December 27, 2019

REVISION OF SECTION 715

LIGHTING AND ELECTRICAL MATERIALS

1. **NOTICE**

This is a standard special provision that revises or modifies CDOT’s *Standard Specifications for Road and Bridge Construction*. It has gone through a formal review and approval process and has been issued by CDOT’s Project Development Branch with formal instructions regarding its use on CDOT construction projects. It is to be used as written without change. Do not use modified versions of this special provision on CDOT construction projects, and do not use this special provision on CDOT projects in a manner other than that specified in the instructions unless such use is first approved by the Standards and Specifications Unit of the Project Development Branch. The instructions for use on CDOT construction projects appear below.

Other agencies that use the *Standard Specifications for Road and Bridge Construction* to administer construction projects may use this special provision as appropriate and at their own risk.

**Instructions for use on CDOT construction projects:**

Use this standard special provision on all projects with roadway lighting.

Section 715 of the Standard Specifications is hereby deleted for this project and replaced with the following:

**715.01** **General.** Materials shall be of a standard line from a name brand manufacturer. Electrical material shall be listed by the Underwriters’ Laboratories, Inc., and shall conform to the National Electrical Code.

Material shall be the same as, or compatible with, that used and accepted by the agency responsible for maintenance.

The Engineer may inspect all lighting materials and all electrical materials and accept or reject them at the project site. Samples may be taken, or manufacturer's certifications may be accepted in lieu of samples.

**715.02 Light Standard Foundations and Concrete Foundation Pads.** Concrete shall be Class BZ for cast-in-place concrete foundations. All concrete shall conform to Section 601.

Anchor bolts shall be designed by the Contractor's Engineer and shown on the working drawings, or as provided by the pole manufacturer. The threaded ends of the anchor bolts, the nuts, and the washers shall be galvanized in accordance with ASTM A153. Galvanizing on anchor bolts shall extend 2 to 4 inches beyond the threads.

Reinforcing steel shall conform to Section 602.

* 1. **Light Standards**.
1. *General*. Structural components of light standards, bases, couplers, anchor bolts, luminaires, and other attachments to be used for lighting shall be designed for a minimum of 115 MPH wind velocity, in accordance with ASCE 7-10 2016 Risk Category III.

Breakaway bases and couplers shall meet the breakaway requirements specified in AASHTO's Standard Specification for Structural Supports for Highway Signs, Luminaires, and Traffic Signals, Section 12. Conformance shall be verified by crash tests reviewed and accepted by FHWA. A certificate of compliance shall be provided.

1. *Metal Light Standards*. Metal light standards shall be fabricated of either steel or aluminum, unless otherwise specified. Whenever Light Standard Metal is specified, the Contractor may furnish either steel or aluminum. Material type and shape of light standards shall be the same throughout the project, unless otherwise shown in the Contract.

Standards shall have cable-entrance holes located in conformity with the type of arm mounting used. Metal surfaces shall be free of imperfections marring the appearance and of burrs or sharp edges that might damage the cable.

Metal poles shall be tapered and shall be supplied with pole caps.

Aluminum alloys shall have a minimum yield strength of 25,000 psi. Aluminum poles, arms, and fittings shall be made of aluminum alloy conforming to the following for the material form required:

|  |  |
| --- | --- |
| **ASTM Standard** | **Alloy Number** |
| B 209 | 6061-T6 |
| B 211 | 6061-T6 |
| B 221 | 6061-T6 |
| 6063-T6 |
| 6005-T5 |
| B 241 | 6061-T6 |
| 6063-T6 |

Aluminum poles may also be made of aluminum alloy 5086-H34 conforming to ASTM B313 (excluding pressure and burst tests).

Aluminum mast arms shall be tapered unless otherwise shown on the plans.

Steel mast arms shall be made of Schedule 40 standard steel pipe conforming to ASTM A53.

Steel poles, mast arms and base flanges shall be hot-dip galvanized in accordance with ASTM A123. Units on which the spelter coating has been damaged shall be repaired as provided in AASHTO M 36, or other approved method.

