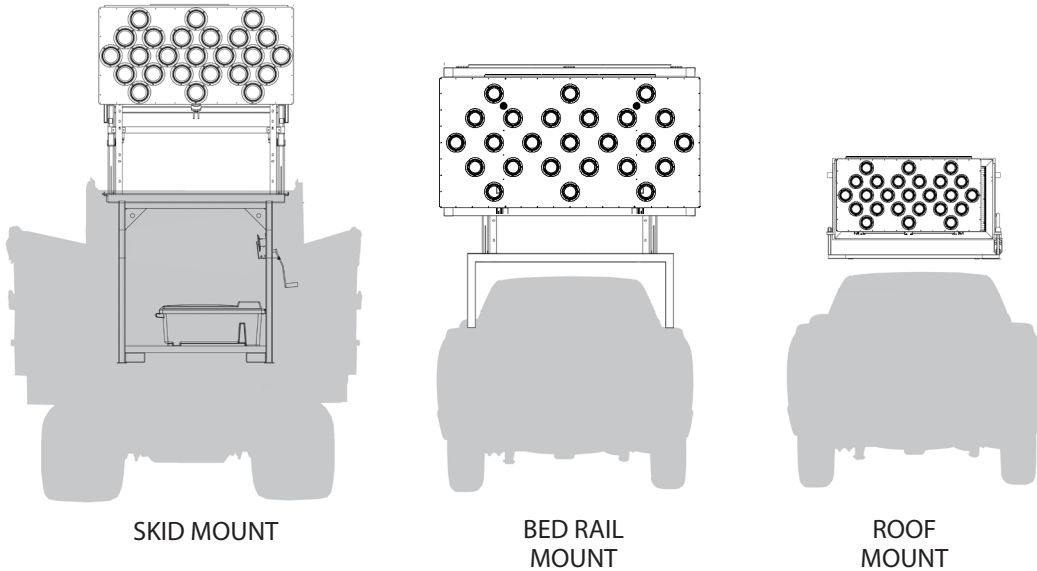


Silent Sentinel  
Solar Powered Advanced Warning  
**Vehicle Mounted**  
**Arrow Panels**

**Procurement  
Specifications**



*As Reliable as the Sun*

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This document presents a detailed specification for vehicle-mounted Type-B and Type-C Advance Warning (Flashing) Arrow Panels. This specification typically requires additions and/or modifications to meet a user's specific requirements.

This specification is subject to periodic revisions as required without notice.

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## 1. General

### 1.1 Product Description

The **SILENT SENTINEL Vehicle Mount Flashing Arrow Panel** is an advance warning (flashing) arrow panel designed for temporary and/or mobile applications. Several panel sizes and mounting options are available including: a Universal/General Mounting Kit, an Pivoting "Over-the-Cab" Mounting Kit, and a Pivoting Skid-Mount Kit (several models/configurations of each are available to fit most mid and full sized pickup truck beds). The **SILENT SENTINEL** consists of an arrow display panel, an electronic control console and necessary wiring and cables. Various mounting configurations and options such as wired or wireless control, various cabling kits, auxiliary battery packs, solar arrays and lifting mechanisms are available to provide for a wide variety of customizable installations to suit many different applications.

### 1.2 Design Objectives

1.2.1 Maximize reliability by using generally accepted design techniques for outdoor-use electrical and electronic equipment.

1.2.2 Minimize operating cost by using a renewable energy source, requiring minimal maintenance.

1.2.3 Maximize safety and effectiveness by using a high contrast arrow display panel with long-life expectancy, high-reliability LED lamp technology

1.2.4 Meet or exceed the standards for Arrow Boards as listed in the U.S. Federal Highway Administration (FHWA) Manual on Uniform Traffic Control Devices (MUTCD).

### 1.3 Performance Objectives

1.3.1 Visibility greater than 1 mile.

1.3.2 Legibility at 1 mile.

1.3.3 Minimal glare from sunlight and headlights.

1.3.4 Continuous, uninterrupted operation on vehicle-provided power and/or solar power (if so equipped).

1.3.5 One month minimum, three month typical maintenance interval.

### 1.4 Quality Assurance Objectives

1.4.1 All manufacturing shall be carried out in a facility with a completely implemented and properly maintained ISO 9001:2015 certified quality management system.

1.4.2 All units shall bear the CE Mark indicating acceptable EMC (Electromagnetic Compatibility) to insure that the units are neither susceptible to nor produce any electromagnetic interference.

