION III

SPECIFICATIONS

Specifications are provided for reference to determine quality levels and installation expectations. Designer shall provide their standard documents incorporating UPRR requirements.

ELECTRICAL SPECIFICATIONS

DIVISION 16

16010	General
16020	Work Included
16025	Codes and Fees
16030	Tests
16035	Inspections
16040	Equipment Identification
16050	Basic Materials and Methods
16111	Conduit System
16120	Wires and Cables
16121	Wire Connections and Devices
16130	Boxes
16131	Junction and Pull Boxes
16140	Wiring Devices
16150	Motors
16155	Motor Starters
16156	Control Panels
16160	Panelboards
16170	Disconnect Switches
16181	Fuses
16195	Mounting Heights
16401	Overhead Electric Service
16402	Underground Electric Service
16403	Sectionalizing Enclosure with Fiberglass Ground Sleeve
16450	Grounding and Testing
16460	Transformers
16500	Lighting
16501	Lamps
16502	Ballasts
16510	Interior Lighting Fixtures
16520	Exterior Lighting Fixtures
16530	Lighting Contactors
16540	Radio Operated Lighting Control
16640	Cathodic Protection
16800	Communications Entrance
16900	Programmable Logic Controllers

16010 - GENERAL PROVISIONS

A. GENERAL –

1. The electrical work here under shall consist of furnishing all labor, equipment, materials, tools, transportation, and services required for the electrical work as indicated on the plans and as specified herein.
2. The term Engineer, as referred to herein, shall mean the "Manager of Electrical Design", or his designate.
3. The specifications and drawings require finished work, tested and ready for operation. Provide and install all accessories and/or appurtenances required for a complete installation whether specified, drawn or implied.
4. Any deviations in the work shown or implied on the Electrical Drawings, or as herein described, shall have the written approval of the Engineer.
5. Applicable requirements of Conditions of Contract, of Sections listed under General Requirements and of Division 15, apply to work specified under Division 16.
6. Poles may support signal wires as well as electrical. Verify with local electrician or Manager of Electrical Design before removing any signal or communication wire.

B. WORKMANSHIP –

1. All installations and electrical work must present a neat and professional appearance upon completion. All electricians must be journeymen licensed electricians in the state in which the project is being constructed. Apprentice electricians may be allowed to work on the project; however, no more than one apprentice (unlicensed) electrician may be allowed per each licensed electrician. Laborers may be used to handle and move material, dig trenches, and other manual labor not requiring electrical knowledge. Laborers, may not: work with wire and conduit, install electrical equipment, or any other duties and functions as may be governed by all local rules for Electricians. The Contractor shall remove any electrician, apprentice, or Laborer, who, in the Engineer's opinion, is not performing the work in the best interest of the Railroad, or who does not meet the requirements of these specifications.

C. EXAMINATION OF PREMISES –

1. Examine the premises and all conditions thereon and/or therein, and take into consideration all conditions that affect the work under the contract prior to bidding.

D. COORDINATION OF WORK –

1. Plan all work to proceed with a minimum of interference with other trades. Provide all openings for the electrical work as required. Make provisions for all special frames, openings and pipe sleeves as required.
2. Pay for all extra cutting and patching made necessary by failure to properly direct work at the correct time.
3. Coordinate work with the local electric utility company. Installation shall conform to all utility requirements. Provide UPRR Manager of Electrical Design copies of all correspondence with the utility company.

E. COOPERATION WITH OTHER CONTRACTORS –

1. Coordinate the work with other Contractors, so that all the work progresses expeditiously. Promptly report to the Engineer any delay or difficulties, encountered in the installation of the work which would delay the construction schedule, or make the work unsuitable to connect with, or receive the work of others. Failure to so report shall constitute an acceptance of the work of others as being fit and proper for the execution of the work.

F. INTERFERENCE –

1. INTERIOR WORK

- a. Wherever piping, or conduit, is run on ceilings, arrange the run of the piping in a manner that does not interfere with grilles, ducts, lighting outlets, lighting fixtures, or other similar items.

2. EXTERIOR WORK

- a. Wherever overhead wiring is run on poles, or other structures, verify the overhead routing on or between said structures does not interfere with any other power, or communication wiring, or with the structures, or facilities. If interference is discovered at any location, the interference shall be brought to the attention of the Engineer prior to construction.

G. OPENINGS IN PIPES –

1. Keep closed all openings in pipes, ducts and conduits during progress of the work.

H. ACCESS TO EQUIPMENT –

1. All control devices, specialties, pull boxes, etc., shall be located to provide for easy access for operation, repair and maintenance; if concealed, access doors, or removable panels, shall be provided.

I. PROTECTION OF APPARATUS, ETC. –

1. Take such precautions as necessary to properly protect all apparatus, fixtures, appliances, material, equipment and installations from damage of any kind. Failure to provide protection to the satisfaction of the Engineer shall be cause for rejection of any particular piece of material, apparatus, equipment, etc., concerned.

J. CLEANUP AND PAINTING –

1. Clean the interior of all panelboards, pull boxes, and equipment enclosures of the electrical work.
2. Wash and wipe clean all lighting fixtures, lenses and lamps.
3. All equipment shall have factory applied finish. Damaged finishes shall be refinished.

K. GUARANTEE –

1. GUARANTEES AND WARRANTIES

- a. The Contractor shall guarantee all Work under this Agreement for a period of one year from the date of acceptance by the Railroad, unless otherwise indicated.
- b. Contractor shall leave the Work in perfect order at completion, and the final certificate of payment shall not relieve him of the responsibility for negligence, faulty materials, or workmanship; upon written notice, he shall remedy any defects or workmanship that may appear during the time herein before mentioned and pay all expenses due therefrom to the entire satisfaction of the Engineer.
- c. The owner may assume beneficial occupancy of a portion of the work. Owner and contractor shall agree as to extent of the work that is deemed complete. Contractor shall provide a written statement to the owner describing the portion of the work and the date warranty coverage begins.

L. SUBMITTALS

1. SHOP DRAWINGS

- a. Furnish submittals for all equipment and items to be used in the installation per table "Submittal Requirements". Submit one electronic copy. Submittals shall be provided within 60 days of the Contract Date.
- b. Clearly indicate the proposed items (by drawing schedule symbol: i.e. Light Fixture "D"), the manufacturer's name, supplier, catalog number, cuts, diagrams, drawings, capacities, characteristics and details in conformance with the drawings or schedules. The manufacturer shall certify capacities, dimensions and special features required.
- c. Shop submittals shall bear the stamp of the contractor and shall indicate that the contractor has reviewed and approved the shop submittals for the application. Shop submittals without the contractor's signature indicating approval shall be returned without action.
- d. Indicate the Manufacturer's delivery time for the item after receipt of approval by the Engineer.

2. OPERATION AND MAINTENANCE MANUAL

- a. Prior to final approval of the installation, obtain and submit to the Engineer, three (3) bound copies and one (1) electronic copy of SD disc of descriptive literature, maintenance and operation data, and parts lists of each item of electrical equipment requiring maintenance and special operation procedures, furnished and installed under the contract.
- b. Turn over to the Engineer drawings, instructions and manuals supplied with equipment furnished by others.

M. ACCESSORY SCHEDULE –

1. Furnish the Owner a complete equipment accessory schedule listing each piece of equipment and the related size, type, number required and manufacturer of the following items:

- a. Renewable filters, fan belts, etc., supplied under the electrical portion of the contract.
- b. Renewable electrical items, i.e. fuses.

N. LUBRICATION –

1. Provide all lubrication for the operation of all equipment furnished under the contract until acceptance. Provide a chart listing each piece of equipment, the proper type of oil or grease required and recommended frequency of lubrication.
2. Run in all bearings and after bearings are run in, drain and flush bearings and refill with new oil. Equipment shall be so arranged that tools (screwdrivers, wrenches, etc.) will not be required to make lubrication points accessible. Extensions on grease, or oil, fittings shall be provided where required for access to lubricate.

O. FUEL AND OIL –

1. Provide all fuel and oil for testing.
2. At turn over to owner, fuel tanks shall be full and all fluids shall be at normal operating levels.

P. UTILITY SERVICE CONTINUITY –

1. Arrange the work so that electrical services are available to the existing facilities as required by the Special Conditions, except for unavoidable short periods of interruption necessary for the performance of the work. Periods of interruption shall be coordinated with the Owner. Utilities shall not be interrupted without the Owner's written approval as to time and duration of the interruption. Utilities to existing facilities shall not be disconnected until new, or temporary, facilities are installed.

Q. SUBSTITUTIONS FOR MATERIALS SPECIFIED –

1. Materials and items of equipment furnished must meet the requirements of the drawings and specifications as to quality, performance, suitability and appearance.
2. Any proposed substitutions will be judged on the basis of quality, performance, appearance and on the governing space limitations. The reputation of the manufacturer, time requirements and the availability of repair, or replacement, parts may also be considered.
3. The Owner also reserves the right to reject, or accept, material, or equipment items, which fail to meet all of the stipulated requirements. Allow a suitable credit for a substitution. All substitutions and credits must be approved by the Engineer in writing.
4. The Engineer is the sole and final judge as to the suitability of substitution items. Approval of substitutions shall be in writing prior to installation.
5. The entire cost of all changes of any kind due to Contractor requested substitutions, will be borne by the Contractor

R. MATERIALS AND EQUIPMENT FURNISHED BY CONTRACTOR –

1. GENERAL

- a. Where certain materials and equipment are indicated to be furnished by contractor and installed, or connected, under the Contract, verify installation details and coordinate the work schedule accordingly. No substitution will be allowed for the following material:

2. SELECTED SUPPLIERS AND MANUFACTURERS

- a. Union Pacific has purchasing agreements with the following suppliers. Identify the project as being for Union Pacific Railroad to obtain pricing. Obtain the following materials from the indicated suppliers.
 - (1) Medium Voltage Pad Mount Switches
 - (a) Manufactured by S&C Electric Company, Contact: Larry Schultz, Telephone: 913-768-1115
 - (2) 600 Volt Distribution Equipment
 - (a) Manufactured by Square D Equipment, Graybar, Contact: Kyle Naughton, Telephone: 402-592-7676
 - (3) High Mast Lighting
 - (a) Manufactured by MUSCO Light Structure with 10 year performance warranty, MUSCO, Contact: Brandon Albers, Telephone: 641-673-4740
 - (4) Area Lighting
 - (a) Manufactured by Holophane Mongoose or GE Tiger, WESCO, Contact: Andy Messner, Telephone: 402-333-2900
 - (5) Lamps
 - (a) Manufactured by Phillips, WESCO, Contact: Andy Messner, Telephone: 402-333-2900
 - (6) Lighting Contactors
 - (a) Manufactured by Square D Equipment, Graybar, Contact: Kyle Naughton, Telephone: 402-592-7676
 - (7) UPS & TVSS
 - (a) Manufactured by MGE, Power Protection Products, Contact: Brian Branigan, Telephone: 402-393-1223
 - (8) Engine Generator
 - (a) Sizes less than 500 kW manufactured by Cummins Onan, Cummins Central Power, Contact: Eric Carlson, Telephone: 402-951-2771
 - (b) Sizes 500 kW and greater manufactured by Generac Power Systems, Titan Energy Systems, Contact: Mike Marcinek, Telephone: 402-932-4373
 - (9) Transformers
 - (a) Manufactured by Howard Industries, Echo Electric, Contact: Alan Devereaux, Telephone: 402-330-9995
 - (10) Reclosers
 - (a) Manufactured by Cooper Kyle W-group hydraulically controlled

(i) Coordinate with Utility before purchasing

- (11) Recloser Bypass Switch
 - (a) Manufactured by Cooper, ABB or S&C
- (12) Gang Operated Switch
 - (a) Manufactured by Cooper or S&C
- (13) Overhead Cable Warning Marker Sphere
 - (a) All sizes: TANA Manufacturing, P.O. Box 370, California, MO 65018
 - (b) 36" & 20" sizes: P&R Technologies, P.O. Box 554, Portland, OR 97207, Telephone: 503-292-8682

S. DELIVERY AND STORAGE OF MATERIALS –

- 1. Make the required arrangements for the introduction into the building of equipment too large to pass through finished openings. Deliver the material at stage of the work that will expedite the work as a whole. Mark and store the material in a way to allow for checking and inspection.
- 2. The contractor may be allowed to store materials inside UPRR facilities. The contractor is responsible for all stored materials. Replacement of damaged or missing materials shall be at the contractor's expense.