Base flanges for both aluminum and steel poles shall have continuous welds both inside and outside, unless otherwise permitted. Base flanges inserted into the pole and bonded shall meet the requirements for materials and strength stated herein.

Base flanges for aluminum poles and transformer bases shall be aluminum castings of alloy ANSI 356.0-T6 or UNS A03560 T6 conforming to ASTM B26 or an acceptable equivalent.

Each metal light standard shall be wired with a breakaway, submersible fused connector of proper capacity rating. The fused connector shall be located in the transformer base. If the light standard has no transformer base, the fused connector shall be located in the pole at the hand hole.

Transformer bases shall have vandal resistant, removable access doors.

The transformer base shall be a frangible breakaway type as shown on the plans and shall accommodate the anchorage and base flange of the light pole supplied. Each transformer base shall have a ½ inch bolt or lug fastened inside the base for grounding; the lug or bolt shall be visible from the door opening.

1. *Hardware*. Hardware used with steel standards shall be either cadmium plated steel, hot dip galvanized steel, or stainless steel. All hardware used with aluminum standards shall be anodized aluminum or stainless steel with anti-seize compound. Bolts to be inserted in aluminum threads shall be stainless steel with an anti-seize compound.

**715.04 Luminaires, Light Sources, and Lamps.** Luminaires shall be UL or ETL Listed for use in wet locations and IP66 rated. Luminaires shall be adaptable to the type of power distribution system to be used.

1. *General*. Luminaires shall conform to the following requirements:
2. Housing. The luminaire enclosure shall be an injection-molded or die-cast opaque housing. The housing shall have a powder-coated, corrosion- resistant finish. The color shall be as specified on the plans. The mounting shall be as shown on the plans.

The housing shall have a door that provides access to all internal components. The door shall be equipped with a safety catch and a latch. The housing shall have an inner rolled flange to support the door frame. The door frame shall be an aluminum casting, hinged to the housing. The door frame shall be sealed to the housing with a molded silicone gasket and shall be secured with a minimum of four captive screws.

1. Optical Chamber. The luminaire distribution shall be equal to or less than an Illuminating Engineering Society (IES) TM-15-11 Backlight, Uplight, and Glare (BUG) ratings listed below in Table 715-1 based on initial lumens or Light Loss Factor (LLF) = 1.0. Roadway luminaires with a U value greater than U0 shall not be accepted. The optical chamber shall be completely sealed from the housing, or the housing shall be completely sealed. A seamless one-piece memory- retentive gasket shall seal the optical chamber or housing against the luminaire lens door. All wires entering the optical chamber shall be gasketed at their point of entry. Socket mountings, rivets used in the construction or support of the reflector system, and all other penetrations into the optical chamber shall be completely sealed. The optical chamber shall be water tight when the luminaire door is closed.

**Table 715-1**

**BACKLIGHT, UPLIGHT AND GLARE (BUG) VALUES**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Luminaire Mounting Location** | **Minimum Initial Luminaire Lumen Range** | **Backlight** **(B) Rating Maximum** | **Uplight** **(U) Rating Maximum** | **Glare (G) Rating Maximum** |
| Non median- mounted | Less than 6,000 | B1 | U0 | G1 |
| 6,000 – 14,000 | B2 | U0 | G2 |
| 14,000 – 24,000 | B3 | U0 | G3 |
| Above 24,000\* | B3 | U0 | G4 |
| Median- mounted | Less than 6,000 | B2 | U0 | G1 |
| 6,000 – 14,000 | B3 | U0 | G2 |
| 14,000 – 24, 000 | B4 | U0 | G3 |
| Above 24,000\* | B4 | U0 | G4 |
| \*By special application only. |

