**Purchase Specification**

**for a**

**Solar Self-Contained Rectangular Rapid Flashing Beacon (RRFB)**

1. **Overview**

Each Rectangular Rapid Flashing Beacon (RRFB) 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 RRFB shall include either one or two light bars. The RRFB shall conform to all provisions of the MUTCDC, Fifth Edition and the Pedestrian Crossing Control Guide, Third Edition. The RRFB shall be pre-wired to the maximum extent possible.

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 shall not exceed 15” in height from bottom of adapter fitting to top of solar panel. The depth of the solar engine shall not exceed 4”.

The overall weight of the solar engine assembly (including two batteries but not including light bars or pushbutton) shall not exceed 20 lbs. (9.1 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. **Light Bars**

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

The light bar housing shall be constructed from aluminum and shall have the approximate dimensions: 24” L x 1.5” D x 4.5” H (61.0 cm L x 3.8 cm D x 11.4 cm H).

Each light bar shall conform to all provisions of the MUTCDC and Pedestrian Crossing Control Guide requirements.

Each of the two modules in a light bar shall have 8 LEDs and shall be purpose-built by the manufacturer of the RRFB including the optics. The optics shall be premium, UV-resistant polycarbonate.

Each end of a light bar shall include a side-emitting pedestrian confirmation light composed of a single LED. Users shall have the option of using both confirmation lights for median applications, or covering one confirmation light with an included sticker for side-of-road applications.

The light bar shall be mounted to the post or pole using a separate bracket assembly to facilitate mounting two light bars back-to-back (bi-directional) and to allow the light bar(s) to rotate horizontally for aiming.

The light bar bracket shall be constructed from galvanized or stainless steel and shall have both banding and bolting mounting options and shall be able to be mounted to all specified pole types.

The light bar assembly shall open for access to the wiring connections for the LED modules. LED modules shall be rated to NEMA 3R.

Light bar wiring harnesses shall be included.

Fasteners shall be stainless steel.

1. **Mounting**

Mounting adapter hardware for the RRFB shall be available for the following configurations:

* 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

Mounting configurations shall not require specialized tools.

1. **Configuration**

The solar engine 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 flash rate shall be the wig-wag plus simultaneous (WW+S) providing 75 flashing sequences per minute. The flash rate of each individual RRFB indication, as applied over the full flashing sequence, shall not be between 5 and 30 flashes per second to avoid frequencies that might cause seizures.

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 while always maintaining adherence to SAE J595 Class I specifications. 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.
* Radio channel (choice of 1 to 14)
* Radio power on/off status
* Radio equipped status
* Daytime intensity
* Flash pattern
* Night intensity setting
* Adjustment for ambient daytime brightness
* 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 (ALC). If this safety feature is enabled, it allows the RRFB to temporarily reduce the intensity of the light bars 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 RRFBs in the system when changed in one RRFB.

1. **Solar Panel System**

The solar engine shall include one 18V nominal solar panel rated at 15 watts with bypass diode. Nominal voltage of the RRFB shall be 12 volts. 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 7 amp-hour 12-volt nominal sealed valve-regulated AGM lead-acid maintenance-free batteries. Each battery shall be equipped with a fast-acting 7A cartridge 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 operating temperature range of the battery shall be -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 be secured in place with straps.

1. **Operational Specifications**

The RRFB shall meet the minimum photometric specifications of the Society of Automotive Engineers (SAE) standard J595 Class I dated January 2005. A photometric report by a certified third-party testing laboratory shall be provided to demonstrate compliance with J595.

The color of the yellow light bar indications shall meet the specifications of SAE standard J578 (Color Specification) dated December 2006.

The RRFB system shall have the capacity to meet a minimum array-to-load (ALR) of 1.2 while meeting the specified daily activations and flash duration year-round using the applicable peak sun hours insolation available at the installation location. Refer to Section 11 Solar Simulations for details on insolation data sources.

The controller shall be able to support up to 1.4 amps combined current through the RRFB 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, an RRFB will broadcast an activation to all other nearby RRFBs sharing the same channel.

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

The RRFB 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 pedestrian pushbutton with voice message.

The pedestrian pushbutton shall be ADA compliant and have these accessibility features:

* Activation area of 2” minimum across in at least one direction
* Shall be operable with a closed fist
* Shall be operated with a maximum of 3.5lbs (15.5N)
* Shall have a visual contrast with the body background of at least 70 percent
* Voice message “Yellow lights are flashing”, spoken twice by default
* Visible indicator LED
* Visible indicator for button press confirmation
* Tactile directional arrow

A solar simulation shall be provided to verify the pushbutton with voice message load can be supported by the RRFB for reliable year-round operation. The pushbutton shall be self-contained with no external controller. The pushbutton shall have wireless Bluetooth communication for changing volume and other settings via companion smartphone application.

All RRFBs 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 RRFB has been activated for 15 seconds the RRFB will continue for an additional 20 seconds, or 35 seconds in total.

If the RRFB has ceased its flashing cycle, any subsequent activation shall activate the RRFB immediately regardless of how recently the RRFB ceased operation.

Pushbutton wiring harnesses shall be included.

1. **Solar Simulations**

Detailed solar simulations shall be provided as evidence that the RRFB 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” (EBR).

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, an RRFB will take energy in from the sun and consume energy through the flashing of the light bars, 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 RRFB over a 24-hour period. Energy-In is available to operate the RRFB, charge the batteries, 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 RRFB 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 300 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 light bars including pedestrian indicators at rated intensity per activation. The number of light bars 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

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 RRFB 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)

RRFB autonomy shall be determined based on regional requirements – at a minimum of 10 consecutive days.

1. **Environmental Testing**

The RRFB solar engine and light bars 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 RRFB shall be FCC certified to comply with all 47 CFR FCC Part 15 Subpart B Emission requirements.

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 RRFB shall be manufactured by Carmanah Technologies Inc.

Manufacturer: Carmanah Technologies Inc.

Model: R920-E Solar RRFB

Toll-Free: 1-877-722-8877

www.carmanah.com