T. NUMBER OF SPECIFIED ITEMS REQUIRED –

- 1. Wherever in the specifications an article, device, or piece of equipment, is referred to in the singular, the reference applies to all similar articles shown on the drawings, or required to complete the installation.

U. DRAWINGS –

- 1. The electrical drawings constitute a part of the contract; indicate the general arrangement of circuits and outlets, locations of switches, panelboards, conduit, and other work. Data presented on the drawings are as accurate as preliminary surveys and planning can determine, but accuracy is not guaranteed and field verification of all dimensions is directed. Specifications, distances and levels will be governed by actual field conditions. Review Architectural, Structural, Plumbing, Heating, Air Conditioning and ventilating plans, (when part of the Contract), and adjust the work to conform to all conditions shown thereon. Discrepancies shown on different plans, or between plans and actual field conditions, or between plans and specifications, shall be promptly brought to the attention of the Engineer. All items not specifically mentioned herein, which are obviously necessary to make a complete working installation, like bolts, nuts, washers, etc., shall be included.

V. SITE ACCESS –

- 1. Contractor and any sub-contractors shall comply with Union Pacific e-Railsafe including but not limited to background information and personnel credentials. Go to e-Railsafe.com for information.

W. SAFETY –

- 1. GENERAL

- a. As part of Union Pacific Railroad's focus on safety, we want to make certain that our Contractors establish and maintain safe work practices, including the proper training of their employees. Union Pacific will not allow contractors to perform work on our property unless they have been properly trained for the work they are performing.
- b. Training for Engineering Department contractors falls into two primary categories:

2. REGULATORY TRAINING

- a. Training is required by federal, state or local workplace safety regulations. This training includes, but is not limited to:
 - (1) FRA Roadway Worker Protection (for those working within 25 feet of any track). This training is available from several sources, including other railroads, railroad industry training professionals and computer based training. Several internet web sites now offer RWP training for a modest fee, including:
 - (a) www.railroadeducation.com
 - (b) www.nrcma.org
 - (c) UPRR does not endorse any specific RWP training program nor does it require contractor employees to be trained specifically on UP's On-Track Safety Program. However, we do require that our contractors properly train their employees on RWP as required by 49CFR214.343.
 - (d) OSHA Fall Protection (for those working on elevated structures 6' or higher).
 - (e) OSHA Confined Space Entry (for those working in confined spaces).
 - (2) Please note that Union Pacific Railroad does not provide regulatory training for contractors' employees but will assist contractors in locating training resources. The frequency of training is mandated in each regulation.
 - (3) Union Pacific Railroad insists on 100% compliance with all governmental regulations by its Contractors and their employees.

3. UPRR SAFETY TRAINING

- a. Training is required for Engineering Department contractor employees or design consultants to perform work on UP property. This training is in addition to the regulatory training described above and is available in several different formats:
 - (1) Pamphlet entitled "Minimum Safety Requirements for UPRR Contractors". A PDF copy of the pamphlet is available at www.uprr.com/suppliers/sup_ovr/terms.shtml for download.
 - (2) Pamphlet entitled "UPRR Electrical Safety Rules" (Document #PB-20502). A PDF copy of the pamphlet is available in Appendix C of the Division 16 specification.
 - (3) Online Training program via www.contractororientation.com. The information presented is the same as the video and pamphlet; however,

this web site also provides record keeping and testing services. Once a person completes the course, they are sent a wallet-size card showing successful completion.

- (4) UPRR Safety Training must be completed every calendar year. Please note that this training does not meet the requirements for Roadway Worker Protection Training.
- (5) Contractors must furnish employees with documentation that they have completed the required regulatory and UPRR safety training. This can be accomplished by issuing cards denoting the employee's training, issuing list of employees who have completed specific training or by having available, at the job site, other forms of documentation.
- (6) Under government workplace safety regulation, each employer is responsible for the training of their employees. Union Pacific Railroad provides the necessary resources to train our employees and we expect the same from our contractors.
- (7) Contractors to UP also have oversight responsibilities for monitoring the training and compliance of employees of sub-contractors. Make sure that the sub-contractors you hire are familiar with and comply with the training requirements outlined above.

X. DEMOLITION –

1. Provide all demolition required whether specifically shown or not.
2. Poles which support signal/communication wiring shall be topped after demolition of power wiring instead of removing poles. Coordinate with Engineer.
3. Deliver all transformers to a location in the yard identified by UPRR. UPRR will dispose of transformers.
4. The contractor will legally dispose of all other materials off site.
5. Brush and small tree limbs may be chipped and spread on the right of way but not within yard limits. Areas where materials may be spread on the right of way shall be identified before bidding.

16020 - WORK INCLUDED

- A. Division 16 includes all electrical work to constitute a complete installation. The electrical work includes all that is shown on the plans, but is not limited to the following:
1. Setting poles.
 2. Mounting street lighting fixtures.
 3. Mounting floodlights.
 4. Providing electrical service and electrical distribution equipment, including transformers, cutouts, lightning arresters, crossarms, and other primary power distribution equipment as indicated on the plans.
 5. Power and lighting panelboards and enclosures.

6. Branch circuit wiring, including conduit, wire, switches, receptacles and associated outlets and fittings.
7. Motor control equipment.
8. Interior and exterior lighting fixtures, including lamps and auxiliaries.
9. Reconnect all 600 volt or less electrical equipment currently served by the electrical distribution system. All services presently operating shall operate from the updated distribution system.
10. Cutting, patching, excavating and backfill where required.
11. Chases, sleeves, recesses, blocking, framing and supports, including structural and concrete framework where required.
12. Testing and guarantees.
13. Shop drawings and as-built drawings.
14. Cathodic protection.
15. Grounding of all systems and equipment.
16. POWER SYSTEM STUDY
 - a. Provide power system study for electrical apparatus included as part of this project. Analysis shall be undertaken from the last overcurrent device in this project to the utility service. Include all generator services and motor contributions. Accomplish the analysis using SKM Power Tools software or ETAP Power System software compatible with the software owned by Union Pacific. The actual study shall be accomplished by one of the firms Union Pacific has pre-approved for completing such an analysis. Those firms are:
 - (1) AVO Electrical Engineering Services, Dee Jones, email: dee.jones@avoedivison.com
 - (2) Eaton Electrical Services and Systems Division, Daniel Lakin, email: DanielFLakin@eaton.com
 - (3) Emerson Reliability Services, L. Robin Tennison, email: Robin.Tennison@Emerson.com
 - (4) GBA, Alan Lehman, email: alehman@gbateam.com
 - (5) Interstates Companies, Seth Vis, email: seth.vis@interstates.com
 - (6) TKDA, Eric Lechowicz, email: eric.lechowicz@TKDA.com
 - (7) Zachry Engineering Corporation, Steve Thompson, email: thompsons@zhi.com
 - b. Output of the analysis shall include: hard copies of the one line diagrams, hard copies of the final report, electronic copies of the one-line diagrams and final report and Arc Flash Hazard labels affixed to equipment analyzed as part of the study.
 - c. The firm completing the analysis shall comply with the UPRR Power System Study Specification. A copy of the complete UPRR Power System Study specification shall be provided on request.

17. AS BUILT DRAWINGS

- a. Provide and maintain in the field office, one complete set of all drawings and specifications, which form a part of the Contract. Immediately after work is installed, accurately draw on the prints in colored pencil, any and all work which is installed differently from the work indicated on the drawings. Correction of the drawings must be done daily.
- b. Obtain from UPRR an electronic copy of the contract documents. Post all changes from the hand marked drawings to the electronic copy. Electronic copy shall be in dgn (Microstation V7 or V8) or dxf format.
- c. At project completion and before invoicing for retainage, provide to Engineer one marked up copy, one electronic copy on disc and one plotted copy from the electronic copy for review.

16025 - CODES AND FEES

A. CODES –

1. All electrical work must be executed in accordance with the latest published edition of the National Electrical Code (NEC), The National Electrical Safety Code (NESC), and all State, County and local rules, regulations and ordinances applicable to electrical work. Details of construction and installation, which are not specifically designated on the plans, must conform to the above.

B. PERMITS –

1. Contractor shall obtain and pay for all permits and licenses pertaining to the work. The Certificate of Inspection and Approval, if official inspection is required, shall be turned over to the Owner on completion of the job and before acceptance of the construction.

16030 - TESTS

A. GENERAL –

1. Upon completion of the installation, make tests for operation to the satisfaction of the Engineer. Take voltmeter and ammeter readings for all motors, in the presence of the Engineer. (See Section **16035 - INSPECTIONS**, for further information regarding inspections and requirements.) For additional tests, see Section **16450 - GROUNDING AND TESTING**.
2. Upon completion of the installation, all insulated conductors shall test entirely free of grounds and short circuits. All insulation testing shall be performed with a 500-volt "megger" or equivalent testing device, which shall give resistance readings between conductors and from conductors to ground. The test readings shall show that the insulation is sound.
3. Take voltage and ampere readings at the mains of each panelboard. Unbalances greater than 15% shall be corrected and repaired, prior to final approval.

B. PHASE ROTATION CHECK –

1. Demonstrate that all power receptacles, service feeders and main power feeders have the same A-B-C phase clockwise rotation.