1. Lens and Lens Door. The lens shall be constructed of clear, flat (for lamps over 3200 lumens), tempered glass. The glass shall be thermal-resistant and impact-resistant. The lens shall be sealed to the door frame with continuous silicone gasketing. The door shall have an easy-access, quick- release safety latch. The door shall have aluminum or stainless steel quick-release hinge pins for tool-less or one-hand easy and secure opening. When the door is closed, the electrical component compartment and the optical chamber shall be completely sealed.
2. Electrical Components. All components shall be listed for wet locations by Underwriters Laboratory (UL) or by an Occupational Safety & Health Administration Nationally Recognized Testing Laboratory (OSHA NRTL). Luminaires shall operate from 120 to 277 VAC as specified on the plans or be adaptable to the type of power distribution system to be used. All internal wiring and quick disconnects shall be rated for at least 600 VAC and insulated for 302°F. The dimmable driver shall be easily removable from the luminaire housing without the use of tools. The following components shall be in accordance with corresponding sections of ANSI C136.37:
3. Wiring and grounding electrodes.
4. Terminal blocks for incoming AC lines.
5. 7-pin photocontrol receptacle.
6. Latching and hinging.
7. *Roadway Luminaires*. Roadway luminaires shall be LED type with integral dimming driver, flat lens, aluminum housing, and be UL Listed for wet locations. All luminaires for the project shall be the same type and design unless the plans specify otherwise.
8. The luminaire and all components shall be UL or Intertek Testing Services (ETL) listed for Wet Location and shall have minimum Ingress Protection Rating of IP66.
9. The light source shall be composed of LED modules connected to a non-integrated driver and be ready for connection to a production line luminaire. Luminaires utilizing integrated driver LED light sources, screw-based products, or panel retrofit products shall not be used.
10. The luminaire shall have a Type II, III, or IV distribution for non-median mounted luminaires, and Type II, III, IV or V distribution for median mounted luminaires.
11. Transmissive optical components shall be applied in accordance with LED manufacturer’s Original Equipment Manufacturer (OEM) design guidelines to ensure suitability for the environment in which the luminaire is installed.
12. Luminaires shall utilize an adjustable slipfitter-type mounting system for installation on 1.25-inch (1.66-inch o.d.) to 2-inch (2.375-inch o.d.) diameter pipe tenons. Slipfitter shall consist of a two-piece clamp and four 9⁄16 inch hex bolts. Slipfitter shall allow for a vertical tilt adjustment of at least ± 5 percent in order to mount luminaire plumb to foundation for a U0 rating. Luminaires shall be equipped with integrated leveling bubble.
13. Access to all internal parts requiring replacement shall not require tools (i.e. “tool-less entry”).
14. The luminaire housing shall be constructed of aluminum alloy.
15. The Power Supply/Driver shall be provided in compliance with subsection 715.05. The dimming driver must be internal and thermally separated from the LED compartment.
16. The dimming 7-pin photocell receptacle shall conform to subsection 715.04(d) below.
17. The luminaire finish shall be corrosion resistant Super triglycidyl isocyanurate (TGIC) polyester powdercoat. The color shall be gray.
18. Powder coat: Super TGIC polyester powder coat 2.5 mil nominal thickness.
19. Finish shall exceed a rating of 6 per ASTM D1654 after 1000hrs of testing per ASTM B117.
20. The coating shall exhibit no greater than 30 percent reduction of gloss per ASTM D523, after 500 hours of QUV testing at ASTM G154 Cycle 6.
21. The Effective Projected Area (EPA) for wind-loading calculations shall be no greater than 1.2 square feet.
22. The luminaire weight shall not exceed 45 pounds.
23. The luminaire shall be tested in accordance with IES LM-79 and IES TM-21 certifying photometric performance and rated life, respectively. IES LM-79 (performance) and IES TM-21 (predicted life at 55 °C) testing shall both be for the same luminaire’s operating drive current as specified.
24. The luminaire shall have a maximum Backlight rating as shown in Table 715-1, an Uplight rating of U0, and a maximum Glare rating as shown in Table 715-1.
25. The luminaire system efficacy shall not be less than 68 luminaire lumens per input watt.
26. The luminaire shall have an external label per ANSI C136.15 and internal label per ANSI C136.22.
27. *Light Sources*. LED luminaires shall not be retrofit to existing luminaire housing; the Contractor shall replace the housing along with the luminaire as a single unit. Light sources shall be compatible with dimmable drivers supplied with the luminaires in which they are to be installed. All light sources of a similar type shall be provided by the same manufacturer.