1.4.3 Manufacturer shall have a factory authorized service center located within 150 miles of point of delivery. Authorized service center shall receive all units from factory in order to inspect for any shipping damage and verify proper operation prior to final delivery. Delivery directly from manufacturer's facility without inspection by an authorized service center shall not be permitted. Additionally, authorized service center shall be capable of performing warranty service and repairs, and shall provide on-site training on the proper use and maintenance of all equipment delivered.

## 2. Physical

### 2.1 Dimensions & Weights

#### 2.1.1 Length

2.1.1.1 Operating:	Cab-Mount - 33 in. (84 cm)	Skid-Mount - 45 in. (114 cm)
	<i>w/ Solar Array - 45 in. (115 cm)</i>	<i>w/ Solar Array - 57 in. (145 cm)</i>

2.1.1.2 Transporting:	Cab-Mount - 59 in. (150 cm)	Skid-Mount - 62 in. (158 cm)
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#### 2.1.2 Width

2.1.2.1 Overall:	Type B - 60 in. (153 cm)	Type C - 96 in. (244 cm)
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2.1.2.2 At base:	Cab-Mount - 55 in. (140 cm)	Skid-Mount - 55 in. (140 cm)
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#### 2.1.3 Height (Above cab base or truck bed as applicable)

2.1.3.1 Operating:	Cab-Mount - 62 in. (160 cm)	Skid-Mount - 112 in. (285 cm)
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2.1.3.2 Transporting:	Cab-Mount - 32 in. (82 cm)	Skid-Mount - 82 in. (208 cm)
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#### 2.1.4 Weight (approx.)

2.1.4.1 Type B:	Cab-Mount - 220 lb. (100 kg)	Skid-Mount - 360 lb. (163 kg)
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2.1.4.2 Type C:	Cab-Mount - 260 lb. (118 kg)	Skid-Mount - 400 lb. (182 kg)
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*(Note: Add 40 lb. (18 kg) for Solar Array and 170 lb. (77 kg) for Battery Pack)*

### 2.2 Environmental

2.2.1 Temperature, operating and storage - -40 to +185°F (-40 to +85°C)

2.2.2 Relative Humidity - 20% to 98%, non-condensing

#### 2.2.3 Wind

2.2.3.1 Transport position, maximum travel speed - 70 MPH (12 KPH)

2.2.3.2 Operating position, maximum travel speed - 35 MPH (56 KPH)

2.2.4 Electrical Interference - Unaffected by RFI (Radio Frequency Interference) and EMI (Electromagnetic Interference).

### **3. Frame and Sign Support**

#### **3.1 Frame Construction**

3.1.1 Mounting frames shall be constructed from a combination of welded 7 Gauge (3/16-inch) and 1/4 inch CNC formed steel plate, 2 x 4 x 1/8 inch structural steel tubing, 2 x 2 x 3/16 and 2 x 2 x 1/8 inch structural steel tubing and 2 x 2 x 1/8 HRS angle as appropriate for the desired installation.

3.1.2 Skid-mount frame base shall accommodate the addition of an enclosure for the optional battery power pack.

3.1.3 All frames shall be designed such that the sign panel and any optional equipment mounted directly to the frames facilitate quick, easy installation and removal from vehicle.

3.1.4 All frames shall be equipped with tie down points and/or foot pads with mounting holes to facilitate securing to vehicle.

3.1.5 All frames shall be completely assembled with removable fasteners to accommodate quick, easy maintenance and repair.

3.1.6 All fasteners shall be rust resistant and equipped with all metal (stover) or nylon-stop lock nuts to prevent loosening of fasteners during normal transportation and operation.

#### **3.2 Arrow Panel Support**

3.2.1 Sign panel mounting/support arms shall be constructed from 2 x 2 x 1/4-inch HRS angle.

3.2.2 Pivoting sign panel support frame shall accommodate the addition of an optional integrated support frame for mounting the optional solar array. The solar array shall be positioned to accommodate charging in both the operating and the traveling positions.

3.2.4 Pivoting sign panel support shall be designed such that it may be equipped with either a manually-operated automatic-brake winch and cable mechanism (skid mount option only) or a 12VDC motor-operated remotely-controlled linear actuator for raising & lowering the sign panel and optional solar array, if so equipped, from the travel position into the operating position.