16035 - INSPECTIONS

A. GENERAL –

1. Two inspections and their subsequent reports may be made by the Engineer (or his designee), prior to completion of the project. The two inspections include "Rough-in" and "Final". Failure to properly notify the Engineer, for either inspection may cause removal of some building material to properly verify installation. Any additional costs i.e. removal and re-installation of drywall, painting, etc., caused by failure to notify the Engineer, will be borne by the Contractor. The results may also include forfeiture of payments, and/or cancellation of Contract. Notify the Engineer a minimum of one (1) week prior to each inspection. These inspections are in addition to those inspections required by any Local or State Inspector.
2. A maximum of two trips per each of the two inspections (Rough-in and Final) are allowed. If the second trip still shows the same corrections have not been made, all expenses for subsequent trips will be borne by the Contractor at the rate of \$75.00 per hour plus all living and travel expenses.

B. ROUGH-IN INSPECTION –

1. A Rough-In Inspection will include inspection of all items to be concealed. A signed report will be made and forwarded to the Contractor, noting any defects which will need to be corrected prior to proceeding. Once corrections have been made another inspection will be performed and an approved and signed inspection report will be forwarded to the Contractor. Prior to proceeding with installation of drywall, concrete, or other material which would render making visual inspections impossible, the Contractor must have the approved Rough-In Inspection document.

C. FINAL INSPECTION –

1. A Final Inspection will include inspection of all items. A signed report will be made and forwarded to the Contractor, noting any defects which will need to be corrected prior to acceptance. Once defects are corrected, an approved Final Inspection document will be forwarded to the Contractor.

16040 - EQUIPMENT IDENTIFICATION

- A. Identify all panelboards and switchboards, with a permanently attached, engraved, plastic or phenolic nameplate. The nameplate shall have a white background with contrasting black lettering not smaller than 3/8" in height. Indicate panel name, or designation and voltage, phase, and wire characteristics, i.e. 120/208V, 3P 4W.
- B. Identify all junction boxes 4" x 4" and larger with system, equipment served and/or circuit numbers. Adhesive plastic tape may be used for the purpose.
- C. Tag all empty conduits at each end; identify system served, origin and terminal points.
- D. Identify all disconnects, starters, equipment enclosures, terminal boxes and pull boxes, with embossed labels and clear overlay to identify item, system, service and contents.

- E. Number all transformers according to transformer schedule. Label all transformers with kVA rating if not already labeled. Overhead transformer kVA rating shall be readable from the ground.

16050 - BASIC MATERIALS AND METHODS

- A. All material shall be new unless furnished by UPRR and be free from defect, of current manufacture, and of the quality specified, or shown, and listed by the Underwriters' Laboratories, Inc., (UL) for the purpose to be used, when applicable.
- B. Materials and equipment shall be uniform throughout the installation, i.e., equipment of the same type shall be of the same manufacturer.
- C. All products must conform (unless noted otherwise) to the National Electrical Manufacturer's Association (NEMA) standards, when standards apply.

16111 - CONDUIT SYSTEM

A. GENERAL –

1. Install the entire conduit system continuous from outlet to outlet. Size all conduits in accordance with the NEC, or as shown on the plans, whichever is greater. Conceal conduits wherever possible. Install conduit runs straight and true, elbows, offsets, and bends shall be made without kinking, or destroying the cross-sectional contour of the conduit.
2. Do not use conduit which has been crushed, or otherwise deformed; properly protect conduit before, during and after installation. Protect the conduit from water, mortar, grout, concrete, and other deleterious substances and materials entering the conduit. Do not use conduit showing signs of corrosion.
3. The conduit system, when completed, shall form a continuous electrical conductor and shall be so connected by bonds or otherwise, at boxes, fittings, and cabinets, as to provide effective electrical continuity. Running threads are prohibited. Where necessary for connecting conduits, right and left-hand couplings or Erickson couplings shall be used. All conduits entering panelboards, distribution panelboards, disconnect switches, motor controllers, and the like shall terminate in grounding bushings and shall be bonded together and to the equipment ground bus where provided as part of the installation.
4. Take the necessary precautions to prevent the lodging of dirt, concrete, or trash in the conduit, fittings, and boxes during the course of installation. Clean conduits before pulling wire.
5. Paint surface conduit runs in accordance with the surface paint colors.

B. INSTALLATION –

1. CONDUIT RUNS

- a. Install all conduits with code radius bends with not more than three 90° bends per run unless approved by Manager of Electrical Design. Where more than three 90° bends are required in a particular run, install pull boxes. Avoid conflict with other systems for all conduit runs installed below floor slabs. Where required for ease of pulling or where required by Code, install cast junction, or pull-boxes, even though not shown on the drawings.

- b. Install exposed conduits parallel with and at right angles to the building walls and structural framing. Support the conduit every five feet with rust-proofed, one-hole straps, and anchors as required. On metal construction, beam clamps with machine screws, or bolts, shall be employed. All conduits shall drain. Conduits entering the top of exterior enclosures, or above un-insulated live parts in exterior enclosures, shall be fitted with weatherproof hubs.
- c. Install conduits above or adjacent to mechanical piping, and support independently. Maintain a minimum clearance of 2 inches from mechanical piping. Where conduits are installed adjacent to objects operating above the rated temperature of the insulation, the minimum clearance shall be 6 inches.

2. JOINTS

- a. Cut ends of conduit square and ream to remove burrs and sharp edges. Electrical Metallic Tubing (EMT) joints shall be made with compression type coupling; set screw, or crimp-on type couplings are not acceptable. Running threads shall not be used in lieu of conduit nipples, nor shall excessive thread be used on any conduit. Conduit terminated in cast boxes shall have five full threads of contact. Threads shall be cleaned prior to conduit installation on all boxes and fittings where insulating coatings have been applied.

3. BUSHINGS

- a. Provide insulating-type bushings and double locknuts on the ends of rigid conduits terminating at all steel boxes, panelboard cabinets, motor-starting equipment and other similar enclosures. Use OZ Type B (or approved equal) bushings on all conduits one inch and larger. These are insulating bushings with body threads and conduit stop of malleable iron or steel with phenolic insulation molded on the top. Grounding bushing shall be OZ Type BLG, or approved equal.

4. FITTINGS

- a. Do not fasten exposed conduits, fittings or boxes, to any compressed air, gas or water piping or other similar work unless shown on the plans, or directed by the Engineer. In addition, do not allow exposed conduits, fittings or boxes, to come in contact with any of the piping mentioned above.

5. SIZES

- a. Minimum size conduit below slabs, grade, or in concrete walls, shall be 3/4 inch nominal trade size, unless otherwise noted.

6. FLEXIBLE CONDUITS

- a. Installation of flexible conduits shall be in accordance with the latest published version of the NEC. Use flexible conduit in locations requiring flexibility; do not use flexible conduits as a general purpose raceway. For all motor connections, use liquidtight conduit; entry into a motor terminal box shall be made with a 45 degree, 90 degree, or straight connector approved for use with liquidtight conduit (whichever results in the least mechanical strain between the conduit and motor terminal box). Where flexibility is required for electrical raceways on equipment, liquidtight conduit shall be used in accordance with JIC standards, the specifications and the local inspection agency.

7. SLEEVES

- a. Provide conduit sleeves in all foundation, or masonry, walls for future conduit penetrations. Use sleeves at all locations where electrical conduits penetrate exterior building walls, or foundations. Apply adequate caulking where conduits are inserted to seal the penetrations. All sleeves through floors shall be galvanized pipe of size to accommodate the conduit or pipe. Sleeves through floors shall extend 3 inches above finished floor. Cutting of openings and installation of sleeves is not acceptable. Sheet metal sleeves are not acceptable. Frames through walls and surfaces shall be done in a neat, workmanlike manner. Openings shall be cut only as large as required for the installation. Sleeves and frames through walls shall be installed flush with finished surfaces and grouted in place. Surfaces around openings shall be left smooth and finished to match surrounding surface.
- b. Sleeves through rated walls or floors shall be firestopped as required to maintain the rating of the wall or floor.

8. SPARE CONDUITS

- a. Install a 14 gauge galvanized steel pull wire in all empty conduits. Make pull wire continuous from outlet-to-outlet, with 8 inches of slack at each outlet.

C. INTERIOR CONDUIT RUNS –

- 1. All concealed interior raceways throughout the work shall be new galvanized Electrical metallic tubing (EMT), unless otherwise specified. All exposed interior raceways below 10' shall be galvanized rigid metal conduit (GRMC), and above 10' may be EMT, GRMC, or intermediate metal conduit.
- 2. All exposed raceways below grade shall be galvanized rigid metal conduit (GRMC).
 - a. Inspection pits shall be considered below grade.

D. EXTERIOR CONDUITS - ABOVE GROUND –

- 1. All exterior raceways throughout the work shall be galvanized rigid metal conduit.

E. EXTERIOR CONDUITS - BELOW GROUND –

- 1. All buried conduits shall have a 6 inch wide warning tape buried 1 foot above the conduit or encasing concrete.
 - a. 750 volts or less:
 - (1) Conduit shall be buried a minimum of 4.5 feet below the base of rail.
 - (2) Conduit shall be buried a minimum of 3.0 feet below the natural grade.
 - (3) Conduit shall be Rigid Galvanized Steel at or less than 3.0 feet below grade.
 - (a) Schedule 40 PVC conduit shall be allowed at 3.5 feet to 7.0 feet below grade.
 - (b) HDPE conduit shall be allowed at more than 7.0 feet below grade.
 - (4) All elbows shall be long sweep, Rigid Galvanized Steel.

- b. More than 750 volts:
 - (1) Conduit shall be buried a minimum of 4.5 feet below the base of the rail.
 - (2) Conduit shall be buried a minimum of 4.0 feet below the natural grade.
 - (3) Conduit shall be PVC schedule 40 incased in 3" of red concrete or Rigid Galvanized Steel.
 - (a) HDPE shall be allowed at 15.0 feet or more below grade.
 - (4) All elbows shall be long sweep, Rigid Galvanized Steel.

16120 - WIRES AND CABLES

A. INTERIOR WIRING AND WIRING IN RACEWAYS –

1. GENERAL

- a. All conductors for interior wiring shall be 98% conductivity copper. Insulation shall be 600 Volt THW or THWN thermoplastic, unless otherwise specified. The use of aluminum conductors is not permitted.
- b. No wire shall be smaller than #12 unless otherwise noted, except that wiring for signal and pilot control circuits may be #14 unless otherwise noted. All wire sizes 12 through 10 shall be solid. All wire sizes 8 and larger shall be stranded. All wire sizes shall be as specified on the plans.
- c. Conductors shall be continuous from outlet to outlet. No splices shall be made except within outlet, or junction, boxes. Junction boxes may be utilized where required. Conductors terminating at each wired outlet shall be left not less than 8 inches long to facilitate the installation of devices, or fixtures.