LED light sources shall meet or exceed the following requirements:

1. CCT, CRI and Flux:
2. Correlated Color Temperature (CCT) – All LED light sources shall emit white light and have a CCT no greater than 3400K nominal in accordance with ANSI C78.277.
3. Color Rendering Index (CRI) – All LED light sources shall have a minimum Color Rendering Index (CRI) of 70 in accordance with the IES LM-79 test results.
4. Luminous Flux – LED light sources shall not exceed the junction temperature recommended by the LED manufacturer. Luminous flux differences between LEDs shall not exceed 10 percent.
5. LEDs shall have a minimum rated life of 70,000 hours per IES TM-21 at 55 °C at the normal operating driver current for the specific luminaire. The lumen output shall be maintained at 70 percent of initial rated lumens (L70) or greater at the rated life of the luminaire.
6. LEDs shall be temperature rated for operation and storage within the range of -40°C to +50°C, and shall withstand low and high frequency vibration (ANSI C136.31 Vibration Level 3G) over the rated life of the light source.
7. Cooling System
8. Mechanical design of protruding external surfaces (e.g. heat sink fins) shall facilitate hose-down cleaning and discourage debris accumulation.
9. The cooling system must be passive utilizing heat sinks, convection or conduction.
10. Fans, diaphragms, pumps, or liquids shall not be used.
11. *Photocontrol Receptacle*. Each roadway luminaire shall be furnished with a 7-pin multi-contact twist-lock outdoor lighting dimming receptacle per ANSI C136.41.

Photoelectric controls shall be listed for long life LED’s and have hermetically sealed, cadmium sulfide twist-lock type with high impact polypropylene cover with clear UV stabilized window. Photoelectric controls shall have a turn-on setting of 1.4 foot-candles ±0.2 foot-candles. The maximum ratio of the turn-off to turn-on setting shall be 3:1.

**715.05 LED Drivers.** LED drivers shall conform to the following:

1. Dimming signal protocols are 0-10VDC or Digital Addressable Lighting Interface (DALI).
2. The operating voltage shall be 120/277-volt at 50/60 Hz, and the driver shall operate normally with input voltage fluctuations of ±10 percent, consistent with NEMA SSl-1-2010, Electronic Drivers for LED Devices, Arrays or Systems.
3. The Minimum Power Factor (PF) shall be 0.90 at full input power and across specified voltage range.
4. The Maximum Total Harmonic Distortion (THD) shall be 20 percent at full input power and across specified voltage range.
5. The factory-set drive current shall be 700A or less unless approved by Engineer. If higher drive currents are proposed, the submittal must be accompanied with IES LM-79 and IES TM-21 test results for higher operating drive current.
6. Drivers shall be Restriction of Hazardous Substances (RoHS) compliant.
7. The rated case temperature shall conform to subsection 715.04(c)3.
8. All electronics of the power supply and the LEDs shall be protected from all electrical surges with an elevated electrical immunity rating including, but not limited to, lightning strikes and stray current in rebar and concrete. Surge protection shall be integral to the LED power supply.
9. The luminaire, including driver, shall consume no more than 4 watts in the off state power.
10. Electrical immunity (including surge protection): The luminaire shall meet the “Elevated” 10kV/5kA requirements per IEEE/ANSI C136.2. The manufacturer shall indicate whether failure of the electrical immunity system can possibly result in disconnection of power from the luminaire.
11. Electromagnetic interference: The driver shall comply with Federal Communications Commission (FCC) 47 Code of Federal Regulations (CFR) part 15 non-consumer radio frequency interference (RFI) and/or electromagnetic interference (EMI) standards.

