**Purchase Specification**

**for a**

**Solar Self-Contained CFB System (CFB)**

1. **Overview**

Each CFB system shall consist of a self-contained solar engine that houses the charge controller, flash controller, on-board user interface, wireless communications, batteries, and solar panel. Each CFB system shall include either one or two circular LED beacons. The CFB system shall conform to all provisions of the MUTCD, Chapter 4L, including flash pattern. The CFB system shall be pre-wired to the maximum extent possible. The CFB shall also offer sufficient interior space to house third-party equipment and associated cabling and connectors.

1. **Mechanical Specifications**

The solar engine shall be constructed from aluminum with an integrated solar panel. All batteries and electronics shall be mounted in the solar engine, with no external control cabinet or battery cabinet required.

The solar engine, excluding mounting components, shall not exceed 22” in width, 16” in height, and 5” in depth.

The overall weight of the solar engine assembly (including two batteries but not including lightbars or pushbutton) shall not exceed 40 lbs. (18.2 kg).

The solar engine shall be supplied with a fixed tilt angle of 45 degrees and shall be able to be oriented toward the equator with no additional mounting hardware.

Access to the interior of the solar engine shall be provided by a lid that is hinged on the bottom edge and is fitted with a foam gasket. The lid shall have a lockable latch.

The solar engine shall be vented to provide cooling of the battery and electronic system. The vents shall be screened to prevent ingress by insects and debris.

Fasteners shall be stainless steel.

1. **Signal Housing**

The solar engine shall be capable of direct attachment to the top of a signal head. The signal head shall contain mechanical reinforcement designed specifically to support the weight of the solar engine.

The signal housing shall meet the equipment standard of the Institute of Transportation Engineers (ITE) Vehicle Traffic Control Signal Heads (VTCSH) Chapter 2.

The signal head’s bracket assembly shall be constructed such that the signal head can be removed easily in the field.

The signal housing must be able to rotate independent from the solar engine or bracket for lens alignment.

The signal housing shall be constructed from a choice of UV-resistant polycarbonate or aluminum. The signal housing shall be available in yellow, green or black.

The beacon(s) shall also be capable of being mounted to a post or pole using a separate bracket assembly to facilitate mounting multiple beacons in either vertical, horizontal, or back-to-back (bi-directional) arrangements.

The signal housing shall open for access to the wiring connections for the LED beacons. The signal housing shall be rated to NEMA 3R.

1. **Fixtures**

**4.1 Circular Beacons**

The LED beacons shall conform to the requirements of the Manual of Uniform Traffic Control Devices 2009 with May 2012 Revisions 1 and 2. LED beacons shall also comply with the intensity and beam shape requirements of the ITE Vehicle Traffic Control Signal Heads, Light Emitting Diode (LED) Circular Signal Supplement.

The CFB shall be capable of driving beacons at ITE-compliant intensities if solar conditions and programming configuration permit it.

The beacons shall be current-driven LED strings without active electronics. The LEDs shall be driven by pulse-width modulated fixed current.

The LED beacons shall be available in red and yellow, and in 12” (305mm) and 8” (203mm) diameters. Note: yellow only for pedestrian activated systems.

The LED beacon optics shall be premium, UV-resistant polycarbonate.

LED Beacon wiring harnesses shall be included.

**4.2 LED Enhanced Signs**

The CFB shall be able to optionally operate flashing LEDs in the border of a pedestrian sign.

1. **Mounting**

Solar engine mounting adapter hardware for the CFB shall be available for the following configurations:

Direct to top of signal housing

2” / 2.5” Perforated Square Pole Mount

2 3/8” - 2 7/8” Diameter Round Post Mount

4” - 4.5” Diameter Round Post Mount

Side-of-Pole Mount

Wooden Pole

The signal housing shall be able to mount directly to the above supports or indirectly using C-brackets. Signal housing shall be able to mount in a single or dual (vertical, horizontal or back-to-back) configuration. LED-enhanced signs shall be able to mount in a single or back-to-back (bi-directional) configuration.

Mounting configurations shall not require specialized tools.

1. **Configuration**

The CFB cabinet shall house an auto-scrolling LED on-board user interface that provides on-site configuration adjustment, system status and fault notification.

The user interface shall provide a display of four (4) alphanumeric characters and three (3) control buttons to navigate and change settings and activate functions.

When editing the configuration, the user interface will flash the display indicating it is ready to accept editing and will flash the display rapidly 3 times to indicate the setting change has been accepted.

The flash duration shall be adjustable in-the-field from 5 to 60 seconds in one second increments, 60 to 1,200 seconds in 60-second steps, and 3,600 seconds. Default flash duration shall be 20 seconds.