2. COLOR CODING

- a. All conductors shall be color-coded in their entirety for wire sizes where color coding is commercially available. Phase wires of different phases of multi-wire circuits in the same raceway shall be of different color to provide circuit (phase) identification. color coding shall be as follows, unless otherwise noted:
 - (1) 120/240V, 1Ph, 3W
 - (a) Phase Wires Black and Red
 - (b) Neutral White
 - (c) Ground Green
 - (2) 208Y/120V, 3Ph, 4W
 - (a) Phase Wires Black, Red and Blue
 - (b) Neutral White
 - (c) Ground Green
 - (3) 480Y/277V, 3Ph, 4W
 - (a) Phase Wires Orange, Brown and Yellow
 - (b) Neutral White
 - (c) Ground Green
- b. Conductors in sizes which are not commercially available in color coding shall be taped with corresponding colors at all termination points and in all pullboxes, wireways, gutters, etc. All conductors found not to conform to the requirements

herein will be directed to be removed and replaced as specified at no additional cost to the Railroad.

3. CONDUCTOR SIZING

- a. Size conductors to compensate for voltage drop. Wiring serving exterior lighting and equipment remote from building shall be minimum #10. Branch circuits over 75' in length shall be increased one wire size for each 75' of additional length.

B. EXTERIOR OVERHEAD WIRING –

1. PRIMARY DISTRIBUTION WIRING

- a. All wiring over 600 volts shall be bare ACSR, sized as indicated on the drawings. Installation shall be as detailed on the drawings. Construction shall meet REA Standards, except as shown on the drawings.

2. SECONDARY DISTRIBUTION WIRING

- a. All exterior distribution 600 volts and less shall be of aluminum conductor triplex, or quadruplex, configuration with ACSR full size neutral. Insulation shall be HMW or XLP, suitable for exposed applications. Size as indicated on the drawings.

3. TAPS

- a. Copper to aluminum connections shall only be made with connectors suitable for the purpose.

C. EXTERIOR UNDERGROUND WIRING –

1. PRIMARY DISTRIBUTION WIRING.

- a. All wiring over 600 volts shall be cable assemblies insulated for the voltage class used, sized as indicated on the drawings. Installation shall be as indicated on the drawings. Conductor installation shall be as required by the latest published addition of the National Electrical Safety Code, state and local codes.

2. SECONDARY DISTRIBUTION WIRING.

- a. All wiring shall be installed in raceways. All wiring 600 volts and below shall be single conductor, copper wire with THWN-2 or XHHW-2 insulation.

16121 - WIRE CONNECTIONS AND DEVICES

A. INTERIOR WORK –

1. Splices and taps for smaller than #8 AWG wire shall be made with 3M, Ideal or Buchanan twist-on pre-insulated connectors. Connectors of the porcelain cup-type, with or without metal inserts, shall not be used. Splices in wire #8 and larger shall be made with Burndy type KS, KSU, or KSA, as applicable, solderless lugs. If any other type of connector is proposed for use on any size conductor, the connector shall be specifically submitted for approval prior to use.

2. CIRCUITS AND DEVICES

- a. The location of outlets and equipment terminals are approximate unless detailed, or dimensioned. The exact locations and routing of cables and conduits shall be governed by structural conditions, physical interference, and the location of electrical terminations on equipment, subject to the Engineer's approval. Coordination of electrical equipment installations with other structures and equipment shall be made so that the installed position of electrical equipment shall not interfere with structural strength, or successful operation of other portions of the buildings and related equipment. Conduits shall be stubbed up as near as possible to equipment terminals. The location of all conduit stub-outs for equipment shall be subject to the approval of the Engineer.
- b. Electrical floor plans are shown to scale, however, obtain dimensional information from the Architectural Drawings.
- c. Allowance has been made in the design for the number of raceways and conductors which the Engineer considers minimum for feeding the equipment. If the installed equipment is of larger horsepower than shown, or if the characteristics require increased current, re-size the power conductors, raceways, and the circuit protection, to allow for the changed conditions. Submit the information for review and approval prior to installation.

B. EXTERIOR WORK –

1. Splice all above grade secondary exterior copper to aluminum conductors with a KUP-L-TAP, fully insulated bolt-on, insulation piercing connector as manufactured by Illsco Corporation or approved equal. An acceptable alternate shall be an approved compression type tap, or splice, as manufactured by Anderson, Burndy, Kearney, or other approved equal. Connectors shall be approved for use with aluminum and copper conductors as needed. Connectors shall be installed with a proper application of oxidation inhibiting grease.
2. All below grade splices of secondary conductors are not permitted.

16130 - BOXES

A. INTERIOR –

1. All junction and outlet boxes, unless otherwise specified on the plans, shall be square, or octagon, galvanized boxes and sized to conform to National Electrical Code, except boxes for outlets installed flush with exposed masonry walls, or in dry-wall construction, may be single, or more, gangs as required. All surface-mounted switch and receptacle boxes shall be Appleton handy conduit boxes, or Appleton 4-inch square outlet boxes, or approved equal. Back-to-back or through-wall boxes are not permitted.

B. EXTERIOR –

1. All junction and outlet boxes, unless otherwise specified on the plans, shall be either cast outlet boxes with threaded conduit openings and screwed covers with neoprene gaskets or galvanized boxes with watertight threaded hubs and screwed covers with neoprene gaskets.

2. Pull boxes and handholes where designated on the plans shall be AASHTO H-20 rated. Covers shall be H-20 for extra heavy duty. Covers shall be supplied with label to indicate "Electric 480V", "High Voltage", "Signal", etc. Also provide "UPRR" on label.

16131 - JUNCTION AND PULL BOXES

- A. Provide all boxes required to comply with code. Boxes shall be of NEMA-type in accordance with area designation noted on the drawings.
- B. Outlet boxes shall be standard galvanized steel for dry interior locations and cast boxes for wet and exterior locations.
- C. Telephone and data outlets shall be 2-gang with single gang extension rings. Run 1" empty conduit up to above the finished ceiling and terminate with an insulating bushing.
- D. Outlet boxes for single duplex receptacle outlets shall be 2-gang with single gang extension rings.
- E. No outlet, or junction box, shall be installed where usefulness, or accessibility, will be impaired by other equipment.

16140 - WIRING DEVICES

A. GENERAL –

1. Wiring devices shall be UL listed for the current and voltage indicated. Receptacles shall have ANSI designated configurations and shall be of the grounding type. Switches and receptacles that are required by special conditions of the work to differ from the devices listed herein shall nevertheless be of equivalent quality and contact rating to the nearest counterpart listed herein. All required GFCI protection shall be accomplished by individual receptacles installed at the outlet. No feed thru protection is allowed. Ground fault receptacles shall incorporate the self test feature.

B. SWITCHES –

1. Branch circuit switches shall be specification grade, 20A, 120/277V AC. Following are approved switches in standard ratings. If non-standard switches are required, use only the same manufacturer(s) listed and same switch ratings.

a. Pass & Seymour

(1)	Single Pole	PS20A1W
(2)	Three Way	PS20AC3W
(3)	Four Way	PS20AC4W

b. Hubbell

(1)	Single Pole	1221W
(2)	Three Way	1223W
(3)	Four Way	1224W

C. OUTLET DEVICES –

1. Duplex outlets for interior areas in commercial buildings, office and locker buildings, gate houses, offices within industrial buildings, and other non-industrial areas shall be specification grade receptacles as follows:

a. Pass & Seymour

- (1) Duplex Receptacles, 20A - 125 V
 - (a) 5362AW
- (2) Ground Fault Receptacles, 20A - 120 V with test failure & flashing LED
 - (a) 2095SW
- (3) Isolated Ground, 20A - 125 V
 - (a) IG5362

b. Hubbell

- (1) Duplex Receptacles, 20A - 125 V
 - (a) 5362W
- (2) Ground Fault Receptacles, 20A - 120 V with test failure & flashing LED
 - (a) GF20WLA
- (3) Isolated Ground, 20A - 125 V
 - (a) IG5362

2. Duplex outlets for industrial buildings and facilities, shops, warehouses and all exterior and weatherproof locations shall be specification grade duplex receptacles as follows:

a. Pass & Seymour

- (1) Duplex Receptacles, 20A - 125 V
 - (a) 5362AGRY
- (2) Ground Fault Receptacles, 20A - 120 V with test failure & flashing LED
 - (a) 2095GRY
- (3) Isolated Ground, 20A - 125 V
 - (a) IG5362

b. Hubbell

- (1) Duplex Receptacles, 20A - 125 V
 - (a) 5362G
- (2) Ground Fault Receptacles, 20A - 120 V with test failure & flashing LED
 - (a) GF20GYLA
- (3) Isolated Ground, 20A - 125 V
 - (a) IG5362

3. Duplex receptacle in wet locations shall be 20A, 120V, GFCI receptacle with weatherproof while-in-use metallic cover, Midwest U010010 for a single duplex receptacle. For two duplex receptacles in a single box use Midwest U011010.

D. PLATES, GENERAL USE –

1. Furnish and install wall plates for all devices. Plates on flush devices shall be smooth finish white plastic. Gray color plates shall be installed over gray color devices. Where devices are installed on exposed fittings, or boxes, the plates shall be Appleton, or

approved equal, galvanized steel and of a type designed to fit the outlet box. Blank covers shall be installed on all boxes without devices or fixtures. The finish is to be the same as installed on devices in the room or area.

E. APPROVAL –

1. Wiring devices and plates shall be as manufactured by P&S or Hubbell, only. Any devices, or plates, which are found to be not as specified will be removed and replaced with the specified device, or plate, at no additional cost.

16150 - MOTORS

- A. Wire all permanently installed motors, starters and line voltage control systems, furnished under the contract, or by the Owner, unless specifically noted to the contrary. Check for proper rotation, proper lubrication and proper overload protection on all motors prior to start-up.
- B. Unless otherwise specified, motors shall be general purpose with open-type enclosures, and rated for a temperature rise of 40 degrees C. Where motor horsepowers are specified in connection with equipment drive, the horsepowers specified shall be considered as minimums. The manufacturer furnishing motors shall, in all cases, verify motor horsepowers with the characteristic power curves of the driven. In no case shall the power requirement of the driven machine exceed the nominal nameplate rating plus the service factor of the motor furnished. Advantage shall not be taken of service factors for normal operation loading in the selection of the motors.
- C. Except where otherwise specified with certain equipment items, motors smaller than 1/2 horsepower shall be rated single phase, 60 hertz, 115 volts, and motors 1/2 horsepower and larger shall be rated 3-phase, 60 hertz, 200 or 460 volts as applicable. The motor voltages stated above are utilization, or nameplate, ratings for use on nominal system voltages of 120, 208, and 480 respectively.
- D. Single Phase motors shall be capacitor-start, split phase, or shaded pole-type, or as approved for individual application. Polyphase motors shall be squirrel-cage induction-type, with speed and torque as required for individual application.
- E. Motor speeds, horsepower, classification as to splash-proof drip-proof, totally enclosed, etc., are in general specified with equipment drives as shown in the schedule on the drawings. Where not called for specifically, the Contractor shall obtain the information from the manufacturer of the equipment unit and have the application approved by the Engineer prior to ordering starters. Totally enclosed motors of all sizes shall be fan cooled.
- F. Motors for V-belt drives shall be provided with slide rails. Motors for direct drive with couplings shall be doweled to the base plate at two points.
- G. Alignment of all motors factory coupled to equipment and all motors field coupled to equipment shall be rechecked after all connections have been completed and after 48 hours of operation in designated service.