**715.06 Alternative Power Sources**. Electrical power systems not connected to an electrical power grid shall be one of the following:

1. *General*. Alternative power source systems shall conform to the following:
2. The assembly shall be UL listed for Wet location and shall have a minimum Ingress Protection Rating of IP66.
3. The assembly shall have a minimum impact resistant rating of IK08.
4. The assembly shall withstand low and high frequency vibration (ANSI C136.31 Vibration Level 3G) over the rated life the assembly.
5. *Battery*. All batteries shall conform to the following:
6. The battery shall have an extended operating temperature rated for operation and storage within the range of -40 °C to 85 °C.
7. The nominal voltage shall be 12V.
8. Shall have a minimum rated capacity of at least 12AH at a 10 hour rate at 1.4A.
9. Shall have no less than 80% capacity after 12 months of storage at 25 °C.
10. *Solar Panel*. Solar panels shall be n-type, mono crystalline silicon, with greater than or equal to 20 percent efficiency at 25 °C.
11. *Wind Turbine*. All wind turbines shall conform to the following:
12. Shall consist of an axial flux coreless permanent magnet synchronous generator.
13. Blade materials shall be reinforced polyamide.
14. Shall include anti-vibration mounts.
15. Shall include regulation to stop turbine from rotating when system is fully charged, or wind gusts are above design speeds.
16. The noise generated by the entire assembly shall be less than 50dBA at the adjacent edge of right of way.

**715.07 Conduit**. Unless otherwise specified, conduit shall be rigid metallic or semirigid plastic electrical conduit. Metallic conduit shall be clean, free of burrs, and galvanized.

Plastic conduit shall be a semirigid type currently recommended and approved by Underwriters' Laboratories, Inc. for the proposed use. Underground plastic conduit for street lighting shall conform to ASTM-F441 schedule 80. Fittings shall be the type used outside the conduit. Fittings shall connect the conduit in a manner that makes the joints watertight.

Junction boxes used in structures shall be galvanized steel, 6 inches square by 4 inches deep, with weatherproof covers.

Pull boxes and splice boxes shall be a minimum of 18 inches by 11 inches and 12 inches deep, and sized per NEC 314, unless otherwise shown on the plans. Pull and splice boxes shall have heavy duty weatherproof covers rated for roadway applications. The housing shall be resistant to sunlight exposure, weathering, and chemicals; it shall be unaffected by freeze/thaw cycles. Covers shall fit flush to the sidewalk, turf area, or roadway surface. Hardware and inserts shall be stainless steel. The cover for street lighting circuits shall be marked “ELECTRICAL” or “STREET LIGHTING”. The cover shall list the minimum HS load rating of 22,500 psi.

**715.08 Lighting Circuitry and Wiring**. All wiring shall be copper with 600-volt insulation, rated for outdoor use. Wire sizes #14 AWG through #10 AWG shall be solid copper. Wire sizes #8 AWG and larger shall be stranded copper; except, service ground conductors to grounding electrodes shall be #4 stranded/insulated copper unless otherwise noted on plans. All conductor sizes shall be, at minimum, sized to the breaker amperage feeding the circuit per NEC Table 310.16.

A breakaway submersible, in-line fuse holder and fuse for each hot conductor and breakaway submersible connector shall be installed on the neutral if a neutral is required. The grounding wires shall not be fused or breakaway.

Fuse connectors shall be installed in the phase wires of their respective circuits at the junction box located as a back box to the luminaire or within the pole base or transformer base. The Contractor shall provide sufficient excess conductor length to allow withdrawal of the connected fuse holder from the hand hole. Fuses and fuse holders shall be “UL” listed and shall be installed in such a manner that the fuse stays with the load side when holder is separated. The Contractor shall form loops in the leads on each side of the fuse holders and so position the fuse holders that they may be easily removed or inserted through the opening of hand hole. All electrical apparatus used in the lighting system shall be rated to adequately handle the necessary loads and shall conform to power source requirements.

Bonding and grounding electrodes shall conform to the requirements of subsection 614.10(c).

**715.09 Secondary Service Pedestals, Lighting Control Centers, and Meter Power Pedestal.** Secondary Service Pedestals, Lighting Control Centers, and Meter Power Pedestals shall be metal conforming to ANSI C47.12.28, Pad Mounted Enclosure Integrity Standard and shall be the nominal size and dimensions shown in the Contract.

The cabinets shall be constructed of 12 gauge corrosion-resistant steel with hoods and covers constructed of 14 gauge corrosion-resistant steel. Cabinets shall be NEMA 3R or NEMA 4 construction as indicated on plans and shall be UL listed as “Enclosed Industrial Control Equipment” (UL508A). Cabinets shall be vandal resistant dead-front enclosures.

