

Special Specification 6420

Solar Powered Rectangular Rapid Flashing Beacon Assemblies (RRFB)



1. DESCRIPTION

Furnish and install Solar Powered Rectangular Rapid Flashing Beacon Assemblies (RRFB), as directed, in accordance with all plans and Specifications.

2. MATERIALS

Furnish new materials in accordance with the following requirements.

- 2.1. **Cabinet.** Unless otherwise approved, provide a cast-aluminum alloy or aluminum cabinet with a minimum thickness of 1/8 in. Size the cabinet to provide adequate space for the control electronics, required number of batteries, or both. Install rubber mats in the bottom of the cabinet.

Provide a gasket between the door and cabinet. Supply a stainless-steel, aluminum, or other non-rusting alloy door hinge with a stainless-steel hinge pin. Spot weld the hinge pin at the top of the hinge.

Weatherproof the cabinet to prevent the entry of water. Seal unwelded seams with a clear or aluminum colored weather-seal compound.

Provide vent openings in the cabinet to allow adequate convection cooling of the electronic components and prevention of accumulation of gasses. Locate vents to prevent the entry of water. Screen the vents to minimize the infiltration of dust and insects. Screen material must have openings no larger than 0.0125 sq. in.

Provide a police lock with a metal keyhole cover as an integral part of each door. Provide 1 brass key with each cabinet.

Provide tamper-resistant exposed hardware including screws, bolts, rivets, hubs, etc.

Provide two 3/4 in. stainless steel brackets for strap-type mounting on a wood or metal pole. Ship cabinets with the brackets mounted to the back of the cabinet.

Equip each cabinet with the necessary rigid mounts for a 4 in. ID pole with a 4-1/2 in. OD pole clamp. All necessary hardware for proper mounting must be included. Provide a wiring diagram and schematics for the cabinet assembly.

- 2.2. **Cabinet Accessory Equipment.** Mount a back panel on inside of the cabinet. Mount wiring and accessory equipment, including a flasher, on the back panel.

Equip the cabinet with an 8-section-barrier terminal block with double 8-32×5/16-in. binder head screw terminals or larger. Wire and label the terminals as follows:

- Solar Power +,
- Solar Power – or Battery –,
- Battery +,
- Switch Common,
- Switch N/O,

- Output Circuit 1,
- Output Circuit 2, and
- Output Common.

Provide an on-board, solid-state charge-control circuit to ensure proper charging on the system battery bank. Incorporate a blocking diode for reverse-current protection of the charging circuit. Incorporate thermal compensation in the charge-control circuit to adjust the battery charge rate to variances in temperature with an adjustable voltage swing above and below the ambient set point as defined by the battery manufacturer. Use a battery float voltage calibration as defined by the battery manufacturer for voltages at 25°C. Provide an LED or LCD to indicate solar-panel charging.

Provide a back panel that includes mounting of a solid-state time clock with maximum overall outside housing dimensions of 10.25 in. high by 6.25 in. wide by 7.5 in. deep. Configure the mounting holes as an inverted "T." Place the top hole 3 in. \pm 0.05 in. from the top of the cabinet and 5.75 in. \pm 0.05 in. above a horizontal line connecting the centers of the 2 bottom holes. Place the bottom 2 holes 2.3125 in. \pm 0.05 in. apart from center to center. Position the top hole so that a vertical line through its center bisects the horizontal line. Drill and tap each screw hole for an 8-32 screw.

Provide a user-adjustable low-voltage-disconnect (LVD) circuit in the controller. This circuit must disconnect the battery bank when the battery voltage reaches a voltage deemed critical by the manufacturer of the battery. Provide an LED indication for the LVD circuit. Illuminate the LED when the LVD circuit is active.

Provide a controller that incorporates automatic night dimming. Calibrate the night-dim level to reduce the power of the LED lamp by a maximum of 75% where ambient light levels are 5 ft. candles or less.

Supply a color-coded harness. Use stranded No. 16 AWG wire as a minimum. Use connectors to terminate the harness wiring to components mounted to the pedestal pole, photovoltaic module, and signal beacons. Supply male connectors with each harness. Terminate female connectors for ease of installation. Use 3/8 in. diameter, round-crimp battery terminals. Use spade terminals for flasher termination and regulator-charger terminations. Use chassis tie-downs on the harness and rivet them to the harness bracket. Protect the wires in the harness with spiral tubing. Provide a total voltage drop no greater than 5% of any branch of the harness.

Initiate and terminate the flashing operation of the unit by toggle switch.

Supply a 2-circuit, solid-state flasher. Use a solid-state design with no electro-mechanical devices for the 2-circuit flasher. Construct the flasher for easy replacement of each component.