16155 - MOTOR STARTERS

A. GENERAL –

1. Starters shall be full-voltage type with thermal overload protection and mounted in an NEMA Type 1 enclosure unless otherwise noted or herein specified. In classified areas, provide enclosures suitable for the application. In steam areas and wet areas, provide

NEMA 4 enclosures. Enclosures shall be sized to make all equipment within readily accessible. External manual reset push-button shall be door mounted.

B. MAGNETIC MOTOR STARTERS –

1. Magnetic motor starters shall be rated for voltage and motor horsepower as indicated on the drawings. Starters shall be full-voltage across the line-type with 120 volt holding coils with individual control transformers unless otherwise specified, under voltage release, be capable of mounting not less than four auxiliary contacts which are readily accessible in the field for revising for either normally open, or normally closed operation, and shall come equipped with not less than two of the four sets. Starters for three-phase motors shall be provided with three-pole thermal overload protection of the manual reset type.
2. Motors above 20 HP or as required by local utility shall have reduced voltage starters. Coordinate starter with motor provided.
3. Single phase protection shall be provided for all cooling units and air compressors. Provide Time Mark Model 2501 phase protection relay. Include trip delay relay adjustable from 1 to 10 seconds, unbalance adjustment from 2 to 10 percent, and repeat accuracy ± 1 percent of full accuracy, with automatic reset, capable of operating either shunt trip breakers or motor control circuits.
 - a. If the unit has internal single phase protection (not just overload protection) duplicate single phase protection is not required.

C. AUXILIARY DEVICES –

Where indicated on the drawings, starters shall contain indicating lights, switches, push buttons, or other auxiliary devices mounted in the cover. Push-button shall be heavy duty oil tight. Separate push-button stations with pilot lights shall be installed as shown on the plans. Starter mounted stations shall be heavy duty oil-tight; remote mounted stations shall be NEMA Type 4, watertight and dust-tight.

D. QUALITY –

1. Acceptable manufacturers of motor starters: Square D. All motor starters shall be of the same manufacture, except the fire pump starter which shall be provided with the pump.

16156 - CONTROL PANELS

- A. All control panels installed as part of the UPRR's electrical system shall be UL listed. The control panel must be marked with a Short Circuit Current Rating (SCCR) based on UL 508 A-2001, Supplement SB. Furthermore, the panel must be in full compliance with Article 409 of the latest published edition of the National Electrical Code. In addition, the control panel shall be furnished with an external operable flange type disconnect capable of being locked in both the open and closed positions. The calculated SCCR shall be based on transformer impedance of 1%.
- B. If compliant, OEM control panels supplied with OEM equipment shall be allowed. All other control panels shall be provided by one of the firms Union Pacific has pre-approved for control panel fabrication.
 1. Those firms are:

- a. Carlson System Engineering, Contact: Bill Schmidt, Email: bschmidt@carlsonengineering.com, Telephone: 402-861-6137
 - b. Electrical Engineering and Equipment, Contact: Robert Bengtson, Email: Bob.Bengtson@3e-co.com, Telephone: 515-273-0161
 - c. Gull Wing Industries, Contact: Alan Wadsley, Email: alan.w@gull-wing.com, Telephone: 712 200-2747
 - d. Huffman Engineering, Contact: Dave Pletz, Email: davep@huffmaneng.com, Telephone: 402-464-6823
- C. The control panel builder shall include time on site and travel expenses for set up, prove out and making operations corrections one time after the systems are put in operation. The actual operation shall be by UP employees.

16160 - PANELBOARDS

A. GENERAL –

1. The panelboard shall be of the circuit breaker type, and shall have ratings (voltage, main, number of poles, phases, wires, etc.), as indicated on the drawings. Load-center type panelboards shall not be used. The panelboard shall be manufactured by Square D - no substitutions. Prior to final inspection, clean all panelboard interiors, adjust trims, covers, hinges and locks and, if necessary, refinish fronts to original condition. Balance load on all panelboards so phases are balanced to within 15% of each other.

B. BREAKERS –

1. Branch circuit protective devices for all panels shall be bolt-in type, thermal magnetic circuit breakers for alternating current as specified on the drawings. All 20A breakers shall be switching duty (SWD) type.

C. BUSSING –

1. Bus bars shall be copper or aluminum, braced for 10,000 amps RMS or as shown on the drawings. Tandem or half-sized circuit breakers shall not be permitted.

D. CABINETS –

1. Cabinets shall be made of zinc-coated sheet steel and shall conform to the requirements of Underwriters Laboratories, Inc., and bear the UL inspection label. Trims and doors shall have a suitable primer coat and finish coat of the manufacturer's standard color. Cabinets shall be provided with not less than 4 inch wiring gutters to the top, sides and bottom. Minimum width shall be 20 inch and minimum depth 5-1/2 inches. Trims shall be fitted with hinged doors having combination lock and latch. Doors and trims shall have all flush hardware; all beads, or similar projections, as required, shall be on the inside. When installed, the trim and door shall present a smooth flush appearance.
2. A directory holder with a clear plastic cover and metal frame shall be mounted on the inside of each door. Identify circuits in all panel directories.
3. Panel directory shall be typed and shall identify load type and area circuit serves. Unused circuits shall be labeled "spare" in permanent ink.

E. EXTERIOR CONSTRUCTION –

1. Enclosures for exterior panelboards shall be of NEMA 3R construction. The door shall be capable of being padlocked in the closed position. A directory shall be provided as described above for interior panels.

16170 - DISCONNECT SWITCHES

A. GENERAL –

1. All switches and circuit breakers shall be housed in the appropriate NEMA class enclosure, required for the specific application. All enclosures shall have metal nameplates, front cover mounted that contain a permanent record of switch type, catalog number and HP ratings. All switches shall bear the Underwriters' Laboratories label.
2. The line side of the circuit shall enter the enclosure at the top, and the load side of the circuit shall enter at the bottom, except when necessary to take line and load circuits into enclosure at the same end, separate entry shall be provided for each.
3. Enclosed switches shall not be used as junction boxes, troughs or raceways for conductors feeding through or tapping off to other switches.

B. CONSTRUCTION –

1. All switches shall meet National Electrical Manufacturer's Association requirements when applicable. Each switch shall have a positive quick make-quick break mechanism. The handle shall be pad-lockable in the "Off" position.

C. TYPE –

1. Heavy Duty. Approved manufacturer: Square D.

16181 - FUSES

A. GENERAL –

1. All fuses over 600A shall be dual element Class "L" Bussmann Hi-Caps, unless otherwise noted. All fuses 600A and smaller shall be Class "R" Bussmann Fusetrons, unless otherwise noted. Provide three spare fuses for each size used.

16195 - MOUNTING HEIGHTS

A. GENERAL –

1. Mounting heights above finished floor for devices are listed below. All heights are to be measured from finished floor to centerline of device. Heights may be adjusted to correspond to the nearest masonry course. Where raised floors occur, mounting heights shall be measured from the top of the raised floor.
 - a. Wall Switches
 - (1) 48" Above ground level (Above finished floor)
 - b. Receptacle Outlet (General)
 - (1) 48" Above finished floor

- c. Receptacle Outlet (Office)
 - (1) 14" Above finished floor
 - d. Special Purpose Outlet
 - (1) Within 6' of intended use
 - e. Push buttons
 - (1) 4'-6" Above finished floor
 - f. Clock Outlet
 - (1) 7'-0" when possible or
 - (2) 8" below ceiling
2. The mounting heights of disconnect switches, circuit breakers, motor controllers, push-button stations and other similar devices and equipment will vary depending upon location and whether individual, or group, mounted. For convenience and safety, operating levers, handles or buttons shall be mounted no more than 80" above the finished floor line. Individual device, or pieces of equipment, unless otherwise specified, shall be located approximately 60" above finished floor line. Lighting panels shall be mounted at 72 inches to top of panel where possible.

16401 - OVERHEAD ELECTRIC SERVICE

A. GENERAL –

- 1. Overhead distribution systems shall be built to 15 kV requirements unless stated otherwise.
- 2. Contractor shall furnish all materials for the work herein specified, and for delivery, storage, uncrating, installation, and final acceptance except where otherwise noted on the drawings or specifications.
- 3. Distribution class surge arrestors are required on the overhead distribution system.
- 4. Pole details shall be as indicated on UPRR Standard Pole Designs

B. POLES, CROSSARMS, AND OTHER WOOD MEMBERS –

- 1. Poles shall be ASA Class 2 or 3, as indicated on the plans, Douglas fir, roofed only, not gained, or drilled. Do not substitute Southern Yellow Pine. Set the poles at depths as indicated on ST-D3 standard "Minimum Dimensions and Setting Depths for Poles". All poles shall be treated with Copper Naphthanate, or Pentachlorophenol, per standards of the American Wood Preservers Association, and EEI Specifications.
- 2. Poles supporting primary lines crossing tracks shall be 55 foot long unless indicated.
- 3. All crossarms shall be 3-1/2" x 4-1/4" x 8'-0" long standard EEI distribution type, pre-drilled for steel pins and double arming bolts per standard EEI dimensions. Crossarms shall be pressure treated with Copper Naphthanate, or Pentachlorophenol, per standards of the AWPA and EEI Specifications.
- 4. All other wood members shall be as specified on the plans and shall be pressure treated with Copper Naphthanate, or Pentachlorophenol, per standards of the AWPA and EEI Specifications unless otherwise noted.

C. HARDWARE AND GUYS –

1. All hardware installed shall be hot-dipped galvanized steel. Hardware shall include bolts, washers, nuts, and all other members required to complete the specified work.
2. Guy wire shall be 3/8" diameter steel, high strength, galvanized. Guy assemblies shall be as detailed on the drawings. The down guy angle shall not be greater than 60 or less than 25 degrees from the horizontal unless detailed otherwise.
3. Guy anchors shall be of the type required for the installation.
4. Existing poles on which contractor works shall have steps removed below 8 feet above grade.

D. INSULATORS –

1. Suspension insulators shall be of standard ANSI classification for strength and voltage as specified on the drawings.
2. All pin type insulators shall be as specified on the drawings and shall be suitable for use with standard 1" lead threaded steel support pins. Pin type insulators shall be of standard ANSI classification for voltage as specified on the plans. Ties shall be made per standard REA recommendations. Preformed tie wraps are preferred.

E. TERMINATION KITS –

1. Termination kits shall be 3M, 15kV, QT-III, 7640 series. Select proper termination kit for the application. Cable shall be protected by non-metallic, U-shaped, cable guards.