The cabinet’s external finish shall be polyurethane industrial grade powder paint of

1.7 mil minimum thickness. The cabinet's internal finish shall be polyurethane industrial grade powder paint of 1.7 mil minimum thickness or bare aluminum.

All external fasteners, rivets, screws and bolts shall be stainless steel. Fasteners, except sealing screws, shall not be removable by external access. Hinges shall be stainless steel continuous piano hinge type hinges.

External nameplates shall be permanently attached to the cabinet. A stainless steel handle shall be provided on the front exterior of each cabinet door or hood.

Cabinet shall be equipped with a three point latch. All handles shall be pad lockable per CDOT Maintenance requirements.

The cabinet shall have separate isolated sections for metering equipment (if required), utility termination, and CDOT equipment. All sections must be sealed and pad lockable.

The metering section shall have a hinged swing back hood with an integral hinged polycarbonate sealable window for visual access to meters.

The utility termination section shall be sealed and securable with a padlock. The section shall have a lift off cover with a stainless steel handle. Sufficient clearance shall be provided for a 4 inch diameter conduit for utility cables. Utility landing lugs shall be UL listed and shall accommodate 6 - #350 kcmil conductors. An optional meter fusible disconnect ahead of the meter shall be provided for utility companies that require them.

The CDOT compartment door shall be sealed and securable with a padlock. The compartment door shall be anchorable in an open position. There shall be a print pocket on the inside of the door. The print pocket shall hold all wiring schematics and instructions in a clear weatherproof sleeve with a side opening. Required UL labeling shall be located on the inside of the CDOT door. Distribution and control equipment shall be behind an internal dead-front door with a quarter-turn securing latch and be hinged to open more than 90 degrees. The dead-front door shall be hinged on the same side as the CDOT section door.

Pedestal mounting bolts shall not be visible or accessible externally. Pedestal mounting shall include pedestal mounting base and hardware. Pad mounting shall include concrete pad mounting base, anchor bolt kit and hardware.

Secondary Service Pedestals, Lighting Control Centers, and Meter Power Pedestals shall be rated for 600 VAC, installed with protection against damage from greater currents. The pedestals and centers shall be grounded with grounding rods in conformance with the National Electric Code. The following equipment is for a typical installation and may or may not be required as shown on the plans:

1. Fusible Meter Disconnect ahead of meter (optional per utility company requirements)
2. Meter Sockets (200 amp minimum).
3. Service main circuit breaker that is installed in a circuit load center as sized on the plans.
4. Circuit load center with an all-copper bus for CDOT loads as shown on the plans.
5. Circuit breakers.
6. Ground Fault Circuit Interrupter Receptacle (20 amp, 120 VAC NEMA 5-20R).
7. Multiple Pole Light Contactors.
8. Test Switch.
9. Photoelectronic control with exterior mounted 3-prong twist-lock receptacle.
10. Mounting pans or false backs for circuit breakers, contactors, relays, switches, transformers, and other types of electrical equipment mounted inside the cabinet.
11. Optional: 18” snow skirt (floor stand kit).
12. Optional: Cabinet style HVAC unit (heating, ventilation, and air-conditioning).

The internal wiring of cabinets shall be assembled by a UL listed facility or by a licensed master electrician using UL listed components. Cabinets shall conform to one or more of the following standards where appropriate: UL 50, Cabinets and Boxes; UL 67, Panel Boards and UL 869A, Service Equipment.

Circuit breakers and equipment shall be labeled with an engraved permanent label on the dead-front panel to indicate the circuit controlled.

Multiple Pole Light Contactors shall be “lighting” type, specifically rated for the type of lighting load specified. The contactors shall have a 600-volt rating. All multiple pole light contactors shall be unenclosed, single phase with the number of poles specified on plans; they shall be open type lighting contactors with the rating shown or specified.