3.2.5 All aluminum to steel attachments shall be made with stainless steel hardware and stainless steel or nylon spacers so as to minimize galvanic corrosion.

#### **3.3 Arrow Panel Lifting Mechanism**

##### **3.3.1 Manual Winch and Cable Mechanism - Manual Winch (Skid-Mount Option Only)**

3.3.1.1 Arrow panel lifting mechanism shall consist of a minimum 1,000-pound capacity, automatic brake type winch with 1/4-inch wire rope capable of holding the arrow panel in any position from full upright to the travel (down) position.

3.3.1.2 Winch shall be zinc-plated to minimize rust and corrosion.

3.3.1.3 Winch shall be designed such that the handle can be removed, for added security without interfering with the operation of the automatic brake.

3.3.1.4 Arrow panel shall be secured in the operating (up) position by two stainless steel, spring-loaded, locking pins.

### 3.3.2 Remote-Controlled Motor-Operated Linear Actuator - Power Lift Option (All Pivoting Mount Installations)

3.3.2.1 Linear actuator shall be a completely sealed (weatherproof) lead-screw and ball bearing type drive system with integrated force limiting clutch mechanism to prevent mechanical damage to unit in event of mechanical failure/interference of pivoting mechanism.

3.3.2.2 Linear actuator shall provide a minimum operating force of 1,000 lb. (4,448 N) and a minimum holding force of 3,000 lb. (13,333 N).

3.3.2.3 Linear actuator shall be equipped with a bidirectional brake to hold the sign panel in any position along with electronic end of stroke (Hall-Effect) limit switches to prevent over-travel in either direction.

3.3.2.4 Linear actuator shall operate from a nominal 12 Volt DC power source.

3.3.2.5 Linear actuator shall be capable of completely raising or lowering the sign panel in less than 25 seconds.

3.3.2.6 The linear actuator control unit shall be equipped with LED indication to denote when the sign panel is in the fully raised, intermediate and fully lowered positions.

## 3.4 Surface Preparation and Finishing

3.4.1 Frame structure shall be completely cleaned and deburred prior to finishing. All metal surfaces shall be prepared for finishing using an iron phosphate wash-down process.

3.4.2 A polyamide epoxy primer shall be applied to a dry film thickness of 1.5 mils.

3.4.3 A matte black aliphatic acrylic urethane finish shall be applied to a dry film thickness of 1.25 mils.

## 4. Arrow Panel

### 4.1 Dimensions

4.1.1 Width Overall:     Type B - 72 in. (184 cm) or 60 in. (153 cm)     Type C - 96 in. (244 cm)

4.1.2 Height Overall:    Type B - 36 in. (92 cm) or 30 in. (76 cm)     Type C - 48 in. (122 cm)

4.1.3 Depth Overall :    Type B - 3 in. (7.6 cm)     Type C - 3 in. (7.6 cm)

### 4.2 Construction

4.2.1 Arrow panel frame, including internal braces, shall consist of 3 x 1 x 0.100 inch formed aluminum alloy channel, pulse MIG welded at corners and at internal braces.

4.2.2 Front and rear surfaces shall consist of .063 inch aluminum alloy sheet with a baked matte black enamel finish.

4.2.3 Front and rear panels shall be attached to welded aluminum frame with 8-32 x 3/8-inch, black-finish, stainless steel, torx-head, thread-rolling screws located on 6-inch centers. In order to facilitate simple repair, rivets or any other form of non-removable fastener shall not be permitted.

4.2.4 Arrow panel shall be equipped with 2 1/2-inch diameter by 1-inch thick rubber bumpers to support panel when in the transport (down) position - as required per installation configuration.

4.2.5 Arrow panel shall be equipped with a light sensing device to monitor ambient light and provide information to the control module to regulate the intensity of the arrow panel lamps.

### **4.3 Lamps**

4.3.1 Arrow panel shall be equipped with 15 or 25 lamps, approximately five (5) inches in diameter

4.3.2 Arrow panel lamps shall consist of an array of at least 21 LEDs mounted in a weather resistant high impact polycarbonate housing.

4.3.3 The arrow panel lamp housing shall be completely sealed to protect the internal components from corrosion caused by harsh environmental conditions.

4.3.4 The outer surface of the lamp shall be convex (diverging) to minimize reflection of incident light and to maximize the contrast of the arrow panel display.

4.3.5 The lamps shall provide an Approximate Initial Maximum Beam Candlepower of 1,000 candela typical, 750 candela minimum, over an operating voltage range of 10.7 to 16 VDC. The lamp intensity shall remain constant over the entire operating voltage range.