The 2-circuit, solid-state flasher must operate at 12 VDC. The 2-circuit, solid-state flasher must provide a flash rate in accordance with TMUTCD standards.

- 2.3. **Control Panel.** Provide a control panel that consists of a pedestrian push button activated flash circuit with a settable time period for flash operation. Ensure that the time circuit incorporates a Microcontroller time delay device that can be set to seconds or multiple minutes. Provide a Microcontroller time device that supplies a 12VDC output for operating the RRFB unit. Provide a control panel that allows for quick and easy removal. The back panel and flashing beacons must be connected through a main wiring harness via a circular pin connector (CPC) or other approved method. Provide modular components connected in such a manner that they are easily removed for replacement or maintenance.
- 2.3.1. **Circuit Breaker.** Provide a single pole thermal circuit Direct Current (DC) breaker installed on the "line" or service side of the cabinet.
- 2.3.2. **Flasher.** Provide a flasher that is a solid state, 2 circuit device which controls the flashing sequence of the beacon. Provide a flasher capable of operating at up to 40 W per circuit over a range of 11.4 VDC to 30 VDC. Provide a flasher that produces a flash rate as required in Section 2.4., "Rectangular Rapid Flashing

Beacon (RRFB) Light Bar." Provide a flasher capable of operating in a temperature range of -30°F and +165°F.

- 2.3.3. **Surge Protection Device.** Unless approved otherwise, provide a suitable surge protection device (SPD) capable of protecting up to 24 VDC. Provide a surge arrester of adequate size to fit the enclosure and capable of operating from -30°F to +165°F.
- 2.3.4. **Countdown Timer.** Provide a system that provides the countdown timer function required for proper operations. Provide a time delay relay, or function, capable of operating from -30°C to +60°C.
- 2.3.5. **Communications System.** Provide an RRFB capable of operating hardwired or through wireless communications. The initiation of the signal for the flashers to commence flashing will be by pedestrian push button. Each time a pedestrian pushes a button, the countdown timers will reset to the preset count down time; thus, allowing the beacons to flash for a full cycle for this pedestrian. The amount of time will be determined by the Engineer. Provide a communication system that will work to ensure that the lights will flash for a period that will allow pedestrians to safely cross the street in seasonal weather conditions consistent with the location.
- 2.3.5.1. **Wireless Communications.** When wireless communications are required, ensure all associated units (i.e. on the opposite sides of the road as well as the unit in the median (when included)) are capable of communicating wirelessly. The radio transmitter and receiver will use an unlicensed frequency. The radio will consist of a frequency hopping, spread spectrum transceivers operating in the non-licensed 900 MHz frequency range and at a maximum 1 W transmit power in accordance with Part 15.247 FCC rules. The radio will operate with an input of 10-30 VDC and from -30°F to + 140°F.
- 2.3.5.2. **Hardwired Communications.** When hardwired communications are required, ensure the system must be capable to use 1 cabinet at a location shown on the plans. Install conductors for the 12 VDC circuits to the RRFB's and pushbutton detector as required on the plans.
- 2.4. **Rectangular Rapid Flashing Beacon (RRFB) Light Bar.** Provide an RRFB that complies with FHWA Interim Approval Memorandum dated March 20, 2018. Ensure the light bar contains a minimum of 3 rectangular rapid flashing beacon indications, 2 on each side, and 1 rectangular rapid flashing beacon on the end that is visible to pedestrians in the crosswalk per direction. Ensure each of the 2 yellow indications of an RRFB should have 70 to 80 periods of flashing per minute and have alternating, but approximately equal, periods of flashing light emissions and dark operation. Ensure during each of its 70 to 80 flashing periods per minute, the yellow indications on the left side of the RRFB emits 2 slow pulses of light after which the yellow indications on the right side of the RRFB must emit 4 rapid pulses of light followed by a long pulse, as specified by the FHWA. Provide beacons a minimum size of 5 in. wide x 2 in. high unless otherwise noted on the plans. Provide a light bar that contains an additional side mounted LED array on the end facing the pedestrian crosswalk and that will operate with an input of 10-14 VDC.
- Provide 2 sets of light bars with each pole.
- Ensure the LEDs, used in the light bar, meet the SAE J595 requirement for peak luminous intensity (candelas) for Class 1 over the 10 -14 VDC range. Provide a third-party certification from the vendor stating that the LEDs have been tested and certified as Class 1.
- Provide an RRFB light bar that was assembled and wired as a unit. Provide unit bracket for the light bar, a bottom shell that attaches to the mounting bracket, and a housing unit. The housing may consist of a top shell that attaches to the bottom shell. Mount the housing to the pole with U-bolts.
- 2.5. **Pole and Base.** Unless specified otherwise, the pole will be a schedule 80 spun aluminum 4 in. ID (4.5 in. OD) x 16 ft. H. Provide a pole cap with the pole. Provide a pedestal pole base in accordance with DMS-11140, "Pedestal Pole Base." If available with the base provided, include a pole collar assembly. Provide mild steel anchor bolts in accordance with Item 449, "Anchor Bolts." Provide galvanized bolts, nuts, and washers in accordance with Item 445 "Galvanizing."