Contactors shall be constructed for surface mounting on a false back or bracket within a weatherproof cabinet. The contactor coil shall operate on 120 Volt for 120/240 Volt or 120/208 Volt circuits and 277 Volt, for 277/480 Volt circuits. Contact material shall be designed for lighting ballast or LED driver loads and require no maintenance such as filing, burnishing, or dressing at any time the contactor is in service.

A 277 VAC rated test switch or hand-off-auto (HOA) switch shall be installed in the control cabinets if shown. The test switch shall be a heavy-duty single pole switch or circuit breaker rated at 20 amps and shall be installed in the control cabinet as a roadway lighting test switch. The switch shall be wired to shunt the photoelectric control relay power contactor and energize the lighting circuit contactors. The HOA switch shall be single or double pole, double throw, center off with 15A contacts. The HOA switch shall be wired to the photocell control when switch is in the Auto position, lighting contactor(s) will close when photocell is in low light closure. HOA shall be wired to energize the lighting contactor(s) closure when the HOA is in the Hand position. The HOA’s Off position will turn off the control circuit.

All components of the photoelectric control relays shall be housed in a weatherproof, locking, non-rusting container. The photoelectric control relay shall be rated for long life LED loads and attach to a three prong locking receptacle by a twisting motion.

The photoelectronic control shall have a built in surge protective device for protection from induced high voltage and overcurrents. The photoelectric control relay shall meet or exceed the requirements of ANSI C136.10. The photoelectric control shall be factory set to turn on lights when ambient lighting levels fall to 1.4 footcandles plus or minus 0.2 footcandles when operated at 120 VAC. When operated at 250 VAC, turn on shall not change more than plus or minus 0.3 footcandles from the 120 VAC value. The maximum off to on ratio shall be 1.5:1. The photoelectric control shall be a cadmium sulfide photoelectric control encapsulated for humidity protection, or a silicon junction type photo transistor. The photoelectric control shall be designed for normal operation at a dual voltage of 105 V and 285 V. Power consumption shall be less than 1 watt. At the designated voltage, the photoelectric control shall be capable of controlling a minimum load of 1000 watts. Minimum operating temperature range shall be from -40 °F to 150 °F. A time delay control circuit shall prevent false turn offs by transient lighting conditions. The unit shall include a failsafe circuit for the lighting load such that the lighting systems remain energized if any functional failure of the photoelectric control circuit occurs.

**715.10 Heavy Duty Safety Switch**. All switches shall be heavy duty rated. Switch blades and jaws shall be fixable and plated copper. Switches shall have a pad lockable handle. Switches shall have defeatable door interlocks that prevent the door from opening when the handle is in the ON position (except for double-throw switches). Defeater mechanism shall be front accessible. Switches shall have deionizing arc chutes. Switch assembly and operating handle shall be an integral part of the enclosure base.

Switches rated 30 A to 600 A shall have reinforced fuse clips. Switch blades shall be readily visible in the “ON” and “OFF” position. Switch operating mechanism shall be non-teasable, positive quick-make/quick-break type. Bail type mechanisms are not acceptable. Fusible switches shall be suitable for service entrance equipment (except for 4-pole switches and 1200 A when used on 480Y/277 WYE systems). Switches shall have line terminal shields (except for non-fusible double throw switches).

Switches shall be suitable for systems capable of 200 kA at 480 V with Class J, L, R, or T fusing as applicable for single-throw switches; 100 kA at 600 V for double-throw switches. Embossed or engraved ON-OFF indication shall be provided. Double-make, double-break switch blade feature shall be provided. Fuse pullers shall be provided on all NEMA 3R, 4X and 12 switches through 200 A. Renewal parts data shall be shown on the inside of the door.

All enclosures shall be NEMA 3R unless otherwise noted. Other types, where noted, shall be NEMA 4X watertight corrosion-resistant 316 stainless steel, NEMA 12 dust-tight and oil-tight special industry (dual NEMA 12/3R rating through 800 A). All enclosures shall have a factory installed ground terminal block. Nameplate shall be front cover mounted, containing a permanent record of switch type, ampere rating, and maximum voltage rating. 30 A to 100 A NEMA 4X and 12 enclosures shall be provided with draw-pull latches.