4.3.6 The lamps shall produce a field spread (angularity) of 30 degrees horizontal by 6 degrees vertical.

4.3.7 The color of the light produced by the lamps shall be amber (approximate wavelength of 592 nanometers).

4.3.8 The lamps shall have a minimum life expectancy of 100,000 hours (200,000 hours typical).

4.3.9 The lamps shall be equipped with quick disconnect terminals to accommodate quick, easy replacement of lamps without regard to polarity. The lamps shall not be polarity sensitive (i.e. capable of connection and operation without concern for polarity).

4.3.10 Arrow panel lamps shall be equipped with a automatic polarity detection circuit to enable operators to connect quick disconnect terminals to lamp without regard to polarity (i.e. either orientation) and ensure proper operation.

4.3.11 Arrow panel lamps shall be secured to the arrow panel by a black, molded, impact-resistant shroud, approximately five (5) inches in diameter and approximately four (4) inches high. Lamp shroud shall mount to panel with stainless steel screws through keyholes such that the shroud and lamp can be removed from the panel without the need to remove the screws from the panel.

4.3.12 Arrow panel lamps shall be keyed to the shroud and the shroud shall be keyed to the front panel so the lamps are secured to the front panel with proper lamp beam orientation.

4.3.13 The rear of the arrow panel shall be equipped with three (3) ultra-bright LEDs, in watertight housings, to indicate the arrow panel pattern currently being displayed. This provides a visual indication to individuals in the work zone that the arrow panel is functioning properly.

#### 4.4 Connectors and Wiring

4.4.1 Arrow panel shall be equipped with a watertight connector AMP CPC Series 2 Receptacle P/N 205843-1 with Peripheral Seal P/N 206403-3, or equivalent, to permit arrow panel to be removed quickly and easily for repair. Arrow panel control cable connector shall be suitable for outdoor use and completely sealed against moisture. Arrow panel control cable connector shall be equipped with gold flashed pins to provide maximum electrical contact reliability.

4.4.2 All internal wiring pass throughs shall be fitted with plastic grommets to prevent wire damage and/or failure.

4.4.3 All internal wiring shall be secured to inside of front panel to prevent wire damage and/or failure.

#### 5. Main Control Module

##### 5.1 Physical

5.1.1 Control module shall consist of a totally solid state fully integrated device which provides for wired or wireless control of the arrow sign panel, lamp pattern generation, battery status monitoring and indication, solar electric charge control, low battery voltage disconnect, high battery voltage disconnect, reverse battery polarity protection and surge protection.

5.1.2 Control module shall be portable and shall be equipped with a mounting bracket for ease of installation, either in the vehicle cab or in a weather resistant, lockable, molded HDPE (High Density Polyethylene) enclosure secured to the skid mount frame.

5.1.3 Control module front panel shall be completely sealed to accommodate operation in all types of weather.

5.1.4 Control module shall be constructed of all industrial temperature range components to insure reliable operation under all outdoor environmental conditions.

5.1.5 Control module power and control cables shall be equipped with locking type connectors to provide secure reliable operation while permitting quick, easy removal of the control module for maintenance and repair.

##### 5.2 General Operation

5.2.1 Control module shall be equipped with an array of membrane push buttons to enable an operator to quickly and easily select the desired arrow panel pattern with the push of a single button and shall be capable of controlling the arrow panel either via direct wired or remote wireless control.

5.2.2 Control module shall be equipped with multicolored LED indicators for monitoring battery voltage (charge) level, solar charger activity and lamp intensity control settings.

5.2.3 Control module shall employ lamp power drivers that provide completely automatic short circuit and over temperature protection. If lamp wire leads are shorted together or to the chassis or if the wrong type of lamp is connected to the lamp wire leads no damage should occur to the lamp power drivers.

5.2.4 Control module shall be completely protected against reverse battery and solar array connections.



5.2.5 Integrated charge control circuit shall provide for dual slope, temperature compensated control so as to maximize transfer of energy into the battery while protecting batteries from overcharging, minimizing outgassing and minimizing loss of electrolyte.