F. POLE BANDING –

1. All new poles and existing poles which have work as part of this contract shall have a self-adhering, plastic, reflective, safety yellow band at least 2" wide completely around pole diameter. The band shall be mounted 3 to 4 feet from grade. The band shall be securely affixed with #6 aluminum nails or non-rusting screws for a permanent installation.

G. POLE NUMBERING –

1. All new poles and existing poles which are reused as part of this project shall be numbered according to the design drawing(s). Numbers shall be metal, at least 3" in height, and shall be securely affixed to poles with nails. All poles designated as Primary will have the numbers attached horizontally to the pole; all Secondary poles will have the numbers attached vertically to the pole.
2. If there is no pole numbering scheme on the design drawing(s), or the existing numbers conflict with the design drawing(s), a numbering plan (created according to the UPRR Pole Numbering Procedure) shall be submitted to the UPRR Omaha Electrical Design Project Engineer for approval prior to numbering poles.

H. AERIAL CABLE MARKERS –

1. Union Pacific Railroad requires all new and replacement aerial power cables that cross the right of way be marked to enhance the visibility of the cables.

2. Markers shall be molded acrylic plastic or molded ABS plastic. Markers shall be Danger Orange in color with the coloring agent incorporated into the molded material. Where recommended by the manufacturer, other colors may be submitted for approval. Provide provisions for attaching to the cables. Where applicable, provide corona effect protection.
3. Markers for cables over 50 feet above top of rails shall be 36 inches in diameter. Markers for cables below 50 feet but above 29.5 feet above top of rails shall be 20 inches in diameter. Markers for cables below 30 feet shall be 12 inches in diameter.

16402 – UNDERGROUND ELECTRIC SERVICE

A. GENERAL –

1. OVER 600 VOLTS

- a. Conductors shall be 15 kV, shielded, 133% EPR insulation installed in rigid steel conduit or schedule 40 PVC encased in minimum of 3 inches of red dyed concrete.
- b. Conductor termination points shall be above ground.
- c. Devices shall have load break, angled termination blocks.
- d. Conductors shall have distribution class surge arrestors.
- e. Cables shall make transitions via sectionalizing enclosures

2. 600 VOLTS AND LOWER

- a. Conductors shall have 600 volt THHW-2 or XHHW insulation installed in rigid steel conduit or schedule 40 PVC conduit. Local yard soil types and preferences will determine if PVC is allowed.
- b. Conductor termination points and splices shall be above ground.
- c. Conductors shall be produced in USA.

B. INSTALLATION –

1. All underground wiring shall be tested per manufacturer instructions. 15 kV wiring shall be tested at the voltage recommended by manufacturers.
2. 600 volt wiring shall be tested for grounds and short circuits.

16403 – SECTIONALIZING ENCLOSURE WITH FIBERGLASS GROUND SLEEVE

C. GENERAL –

2. SUMMARY

- a. This Section includes sectionalizing enclosure, fiberglass ground sleeve, and 4 point junction.

3. REFERENCES

- a. ANSI/NFPA 70 - National Electrical Code
 - b. ANSI/IEEE C2 – National Electric Safety Code
4. SYSTEM DESCRIPTION
- a. The unit shall be used as an outdoor junction and switching point for primary underground distribution circuits.
5. SUBMITTALS
- a. Provide copies of the following documents to UPRR Electrical Design Department for review and comment in accordance with the general requirements of Division 1 and Division 16:
 - (1) Product Data: For sectionalizing enclosure, ground sleeve, junction points, and accessories.
 - (2) Shop Drawings:
 - (a) Descriptive information stating conformance to codes, recognized testing, or manufacturing standards.
 - (b) Manufacturer's name and catalog cuts listing type, model No., catalog No., materials, styles, finish.
 - (3) Operation and Maintenance Data: For sectionalizing enclosure, ground sleeve, junction points, and accessories.
6. QUALITY ASSURANCE
- a. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
 - b. Comply with NFPA 70.
 - c. Manufacturer shall have specialized in the manufacture and assembly of units for at least 10 years.
7. DELIVERY, STORAGE, AND HANDLING
- a. Deliver, protect, and handle products in accordance with recommended practices listed in manufacturer's Installation and Maintenance Manuals.
 - b. Provide provision that meet the manufacturer's requirements for storing equipment outdoors.
 - c. Provide NEMA and manufacturer's written instructions to avoid damaging equipment and finish during storage and installation.
 - d. Provide lifting eyes for installation (as required).
8. WARRANTY
- a. Manufacturer shall warrant equipment to be free from defects in materials and workmanship for 2 years from date of receipt at jobsite.

B. PRODUCTS –

1. SECTIONALIZING ENCLOSURE

a. Features: The sectionalizing enclosure shall include the following features:

- (1) Heavy-duty channelized construction;
- (2) Full width channelized rails for junction bracket reinforcement;
- (3) Corrosion resistant penta head bolt and handle
- (4) All hardware, including hinges, handle, padlock hasp, and nut for locking bolt, shall be easily replaceable from the interior only;
- (5) Wind locks;
- (6) Blind threaded lifting provisions;
- (7) Single-Phase enclosure shall have 2 parking stands; Three-Phase enclosures shall have 6 parking stands;
- (8) Fault indicator provisions;
- (9) Special junction mounting brackets shall be available;
- (10) Unit shall be REA Approved.

b. Specifications: The unit shall include the following:

- (1) Stainless Steel hinge barrels, pins, padlock hasp, and exterior hardware;
- (2) Unit shall be fabricated from tough 14 gauge steel standard;
- (3) Edges of cover shall be chamfered to provide maximum strength and tamper resistance;
- (4) Standard mounting bracket shall accept 15 KV – 2, 3, or 4 point junctions;
- (5) Durable Finish which meets ANSI standard C57.12.28;
- (6) Paint Color shall be pad mount green [Munsell Green (#7GY3.29/1.5)].

2. FIBERGLASS GROUND SLEEVE FOR SECTIONALIZING ENCLOSURE

a. Features: The fiberglass ground sleeve for sectionalizing enclosure shall include the following features:

- (1) Heavy-duty, reinforced fiberglass construction with stress area strengthened with non-hydrosopic laminated reinforced materials;
- (2) Molded exterior surface coated with pad mount green gel to provide UV and weather protection for resin and glass;
- (3) Molded stacking blocks for storage and transportation;
- (4) Construction shall be of fire retardant resin.

C. EXECUTION –

1. INSTALLATION

a. Follow UPRR standard specification

- (1) Ground Sleeves:
 - (a) Install ground sleeve for each sectionalizing enclosure.
 - (b) Ground sleeve shall be installed underground so that a minimum of 6”, but no more than 8”, extends above final grade on all sides.
- (2) Sectionalizing Enclosure:
 - (a) Enclosure shall be bolted to ground sleeve per the manufacturer’s installation requirements.

- (b) Enclosure shall be properly grounded per the NFPA 70 and the manufacturer's installation requirements.

16450 - GROUNDING AND TESTING

A. GENERAL –

1. Provide a complete and effective ground system. At the service entrance, bond the equipment, utility neutral, the building neutral and the building ground conductor to a common ground bus, and connect the ground bus to the ground electrode.

B. SERVICE ENTRANCE –

1. Determine the effectiveness of the service ground prior to building construction. Install a grounding system which provides a maximum resistance to earth of 25 ohms, or less as shown on the drawings.
2. If 25 ohms is not achieved with one 10 foot ground rod, couple another 10 foot ground rod and continue driving the ground system deeper. Measure the ground resistance every 5 feet, starting at 10 feet, until the desired resistance is achieved. If rock prevents driving ground rods deeper than 10 feet, an alternate method is to install additional rods spaced in triangular form not less than 10 feet apart. All ground readings shall be taken prior to connection of the service ground wire.

C. INTERIOR WIRING –

1. Install a separate green equipment grounding conductor in all raceways. Isolated ground conductors shall be permanently identified either by yellow tape on each end of the conductor, or by utilizing a green conductor with a yellow tracer.

D. POLE GROUNDING –

1. Ground all new poles as indicated on drawings and pole schedules in standard details. Add ground to all existing poles that have work done on them and do not already have an existing ground.

16460 - TRANSFORMERS

- A. Contractor shall supply a list of installed and spare transformers new for this project. List shall include Transformer number, Manufacturer, Serial Number, Location or Pole Number, KVA, Primary Voltage, Secondary Voltage, Impedance, Tap information and PCB content.

B. THREE PHASE, OIL FILLED, PADMOUNT TRANSFORMERS –

1. KVA – See drawings
2. HV – See drawings
3. LV – See drawings
4. 65 Degree C Rise, OA, 60 Hertz
5. Four 2-1/2% taps, 2 above and 2 below normal
6. Dead Front Loop Feed Wells & Inserts, Primary Bushings
7. Bayonet Fusing – partial range current limiting fuse
8. Stud Secondary Connections and appropriate lugs
9. Ground pad
10. Fill Plug, Drain Plug
11. Pressure Relief Device

12. Mineral Oil Filled, Certified Non-PCB

C. SINGLE PHASE, OIL FILLED, PADMOUNT TRANSFORMERS –

1. KVA – See drawings
2. HV – See drawings
3. LV – See drawings
4. 65 Degree C Rise, OA, 60 Hertz
5. Four 2-1/2% taps, 2 above and 2 below normal
6. Dead Front Loop Feed Wells & Inserts, Primary Bushings
7. Bayonet Fusing – partial range current limiting fuse
8. Stud Secondary Connections and appropriate lugs
9. Tank Ground Provision
10. Fill Plug, Drain Plug
11. Pressure Relief Device
12. Mineral Oil Filled, Certified Non-PCB

D. SINGLE PHASE, OIL FILLED, POLE TOP TRANSFORMERS –

1. KVA – See drawings
2. HV – See drawings
3. LV – See drawings
4. 65 Degree C Rise, OA, 60 Hertz
5. Four 2-1/2% taps, 2 above and 2 below normal, externally operated tap changer
6. Double bushing in accordance with Fig 10 (4800V and below) and Fig 11 (7200V and higher) of ANSI C57.12.20. One bushing shall be utilized for neutral/ground connection on single phase line to neutral applications.
7. Stud Secondary Connections and appropriate lugs
8. Ground pad
9. Cover assembly designed for pressure relief and self-resealing
10. Mineral Oil Filled, Certified Non-PCB

E. THREE PHASE, DRY TYPE TRANSFORMER –

1. KVA – See drawings
2. Dry type
3. NEMA 1 or 3R – See drawings
4. HV: 480 V – See drawings
5. LV: – See drawings
6. Secondary Connections and appropriate lugs
7. Manufactured by Square D or Acme

F. SINGLE PHASE, DRY TYPE TRANSFORMER –

1. KVA – See drawings
2. Dry type
3. NEMA 1 or 3R – See drawings
4. HV: 480 V – See drawings
5. LV: – See drawings
6. Secondary Connections and appropriate lugs
7. Manufactured by Square D or Acme

- E. Contractor shall supply and install “NON-PCB” stickers on all transformers.