The system shall provide configurable nighttime intensity settings ranging from 10% to 100% of daytime intensity.

The system shall be capable of enabling or disabling ambient brightness auto-adjustment. This feature allows the system to provide optimal output brightness in relation to ambient light levels. If enabled, the ambient brightness auto-adjustment shall adjust output to a range between 50% and 100% of daytime intensity.

The User Interface shall provide viewing and/or programming access for the following:

* Activation Duration (5 to 60, 60 to 1200, or 3600 seconds)
* Digital output that is active during the flashing cycle that allows the control of external devices such as crosswalk illumination. Digital output shall be configurable for night operation only or operation day or night
* 6 Flash Patterns
* Radio Channel (Choice of 1 to 14)
* Radio Status
* Night Intensity Setting
* Adjustment for Ambient Daytime Brightness
* Intensity (20 mA to 1400 mA)
* Self-Test / BIST (Built-In Self-Test) including the detection of shorts or open circuits in the fixture outputs
* Battery Status – General description and actual battery voltage
* Day or Night Status (as determined by dedicated photosensor not solar panel output)
* Solar Panel Voltage
* Automatic Light Control. If this safety feature is enabled, it allows the CFB to temporarily reduce the intensity of the beacons to maintain energy equilibrium. The user interface shall report the amount of dimming being applied in the range of 10% to 100%
* Daily activations averaged over 90 days
* Pushbutton detection
* Firmware Version number

Activation duration, Night intensity setting and adjustment for ambient daytime brightness shall be automatically broadcast to all CFBs in the system when changed in one CFB.

1. **Solar Panel System**

The solar engine shall include one 18V nominal solar panel rated at 30 watts with bypass diode. The solar panel shall be no larger than the footprint of the solar engine enclosure.

Electrical connections on the back of the solar panel shall be contained with an enclosure that prevents accidental contact with either of the power leads.

The solar charging system shall use maximum power point tracking (MPPT).

1. **Battery System**

The solar engine shall house two 18 amp-hour 12V nominal sealed valve-regulated AGM lead-acid maintenance-free batteries. Each battery shall be equipped with a minimum 1.5-amp fuse on the positive lead.

The battery charging system shall be 3-stage and incorporate temperature-compensation to prevent battery overcharging in hot weather.

Batteries, in conjunction with recommended RRFB performance, shall be designed for a demonstrable service life of 5 years.

The battery shall be rated for -40˚ to 140˚F (-40˚ to 60˚C).

Batteries shall have quick connections to facilitate installation and be readily available from multiple suppliers and non-proprietary.

Batteries shall be supported by rubber bumpers and constrained from excessive movement.

1. **Operational Specifications**

The CFB shall flash at a rate of not less than 50 nor more than 60 times per minute. The illuminated period of each flash shall not be less than one-half and not more than two-thirds of the total cycle.

The beacons shall exhibit an MUTCD-compliant flash pattern and activation including alternate, unison and quick-flash

The CFB shall have the capacity to provide 500 20-second activations per day year-round using the applicable peak sun hours insolation available at the installation location. Refer to Section 8. Solar Simulations for details on insolation data sources.

The controller shall be able to support up to 1.4 amps combined current through the CFB fixtures simultaneously.

The system shall use a dedicated light sensor to detect night and day states and apply any optionally-enabled intensity adjustments.

1. **Radio System**

The radio system shall operate at 2.4GHz

Upon detection of a pushbutton press, a CFB will broadcast an activation to all other nearby CFBs sharing the same channel.

The CFB shall have the capability to activate other CFBs by wireless communications within 1,000 feet (304 meters).

The CFB shall have a minimum of 14 unique channels that can be configured on-site to avoid inadvertent activation of nearby systems.

The antenna shall be a low-profile “button” shape that cannot be bent or broken by vandals

1. **Activations**

The system shall be capable of activation by either pedestrian push button, pedestrian push button with voice message, or passive detection. The RRFB shall be capable of operating with either 1 or 2 pushbuttons.

The pedestrian push buttons shall have an LED indicator with audible tone with Piezo control and shall be ADA compliant. The pedestrian push button with voice message shall have three LED indicators, locate tone, and voice message with the MUTCD IA-21 approved message “Yellow lights are flashing”. The message shall be spoken twice. The push button shall be ADA compliant with directional arrow. A solar simulation shall be provided to verify the push button with voice message load can be supported by the CFB for reliable year-round operation.

The passive detection system shall use a short-range microwave sensor providing the necessary range at a low power consumption. The passive detection system shall provide pedestrian presence detection within the targeted area of a crosswalk or trail crossing. A solar simulation shall be provided to verify the microwave sensor load can be supported by the CFB for reliable year-round operation.