5.2.6 Control module shall be equipped with a lamp intensity control circuit to automatically adjust arrow panel lamp intensity to suit changing ambient lighting conditions and to maintain consistent lamp intensity over a wide operating voltage range. A manual override shall be provided for the automatic intensity control circuit so that minimum or maximum lamp intensity can be manually selected. In the event that the lamp intensity control function is inadvertently left in the High or Low setting, the lamp intensity control circuit shall return to the Auto setting upon the occurrence of the first day/night cycle sensed by the light sensing device in the arrow panel. This feature prevents the use of potentially hazardous lamp intensities, i.e. low intensity during daylight hours and high intensity at night, and unexpected excess energy consumption.

5.2.7 Control module shall provide for the following display patterns:

1. Right Arrow - 10 lamps flashing in unison, forming an arrow.
2. Left Arrow - 10 lamps flashing in unison, forming an arrow.
3. Double Arrow - 5 lamps in each arrow head, 3 in center of shaft, flashing in unison.
4. Caution Bar - 7 lamps in center horizontal bar, flashing in unison.
5. Four-Corner Caution - 4 lamps in outer most corners, flashing in unison.
6. Sequential Right Arrow - 2 lamps in left side of center bar in first phase, plus 3 lamps in middle of center bar in second phase, plus 5 lamps in arrow head in third phase flashing in sequence.
7. Sequential Left Arrow - 2 lamps in right side of center bar in first phase, plus 3 lamps in middle of center bar in second phase, plus 5 lamps in arrow head in third phase flashing in sequence.

25 Lamp Panels only:

8. Right Sequential Chevron - 5 lamps on left side of the panel forming a right-hand arrow head in the first phase, plus 5 lamps in the center forming a second right-hand arrow head in the second phase, plus 5 lamps forming a third right-hand arrow head on the right side of the panel in the third and final phase.
9. Left Sequential Chevron - 5 lamps on the right side of the panel forming a left-hand arrow head in the first phase, plus 5 lamps in the center forming a second left-hand arrowhead in the second phase, plus 5 lamps forming a third left-hand arrow head on the left side of the panel in the third and final phase.
10. Sequential Double Arrow - 1 lamp in the center of the panel in the first phase, plus the two lamps adjacent to the center lamp forming a bar in the center of the panel in the second phase, plus 5 lamps in each arrow head (total 10 lamps) in the third phase.
11. Alternating Double Diamonds - 8 lamps in the center of the panel forming a diamond shape in the first phase, dark in the second phase, 16 lamps forming diamond shapes at each end of the panel in the third phase, and dark in the fourth phase.

5.2.8 Control module power consumption, not including lamps, shall be less than 0.5 Watts so as to optimize overall energy consumption.

5.2.9 Control module operating firmware shall be field upgradeable.

5.2.10 Control module shall be equipped with positive locking connectors to provide for reliable operation and easy removal for maintenance and repair. Battery bank and solar array power connector

shall be AMP-CPC, or equivalent, with a 20-Amp minimum per contact current rating to insure minimum voltage drop and maximum energy transfer Arrow panel control connector shall be AMP D-subminiature 37-pin right angle female header AMP P/N 747847-5, or equivalent, with gold flashed pins for optimum reliability.

## 6. Power System

### 6.1 General

6.1.1 Operating Voltage - 12 Volts DC nominal

6.1.2 Operating Energy Requirement - Single Flashing Arrow, <6 Amp Hours per day nominal at Spring or Fall Equinox (i.e. 12 hours of daylight, 12 hours of darkness)

6.1.3 Main Power Switch - Main power switch shall be unnecessary When arrow panel pattern selection switch is in the OFF position, control module shall automatically shut down all unnecessary operations to reduce energy consumption to less than 0.05 Watts. Solar generator charge controller shall operate automatically, as required, during daylight hours and shut down completely at night.

### 6.2 Optional Battery Bank

6.2.1 Number of batteries - 2 std. - upgradeable to 4

6.2.2 Battery type - 6-Volt, heavy duty, deep cycle (flooded lead-acid, Gel-Cell or AGM - specify)

6.2.3 Energy capacity - 260 Amp Hours nominal - upgradeable to 520 Amp-Hours. Sufficient energy capacity to operate the arrow panel, displaying a single flashing arrow for 30 days, without any energy input from the solar array

6.2.4 Battery / Equipment Compartments

6.2.4.1 Battery / Equipment Compartments shall be constructed of molded HMWPE (High Molecular Weight Polyethylene), color impregnated with Federal Safety Orange with 0.5% UV stabilizer added to prevent fading.