16500 - LIGHTING

- A. Furnish and install all lighting fixtures as indicated on the drawings and as specified herein. All lighting fixtures and electrical components shall bear the Underwriters' Laboratories Label of Approval.
- B. Existing light fixtures that are relocated or are indicated to be re-lamped shall be cleaned and re-lamped. Any fixtures that are inoperable shall be identified to the manager of electrical design.

16501 - LAMPS

- A. All lamps shall be manufactured by Sylvania, Phillips or General Electric. All fluorescent lamps shall be T8, 32 watt, low mercury. Provide lamps for all fixtures. Use clear 400 watt HPS for roadway lighting only. Use Metal Halide (MH) lamps for all other applications unless otherwise noted. HPS lamps shall be dual arc tube type. See manufacturer and supplier list for lamp source.

16502 - BALLASTS

- A. Fluorescent fixtures shall have electronic ballasts. The general requirements for electronic ballasts are as follows:
 - 1. Ballast shall comply with UL 935 and with ANSI C82.11.
 - 2. Ballast shall be designed for type and quantity of lamps served.
 - 3. Ballasts shall be designed for full light output unless another BF, dimmer or bi-level control is indicated
 - 4. Ballast shall have a Class A sound rating.
 - 5. Ballast input current shall have Total Harmonic Distortion (THD) rating of less than 10 percent.
 - 6. Ballast shall comply with IEEE C62.41.1 and IEEE C62.41.2, Category A or better for Transient Voltage protection.
 - 7. Ballast shall be high frequency electronic type and operate lamps at a frequency of 42 kHz or higher.
 - 8. Ballast shall provide for a Lamp Current Crest Factor of 1.7 or less in accordance with lamp manufacturer recommendations.
 - 9. Ballast shall have a Ballast Factor (BF) of 0.88 or higher.
 - 10. Ballast shall have a Power Factor (PF) of 0.95 or higher.
- B. The general requirements for HID lamps are as follows:
 - 1. Electromagnetic Ballast for Metal Halide lamp shall comply with ANSI C82.4 and UL 1029. Ballast shall include the following features unless otherwise indicated:
 - a. Ballast Circuit: Constant-wattage autotransformer or regulating high-power factor type.
 - b. Minimum Starting Temperature: Minus 22 deg F for single-lamp ballasts.

- c. Rated Ambient Operating Temperature: 104 deg F.
 - d. Open-Circuit Operation that will not reduce average life.
 - e. Low-Noise Ballasts: Manufacturers' standard epoxy-encapsulated models designed to minimize audible fixture noise.
2. Electronic Ballast for Metal-Halide lamps shall include the following features unless otherwise indicated:
- a. Minimum Starting Temperature: Minus 22 deg F for single-lamp ballasts.
 - b. Rated Ambient Operating Temperature: 130 deg F.
 - c. Lamp end-of-life detection and shutdown circuit.
 - d. Sound Rating: Class A.
 - e. Total Harmonic Distortion Rating: Less than 20 percent.
 - f. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
 - g. Lamp Current Crest Factor: 1.5 or less.
 - h. Power Factor: 0.90 or higher.
 - i. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitation on electromagnetic and radio-frequency interference for non-consumer equipment.
 - j. Protection: class P thermal cutout.
3. High-Pressure Sodium Ballasts shall be electromagnetic type with solid state igniter/starter. Igniter/starter shall have an average life in pulsing mode of 10,000 hours at an igniter/starter-case temperature of 90 deg F.
- a. Instant Re-strike Device: Integral with ballast, or solid-state potted module, factory installed within fixture and compatible with lamps, ballasts and mogul sockets up to 150 watt.
 - b. Minimum Starting Temperature: Minus 40 deg F.

16510 - INTERIOR LIGHTING FIXTURES

- A. Fixture catalog numbers listed in the schedule do not necessarily include all components required for a complete installation. Determine exact mounting requirements, and furnish hardware accordingly. Where fixtures will be supplied by the Owner, verify which additional components may be necessary, and purchase and install them accordingly.
- B. Fluorescent lighting fixtures shall include a disconnecting means for power and grounded conductors accessible to facilitate servicing the ballast(s).
- C. Surface mounted fixtures on walls, or ceilings, shall be anchored so the fixtures cannot be rotated and no light leakage occurs. No plastic, composition or wood-type anchors shall be used.

- D. Coordinate locations of lighting fixtures with other crafts to ensure the lighting fixture installation will not interfere with other equipment.
- E. All diffusers, reflectors, and lenses shall be free of cracks, chips and dents and shall be clean at the time of final inspection.
- F. Exit lights, where required, shall be of steel construction, and fully universal, allowing exit faces to be changed as required. AC/DC power supply with sealed maintenance-free batteries with test switch, pilot light and hi-charge light.

16520 - EXTERIOR LIGHTING FIXTURES

- A. Exterior lighting fixtures shall be as shown on the drawings and shall be labeled as "suitable for wet locations". Housing shall be die-cast aluminum, with conduit access from top or back as required. Lens and door shall be fully gasketed.
- B. Roadway and area lighting fixtures shall be 400 watt HPS Mongoose fixtures by Holophane or 400 watt HPS Tiger fixtures by G.E.
- C. See Manufacturers and Suppliers list for sources of lighting fixtures.

D. MUSCO LIGHTING TOWERS –

1. GENERAL

- a. Contractor shall include in his price the cost of MUSCO lighting towers erected by MUSCO subcontractor, foundations for the lighting towers and electrical connection of the lighting towers.

2. MATERIALS

- a. WARRANTY: 10-Year warranty and maintenance program that includes all materials, labor, and group lamp replacement at the end of year's 2, 4, 6, and 8. Any time 25% or more of the installed lamps on any single structure are not operating; MUSCO shall repair structure to return it to full light output. Warranty certificate will be provided to the appropriate Union Pacific staff upon completion of installation of product.
- b. Maintenance and management of re-lamping schedules for product installed as part of a project for Union Pacific.

3. EXECUTION

- a. Union Pacific Responsibilities:

- (1) Provide reasonable access to the site for construction.

- b. MUSCO Responsibilities:

- (1) Provide required fixtures, lamps, ballasts, ballast enclosures, and pole wire harnesses.
- (2) Provide layout of fixture locations and aiming diagram.
- (3) Provide high mast lighting project management in the form of technical assistance for the installation and path of communication between parties.

- (4) Manage installing subcontractor.
- (5) Experienced project manager on site during crucial periods of the installation.

c. MUSCO Subcontractor Responsibilities:

- (1) Provide labor, equipment and materials to off load equipment at job site per scheduled delivery.
- (2) Provide required structural permits.
- (3) Confirm the existing underground utilities have been located and are clearly marked.
- (4) Provide materials and equipment to install precast concrete foundation as specified on Layout. Remove spoils to owner designated location at job site.
- (5) Provide and install ground rods (one per pole location) for lightning protection per NFPA 780 Code. Poles 70' and below require a #2 ground wire. Poles 80' and above require 2/0 ground wire. Ground rods to be 3/4"x10' or 5/8"x8' with a 10' embedment. Ground rods must be installed in soil, not in the concrete backfill.
- (6) Provide materials and equipment to assemble LSG system.
- (7) Provide materials and equipment to stand LSG system on precast concrete foundation.
- (8) Keep all equipment off of tracks and minimize disruption to on-going daily operations.
- (9) Instruct all employees, workers and subcontractors in any and all safety procedures as required by the owner including use of all required personal safety equipment.
- (10) Provide equipment and materials to remove all construction debris to area designated by owner.
- (11) Provide startup and aiming as required to provide complete and operating lighting system.

d. Contractor Responsibilities:

- (1) Coordinate construction of pole foundation with MUSCO subcontractor.
- (2) Provide, install and connect all electrical system required to energize the lighting towers.
- (3) Contractor shall pay MUSCO lighting charges within 30 days of completion of installation. Contractor shall pay MUSCO retainage within 45 days of MUSCO submission of retention.

16530 - LIGHTING CONTACTORS

A. Lighting contactor as specified in the Lighting and Equipment Schedule (LES). Custom built by Square D:

- 1. 30 AMP fused OCD = 8903REQ3948G1
- 2. 50 AMP fused OCD = 8903REQ3948G2
- 3. 100 AMP fused OCD = 8903REQ3948G3
- 4. 30 AMP breaker OCD = 8903REQ3948G4
- 5. 50 AMP breaker OCD = 8903REQ3948G5
- 6. 100 AMP breaker OCD = 8903REQ3948G6

16540 – RADIO OPERATED LIGHTING CONTROL

- A. Provide UP standard radio operated lighting control for areas indicated. Radio control panel may be integrated with lighting contactor(s) to control specified areas.

16640 - CATHODIC PROTECTION

- B. Contractor shall design and install Cathodic protection system to conform to NACE Publication RP0169 Current Edition - Recommended Practice, Control of External Corrosion Underground and Submerged Metallic Piping Systems. Design and installation shall be by individuals certified by NACE.

16800 - COMMUNICATIONS ENTRANCE

A. COMMUNICATIONS ENTRANCE –

1. Install two 4 in. inside diameter PVC conduits extending from the Telecommunications Closet / Equipment Room to the Service Box. Install two - 1 ¼ and one - 1 in. innerduct within these conduits. Innerduct as follows:
 - a. Corrugated HDPE Premier Corrugated HDPE is manufactured from High Density Polyethylene (HDPE) and shall be placed inside of existing innerduct. This lightweight product offers maximum flexibility, and allows for installation in small or restricted areas. Corrugated duct is available in 1" and 1-1/4" and is orange in color.
 - b. An acceptable substitute is the Mac Cell product. The 4" 3-Cell product is designed to hold larger backbone cables up to 1.34" in diameter in each cell. Up to two packs can be placed in a 4" conduit.
 - (1) Only one 3-cell pack is required.
 - (a) Standard color is green
 - (b) Color-coded pull tapes are pre-installed
 - (c) Factory lubricated
2. A tracer wire is required in all installations using non-conductive conduits.
3. The total number of bends in a conduit section run shall not exceed two 90 bends or equivalent of sweeps and radius bends. Each bend shall have a minimum radius in accordance with existing standards.
4. Encase conduit(s) in concrete (2,500 PSI) where, minimum 36" depth cannot be attained, conduits pass under roads, driveways, or bend points are subject to movement. When crossing under UPRR tracks follow instructions in UPRR web site under Real Estate and crossings. When terminating at a pole, clamp the conduit(s) rigidly to the field side of the pole at a 90-degree separation from power.
5. Conduits terminating inside of a building shall be installed so that the conduit extends 10 cm (4 in.) (Above Finished Floor [AFF]) beyond the surface from which it emanates. Conduits shall be plugged with mechanical-type seals to ensure that foreign matter does not enter the building.
6. The ends of metallic conduit shall be reamed, bushed, and grounded according to the:
 - a. National Electrical Code (NEC).

- b. National Electrical Safety Code (NEC).
- 7. All conduits shall have a non-corrosive pull rope installed.
- 8. Additional details and instructions are available in General UPRR Telecom Building Requirements (latest addition).