Provide pedestal pole bases from manufacturers prequalified by the Department.

- 2.6. **Signs.** Up to 2 sets of signs will be supplied with each pole. Unless required otherwise, each set of signs will include 1 W11-2 pedestrian sign (36 in. X 36 in.) and 1 W16-7p arrow plaque (30 in. X 18 in.); 1 R10-25 push button sign (9 in. X 12 in.); and 1 R1-6 pedestrian crossing sign (12 in. X 36 in.) Provide sign sheeting as required on the plans. Provide sign mounting hardware for the signs.
- 2.7. **Pedestrian Push Button.** Mount a pedestrian push button on the pole to activate the flashing beacons. The button will be an ADA compliant push button with the R10-25 plaque on the push button reading "PUSH BUTTON TO TURN ON WARNING LIGHTS."
- 2.8. **Drilled Shaft.** Provide Drilled Shaft Foundations in accordance with Item 656, "Foundations for Traffic Control Devices." Unless specified otherwise, the drilled shaft foundation will be 24 in. and follow the Department Standard.
- 2.9. **Solar Generator.** Size the system solar generator to provide an array-to-load ratio of 1:1 or greater. Provide a system-average state of charge 90% or greater throughout the entire year. The system-loss of-load probability must remain 0% throughout the entire year. Provide the system with the configuration of RRFB assembly with 2 sets of LED light bars.

The specific configuration will be shown in the Contract. Provide a system-sizing report detailing the photovoltaic array, battery bank, array-to-load ratio analysis, system availability analysis, battery state-of-charge report, battery depth of discharge (DOD), and monthly installation information for that specified region.

- 2.10. **Photovoltaic Modules.** The photovoltaic PV module must provide 12 V DC and be capable of recharging the system to full capacity after 6 hr. of continuous operation and in 3 hr. \pm 0.5 hr. during optimum sun conditions. Supply industrial-grade, polycrystalline-type solar modules. Consumer grade modules are not acceptable. Solar modules must have a power output rating of \pm 5% or better. Ensure PV modules are available to the Department in a graduated product line from 40 to 120 W per module. Each solar module, regardless of wattage, must share common mounting holes for mounting, so that a single mounting structure will accommodate the entire module line. Incorporate a 6 in. square polycrystalline cell and at least 2 bypass diodes installed at the factory into each solar module. Construct PV module with a low-iron tempered glass surface and an industrial grade anodized aluminum frame that completely surrounds and seals the module laminate. Ensure construction is consistent with the demands of installation near humid salt air environments. Provide an ultraviolet- (UV) resistant, weatherproof junction box providing wire termination for up to No. 8 AWG wiring with the PV module.

Provide a photovoltaic module mounting assembly of galvanized steel (ASTM A-153 Class A) or aluminum. Ensure the mounting assembly provides a means of securely attaching the PV module frame to a pole ranging from a minimum 4-1/2 in. outside diameter steel or aluminum pole to a wood pole at a permanent angle of 45° to 50°. Provide at least four 3/4 in. stainless steel bolts, lock washers, and hex head nuts with the mounting assembly to secure the PV module to the frame. Provide a mounting assembly capable of 360° horizontal orientation with a means of locking the bracket at an inscribed angular position about the pole.

The photovoltaic harness must not exceed 2% total voltage drop between the solar module and the charge control circuit.

- 2.11. **Battery.** Provide group-27 gel batteries specified in the system sizing report. Use valve-regulated, gelled-electrolyte batteries rated for a minimum of 2000 cycles with 10% capacity withdraw. Provide 12 V DC batteries. Use lead-calcium for the plate alloy. Use a T881-type terminal element post designed for 1/4 in. bolt termination. Use a polypropylene container or cover. The gelled electrolyte must contain sulfuric acid, fumed silica, pure demineralized and deionized water, and a phosphoric-acid additive. Provide a spill-proof gel cell battery to allow installation in any position. Size the batteries to allow 12 days autonomy. Depth of Discharge (DOD) for the system must not exceed 80%.