All CFBs in the system shall initiate activation simultaneously within 150ms of activation.

If an additional activation occurs while the system is activated, the flash duration shall reset. For

example, with the flash duration set to 20 seconds, if an additional activation occurs after the CFB has been activated for 15 seconds the CFB will continue for an additional 20 seconds, or 35 seconds in total.

If the CFB has ceased operation, any subsequent activation shall activate the CFB immediately regardless of how recently the CFB ceased operation.

Pushbutton wiring harnesses shall be included.

1. **Solar Simulations**

Detailed solar simulations shall be provided as evidence that the CFB is capable of the claimed performance at a specific location. Solar Simulations shall be composed of three calculations: Energy Balance, Array-to-Load Ratio (ALR), and Autonomy. The manufacturer or bidder shall provide a detailed analysis of these three calculations in an “Energy Balance Report”.

Monthly average sunlight (insolation), night length and temperature data for a specific, declared location shall be from recognized public sources such as the NASA Atmospheric Sciences Data Center. All sources shall be cited exactly and accessible online without cost to allow verification of the data.

**Energy Balance**

During a normal 24-hour cycle of operation, a CFB will take energy in from the sun and consume energy through the flashing of the beacons, radio communication, and general quiescent power draw. Energy Balance refers to the evaluation of these energy values to determine overall system sustainability and resistance to variances in sunlight and activation load.

Energy Balance compares Energy-In and Energy-Out. Calculations shall be performed for the “Worst Month” of the year where worst month is determined by the lowest value of Energy-In divided by Energy-Out.

**Energy-In**

Energy-In is the total amount of sunlight energy in watt-hours *available* to the CFB over a 24-hour period. Energy-In is available to operate the CFB, charge the battery, or both. Energy-In shall be determined as follows:

Insolation X Panel Wattage X Shading X charging efficiency X Battery charge acceptance

* The energy from the solar panel shall be based on available solar radiation at the installation location for the panel’s inclination angle. The solar radiation (insolation) values used shall be for the worst-case month of the calendar year.
* Shading from nearby trees, buildings or other structures unique to a particular location are to be factored-in and the calculations shall clearly show and justify the de-rating of the solar panel energy input. A photograph showing the sun’s path and obstructions it encounters shall be included.
* Batteries shall be returned to full charge by sunset at the end of each day.

**Energy-Out**

Energy-Out is the total amount of energy in watt-hours consumed by the CFB in a 24-hour period of normal operation.

Energy-Out is the sum of quiescent and operating loads, measured in watt-hours, in all circuitry over 24 hours with an operating capacity of 600 20-second activations, including:

* Controller quiescent draw (daytime and between flashes)
* Wireless quiescent draw calculated over 24 hours;
* Operating load of pushbutton at rated operating capacity per activation (where applicable);
* Operating load of LED beacons including pedestrian indicators at rated intensity per activation. The number of LED beacons and their electrical load details (voltage, current and power when lit) shall be clearly indicated;
* Energy adjustments due to LED drive circuit efficiency.
* The simulations shall clearly detail the flash pattern being used and calculate the duty cycle of the pattern.
* Calculations shall assume the ratio of day to night activations is 9:1.

**ALR (Array-to-Load Ratio)**

System Array-to-Load (ALR) ratio shall be calculated as: Daily Available Energy-In divided by Daily Energy-Out as defined above.

CFB Solar Simulations shall be calculated demonstrating a minimum Array-to-Load (ALR) ratio of 1.2:1 (1.2)

**Autonomy**

Autonomy is the number of days that the CFB can continue to operate normally in the absence of any solar charging. Autonomy shall be calculated as follows:

(Nominal Battery Capacity de-rated for Temperature minus battery capacity unavailable due to Low Voltage Disconnect) divided by (Daily total energy consumption at the specified number and duration of activations)

CFB autonomy shall be a minimum of 5 days.

1. **Environmental Testing**

The CFB cabinet and LED beacons shall be rated to a minimum of NEMA 3R.

1. **Packaging**

Packaging shall consist of only recyclable corrugated cardboard and soft plastic bags.

1. **Qualifications**

The CFB shall be FCC certified to comply with all 47 CFR FCC Part 15 Subpart B Emission requirements.

The CFB shall be manufactured in the USA and shall be Buy American compliant.

Manufacturer shall provide a 5-Year Limited Warranty, with the exception of the batteries which shall be covered by a 1-year warranty.

The Manufacturer shall be ISO 9001 certified.

The CFB shall be manufactured by Carmanah Technologies Inc.

Manufacturer: Carmanah Technologies Inc.

Model: R820-F Solar Crosswalk Flashing Beacon

Toll-Free: 1-877-722-8877

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