16900 - PROGRAMMABLE LOGIC CONTROLLERS (PLC)

A. GENERAL –

- 1. Provide and install complete in operating condition required PLC(s). Include all required appurtenances. Provide the operational program required. Include field service during start-up including travel and per diem expenses for the site visit.
 - a. Approved PLC design and programming companies are as follows:
 - (1) Snyder Equipment Company, Contact: Mark Galvin, Telephone: 402-895-1781
 - (2) Interstate Companies, Contact: Seth Vis, Email: Seth.Vis@interstates.com, Telephone: 712-722-1664 ext 334
 - (3) Huffman Engineering, Contact: Dave Pletz, Email: davep@huffmaneng.com, Telephone: 402-464-6823
 - (4) Carlson System Engineering, Contact: Bill Schmidt, Email: bschmidt@carlsonengineering.com, Telephone: 402-861-6137
 - (5) Electrical Engineering and Equipment, Contact: Robert Bengtson, Email: Bob.Bengtson@3e-co.com, Telephone: 515-273-0161
- 2. Provide UPRR a completed set of documented as built control drawings if installation differs from project drawings.
- 3. The use of DC wet cell battery power supplies and interfacing PLC logic controls with external DC relays is prohibited unless authorized by the Manager Electrical Design.

B. SPECIFIC –

- 1. As built drawings shall include a schematic of the logic that controls all functions and I/O points for the operation. The documentation shall include real world names of each device such as limits switches, pressure switches, push button stations, pump motors, tank level floats, etc. The control drawings shall be clear and defined to the extent that would allow maintenance personal to trouble shoot the control logic without having to refer to other drawings or specification sheets.
- 2. A fully documented copy of the on-site operational program for PLC's & Panelview shall be provided to UPRR, Manager of Electrical Design, 1400 Douglas Street, MS-0910, Omaha, NE. 68179-0910, e-mail address jharmen@up.com, Phone 402-544-3238, Fax 402-214-1620. The documentation shall include all I/O points with symbol names, I/O addressing comments, and logic rung comment information. This copy shall be provided on a 3 1/2-inch floppy disk or CD.
- 3. SLC/500 series shall be in Allen Bradley's programming software RSLogix 500 English version 7.30.10 or latest version.
- 4. PLC/5 series shall be in Allen Bradley's programming software RSLogix 5, version 7.30.10 or the latest version.

5. RSView32 (MMI) programs shall be Allen Bradley's software version 7.20.00; newer versions shall not be used without permission from the Manager Electrical Design.
6. Panelview programs shall be Allen Bradley's Panelbuilder32 software version 3.81.00.
 - a. The installation shall have all control devices wired as inputs or outputs to the PLC. This shall include hand-off-auto selector switches, auxiliary run contacts on motor starters, level position floats, push button stations, valve position indication, etc. No control devices shall be installed in a manner, that their function would not be monitored or hard-wired external to the PLC logic controller.
 - b. The programming shall allow for remote monitoring, trouble shooting, and making modifications to the operational program that is stored in the RAM of the PLC through a dial up modem. All PLC's shall have EPROM's installed. The status bits S1/10 and S1/12 shall be set to = 1 so error's are cleared and the processor is set to run mode or when input power is cycled to the PLC, the EEPROM will overwrite the RAM memory with the original program and clear all fault conditions.
 - c. If remote operation (MMI) of the system is required, the program tag database shall utilize the same address symbol names or descriptions of I/O points used in the RSLogix program for tag names in the RSView program. A copy of the RS View application program shall be turned over to UPRR, as indicated above.
 - d. When programming tank level controls that has an analog 4 - 20 MA inputs. The operational program shall be set so that the integer files math results will allow for monitoring tank levels in feet, percentage of fill, gallons, and barrels. 4 MA = 0% full, 20 MA = 100% full. The address location for each of these fields shall be clearly documented.
 - e. Program addressing for internal bits, timers, counters, shall start with the factory default series, B3:0, B3:1, B3:2, T4:0, T4:1, etc.

C. MANUFACTURERS –

1. When programmable logic controllers are required, Allen Bradley –Rockwell Automation controls shall be used no substitutions are allowed. PLC-5 or SLC/500 series family shall be utilized. All panel view controls required by the project shall be Allen Bradley Panel View 1000 Color, Key pad and should be connected to the controller utilizing DH+, or DH485.

D. EQUIPMENT –

1. Allen Bradley SLC/500 series minimum shall be an SLC/503 catalog number 1747-L532 C/D, O/S302 CPU=32K, with a memory backup EEPROM chip catalog number 1747-M11 or SLC/504, or SLC/505
2. I/O Rack size shall be a minimum of seven (7) slot catalog number 1746-A7.
3. I/O Rack power supply shall be a minimum of 120 volt A/C catalog number 1746-P2 or 1746-P4.
4. Allen Bradley PLC/5 series shall be used for specific system requirements, coordinate with the Manager Electrical Design whether the project requires a PLC/5.

E. INPUT/OUTPUT MODULES –

1. SLC/500 series shall be 120 volt A/C relay type. Input modules shall be eight (8) point 120 VAC catalog number 1746-IA8 or sixteen (16) point 120 VAC catalog number 1746-IA16. Output modules shall be eight (8) point 120 VAC relay catalog number 1746-OA8 or sixteen (16) point catalog numbers 1746-OW16. Analog 4-20 ma modules shall be 1746-NI4.

F. COMMUNICATIONS –

1. The design shall include a dial up modem connected to the RS232 port of the SLC processor. The SLC RS232 communications port “O” shall be set at DF1 Full Duplex, source ID = 1, 9600-baud rate, parity = none, stop =1, Protocol = Full duplex Modem, Error check = BCC, Embedded Response = Enabled, Duplicate Packet Enabled. The modem shall be Allen Bradley remote access kit 1747-CHORAD. All projects require a modem and shall be tested for proper operation and documented.
2. Radio Modems shall be Data-Linc Group smart spectrum SRM6000, or ESTEEM Model 192S.
3. Ethernet interface shall use a 1761-NET-ENI with a SLC/503 or SLC/504 for existing control panels. New control panels shall use a SLC/505.

G. UPS POWER SUPPLY –

1. For critical plant operations shall include a 120 VAC uninterruptible power supply. The UPS shall be sized to provide 120 VAC for the PLC, modem and all input and output control functions. The UPS shall be Tripp Lite model BC PRO 1400 (10”x 61/2”x 14”) or equal.

H. SURGE SUPPRESSOR –

1. The A.C. power supply shall have surge protection and a disconnecting means located at or near the control panel power strip.

I. LEVEL SENSORS –

1. MTS or Ametek tank level sensors shall have 24 VDC power supply, 4-20 ma output, PVC housing, accuracy of +- .25%, operating range of 2’ to 50’, operating temperature of –22F to 140F, 2 - 4 inch NPT vented still pipe, with calibration capabilities. The Mgr. Electrical Design shall approve any alternate.

J. PRESSURE TRANSMITTERS –

1. Transmitter shall have 4-20 ma output, accuracy of +- .25%, 0 to 160-F operating temperature, stainless steel construction, ¼” NPT male thread connector for mounting, 0-300 PSI operating range, Omega Model # PX305-300 G.I.

K. FLOW TRANSMITTERS –

1. Transmitter shall be insertion type paddlewheel sensor, 0.3 – 30 FPS, accuracy 1-1/2 FPS, maximum pressure 250 PSI, pipe size 2” to 10”, operating temperature 250-F, fitting six brass 1 ½” NPT. Seametrics model # IP101-B, with flow control interface, 4-20 ma output, 6-digit display, K factor range of .50 to 2000, NEMA 4X, Seametrics model # FT420 flow computer.

L. START-UP, FIELD TESTING AND CALIBRATION –

1. GENERAL

- a. The electrical contractor and panel builder shall provide start-up, validation, checkout and programming modifications to the PLC and/or Panelview to assure a working system.
- b. The electrical contractor, with the direct participation of the instrument supplier, and control panel supplier, shall demonstrate the operability and suitability of all instrumentation with regard to installation, proper connection, pressure tests and calibrated accuracy. The electrical contractor shall provide all test equipment necessary to demonstrate this performance. A resident project representative and/or Owner shall witness the calibration and testing of each control loop.

2. CALIBRATION REPORTS

- a. Provide a written calibration report for each measurement and control device. The calibration reports shall include, as a minimum, the following information:
 - (1) Date
 - (2) Technician's name
 - (3) Instrument designation
 - (4) Instrument brand and model number
 - (5) Zero and span settings or setpoint
 - (6) Desired zero, half scale, and full scale values
 - (7) Actual zero, half scale, and full scale values
 - (8) Brand and model number of calibration equipment
 - (9) Signature of technician
 - (10) Signature of witness

3. TRANSMITTER, SENSORS, SWITCHES AND ANALYZERS

- a. Test and calibrate (at three points) the output signal from all analog devices for zero, half scale and full scale after installation. Switches shall be adjusted to the proper set point and shall be verified by calibration. Calibration shall be performed per the applicable requirements of American Society for Testing and Materials (ASTM) and Instrument Society of America (ISA). Calibration may be made by artificial movement or signal simulation when other means are not feasible.
 - (1) Level transmitters shall be calibrated by liquid level in the basin, tank, etc.
 - (2) Flow meters shall be calibrated by measuring known quantities of water over a measured time at various constant flow rates.
 - (3) Temperature transmitters shall be calibrated with a mercury in glass ASTM reference thermometer.

- (4) Pressure transmitters shall be calibrated with calibrated inspectors test gauges.
- (5) Control loops shall be calibrated in place. All instruments shall be calibrated at a minimum of zero, half scale and full scale.

4. CONTROL SYSTEMS

a. Controllers shall be checked to demonstrate that the control action is synchronized with final control element action and other related instrumentation as follows:

- (1) Controller output values and positioner output values shall be checked for proper coordination of controller output with opening direction.
- (2) Positioner output values and stroke shall be checked.
- (3) The indication on controller output gauge or meter shall agree with the final control element action.
- (4) Feedback control loops shall be tuned for stable operation and optimum response to system disturbances. Loops shall maintain stable control over the minimum to maximum process range, with optimum response time, and minimum offset. Loops with critical process limits, such as temperature, shall be tuned for minimum overshoot.
- (5) Final control element actuators, operators or positioners shall be adjusted to provide accurate positioning without excessive movement and wear.

5. Interconnecting wiring on electronic instruments shall be checked for continuity, short circuits, grounding and shielding as shown on approved wiring diagrams. Detrimental ground loops shall be isolated and eliminated. Excessive induced or stray voltages shall be eliminated by separating circuits, loading circuits or other practical means.

6. ALARMS AND INTERLOCKS

a. Alarm settings and interlock actions shall be checked for proper operation in the presence of the Resident Project Representative and/or the Owner. Alarms shall be checked by initiation of the alarm sensor where feasible.

End of Division 16