3. CONSTRUCTION

- 3.1. **Installation.** Install foundations in accordance with Item 656, "Foundations for Traffic Control Devices." Unless otherwise shown on the plans, stake the assembly locations for verification.

Install pole, breakaway base, connectors, wiring, signal beacons, sign, and foundation as shown on the plans or as directed. Install the flasher controller assembly as shown on the plans. Install watertight breakaway electrical fuse holders in all line and neutral conductors at the breakaway base. Use established industry and utility safety practices to erect assemblies near overhead or underground utilities. Consult with the appropriate utility company before beginning such work.

- 3.2. **Communication Requirements.**

- 3.2.1. **Conduit.** Install conduit and fittings of the sizes and types as shown on the plans. Conduit of larger size, than that shown on the plans, may be used with no additional compensation, providing that the same size is used for the entire length of the conduit run. Extend conduit in concrete foundations 2 to 3 in. above the concrete. Seal the ends of each conduit with silicone caulking or other approved sealant after all cables and conductors are installed.

- 3.2.2. **Wiring.** Unless otherwise shown on the plans, furnish stranded No. 12 AWG XHHW conductors. Install above-ground cables and conductors in rigid metal conduit, except for span wire suspended cables and conductors, drip loops, and electrical wiring inside signal poles. Make power entrances to the flasher cabinet assembly through underground conduit. Wire each installation as shown on the plans and as required for proper operation.

Attach ends of wires to properly sized self-insulated solderless terminals. Attach terminals to the wires with a ratchet-type compression crimping tool properly sized to the wire. Place pre-numbered identification tags of plastic or tape around each wire adjacent to wire ends in the cabinet assembly, RRFB light bars, and pedestrian push button terminals.

Splices will not be permitted except as shown on the plans, unless the Engineer approves each individual splice in writing. Make all allowed splices watertight.

- 3.2.3. **Grounding and Bonding.** Ground and bond conductors in accordance with the NEC. Ensure the resistance from the grounded point of any equipment to the nearest ground rod is less than 1 ohm.

- 3.2.4. **Preservation of Sod, Shrubbery, and Trees.** Replace sod, shrubbery, and trees damaged during the Contract.

- 3.2.5. **Removal and Replacement of Curbs and Walks.** Obtain approval from the Engineer before cutting into or removing walks or curbs not shown on the plans to be removed or replaced. Restore any curbs or walks removed equivalent to original condition after work is completed, to the satisfaction of the Engineer.

- 3.3. **Test Period.** Operate completed RRFB installations continuously for at least 30 days in a satisfactory manner. If any Contractor, furnished equipment fails during the 30 day test period, repair or replace that equipment. This repair or replacement will start a new 30 day test period. Replace materials that are damaged or have failed before acceptance. Replace failed or damaged existing system components when caused by the Contractor. The Department will relieve the Contractor of maintenance responsibilities upon passing a 30-day performance test of the RRFB system and acceptance of the Contract.

4. WARRANTY

All equipment must have at least 95% of the manufacturer's standard warranty remaining on the date that the Contractor submits equipment invoices for payment. The Department will not accept any equipment with less than 95% of its warranty remaining.

Provide warranties in accordance with Table 1, "Required Warranties."

Table 1
Required Warranties

| Item | Warranty Type and Period |
|----------------------|--------------------------|
| Photovoltaic modules | Limited 12 yr. |
| Signal beacons | Limited 5 yr. |
| Batteries | Prorated 5 yr. |
| All other equipment | 3 yr. |

5. MEASUREMENT

This Item will be measured by each rectangular rapid flashing beacon assemblies installed.

6. PAYMENT

The work performed and materials furnished, in accordance with this Item and measured as provided under "Measurement," will be paid for at the unit price bid for "Installation of Solar Powered Rectangular Rapid Flashing Beacons Assemblies," of the type (one-way wireless, one-way hardwired, two-way wireless, two-way hardwired) specified. This price is full compensation for furnishing, installing, and testing the completed installation, including complete control cabinets with associated equipment, pedestrian push buttons, rectangular rapid flashing beacon light bars, solar powered flashing controller assemblies, pedestal poles, foundation, transformer bases, mounting hardware; preservation and replacement of damaged sod, shrubbery, and trees; removal and replacement of curbs and walks; equipment, labor, tools and incidentals.

New signs will be paid for under Item 636, "Signs." New conduit will be paid for under Item 618, "Conduit." New electrical conductors will be paid for under Item 620, "Electrical Conductors." New ground boxes will be paid for under Item 624, "Ground Boxes." New traffic signal cables will be paid for under Item 684, "Traffic Signal Cables."