6.2.4.2 Compartments shall be designed to completely contain spills from a failed or damaged battery case.

6.2.4.3 Compartments shall be capable of supporting an operator standing on top of the battery / equipment compartment to service unit.

6.2.4.4 Compartments shall be designed such that the lid automatically latches in the closed position and holds the batteries in place. Lid shall be equipped with a locking hasp capable of being locked in the closed position with a standard padlock.

6.2.4.5 Lid shall be secured to compartment by an integral hinge that permits the lid to be completely removed from the compartment for service.

6.2.4.6 Compartments shall be designed to provide adequate ventilation for the batteries during charging yet prevent the ingress of water during use or transport.

6.2.4.7 Compartments shall be capable of housing two (2) or four (4) BCI Group GC-2 batteries.

### 6.3 Optional Solar Array

6.3.1 Solar array shall remain horizontal in both the travel (down) and the operating (up) positions. Solar array shall erect automatically when arrow panel is raised to operating position.

6.3.2 Photovoltaic module type - Single crystal (monocrystalline) silicon

6.3.3 Number of solar cells per module - 36

6.3.4 Solar array power output - 40 Watts peak

6.3.5 Solar array energy output shall be sufficient to operate the arrow sign, under normal operating conditions, with the solar array in a flat, horizontal position. It shall not be necessary to tilt or rotate the solar array to provide sufficient energy output from the solar array to operate the arrow panel continuously.

6.3.6 Photovoltaic module junction boxes shall be equipped with watertight strain reliefs at all cable entry points.

### 6.4 Wiring and Cabling

6.4.1 All external wire and cable shall be covered with a weatherproof jacket, rated for outdoor use, and secured to trailer frame or superstructure with UV resistant cable ties and anchors.

6.4.2 All wire and cable fittings shall be sealed at bulkheads or enclosure entry points.

6.4.3 All wiring shall be marine grade, multi-strand, tin-plated copper with PVC insulation rated for outdoor use.

6.4.4 All power system wire terminals shall be tin-plated copper to minimize the effects of galvanic corrosion.

6.4.5 Main power wiring shall be 16AWG minimum.

6.4.6 Battery power and solar array power cables shall be equipped with AMP-CPC connectors to mate with the connectors specified in Section 5, Main Control Module.

### 6.5 Charge Controller

6.5.1 Solar power system shall include a solid state charge controller.

6.5.2 Charge controller shall monitor battery voltage and ambient temperature.

6.5.3 Charge controller shall regulate energy flow from the solar array into the battery bank so as to avoid over charging of the batteries and minimize the consumption of electrolyte.

## **7. Documentation**

### **7.1 Operation and Maintenance Manual (Available on CD-ROM and Website)**

7.1.1 Installation and Operation

7.1.2 Maintenance

7.1.3 Service, Repair & Troubleshooting

7.1.4 Wiring Diagrams

7.1.5 Parts Lists & Assembly Drawings

7.1.6 Specifications

### **7.2 Supplement - Truck Mount Specific Documentation**

7.2.1 Configuration Sheet

7.2.2 Wiring Diagram

7.2.3 Assembly Diagrams and Parts Lists

### **7.3 User Guide**

7.3.1 Pre-transport checklist.

7.3.2 Job site setup checklist.

7.3.3 Basic programming instructions.

7.3.4 Basic system status evaluation.

7.3.5 Weatherproof card attached to unit with nylon-coated stainless steel lanyard.

## **8. Maintenance**

### **8.1 Scheduled Maintenance**

8.1.1 SolarArray - Clean with water and mild detergent as needed.

8.1.2 Battery Bank - Check electrolyte level once each month and add distilled water as needed.

### **8.2 Preventive Maintenance**

8.2.1 Battery Bank - Clean and tighten battery electrical terminals.

## **9. Warranty**

### **9.1 Standard Warranty**

9.1.1 Bumper to Bumper - Five (5) full years

9.1.3 LED Lamps - Ten (10) years

9.1.4 Solar Panels - Ten (10) years

### **9.2 Extended Warranty** - Consult factory

## **10. Options**

### **10.1 Battery Charger (for use with optional battery pack)**

10.1.1 Charger type - Switching regulator constant voltage with automatic switch to maintenance or trickle charge.

10.1.2 Input Voltage - 110 VAC 50/60 Hz

10.1.3 Available models with typical recharge times.

10.1.3.1 45-Amp - 20 hours

10.1.4 Battery charger unit shall install in the field with minimum effort.