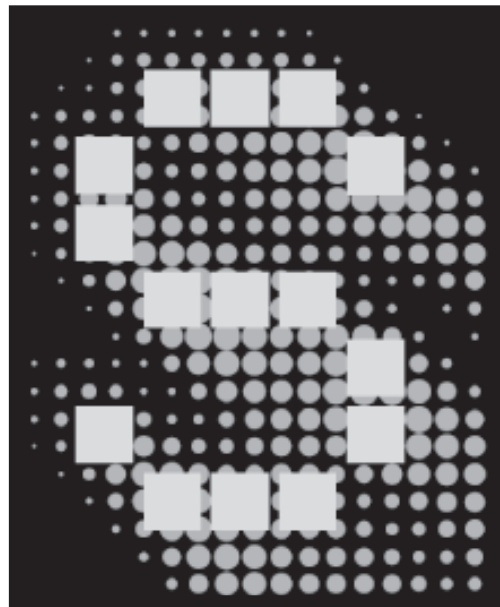


# SILENT SENTINEL *SOL-R-SIGN*<sup>TM</sup>

**SOLAR POWERED  
ADVANCE WARNING (FLASHING) ARROW PANEL**

**PROCUREMENT SPECIFICATION**



***SOLAR TECHNOLOGY, INC.***  
7620 Cetronia Road, Allentown, PA 18106  
Phone: 610-391-8600 Fax: 610-391-8601  
Website: [www.solartechnology.com](http://www.solartechnology.com)

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***Harness the Power of the Sun***

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This document presents a detailed specification for a type-C advance warning (flashing) arrow panel. 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.

P/N 500-525-120

Nineth Edition: 20 December 2007

General email: [info@solartechnology.com](mailto:info@solartechnology.com)  
Technical Support email: [techsupport@solartechnology.com](mailto:techsupport@solartechnology.com)

Web site: [www.solartechnology.com](http://www.solartechnology.com)

## 1. General

### 1.1 Product Description

The **SILENT SENTINEL** is a solar powered advance warning (flashing) arrow panel (FAP). The **SILENT SENTINEL** consists of an arrow display panel, a supporting structure for the display panel, a photovoltaic array, a battery power supply and an electronic control console, all mounted on a heavy duty trailer frame.

### 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 solar power.

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 9001:2008 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**

#### 2.1.1 Length

2.1.1.1 Overall - 100 in. (254 cm)

2.1.1.2 Without tongue - 53 in. (135 cm)

#### 2.1.2 Width

2.1.2.1 Overall - 96 in. (244 cm)

2.1.2.2 Across fenders - 74 in. (188 cm)

#### 2.1.3 Height

2.1.3.1 Sign in transport position - 92 in. (234 cm)

2.1.3.2 Sign in operating position - 134 in. (340 cm)

2.1.4 Ground Clearance, minimum - 13 1/2 in. (34 cm)

2.1.5 Weight - 1,180 lbs. (535 kg)

### **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 towing speed - 70 MPH (112 KPH)

2.2.3.2 Operating position, max. height, outriggers in place - 80 MPH (128 KPH) sustained

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

### **3. Trailer Chassis and Sign Support**

#### **3.1 Trailer Chassis**

##### **3.1.1 Frame Construction**

3.1.1.1 Trailer frame shall be constructed of welded 7 Gauge (3/16-inch) CNC formed steel plate and structural steel tubing with 3 x 3 x 3/16 inch structural steel tubing receiver for the tongue, reinforced and welded to the front crossmember.

3.1.1.2 Trailer shall be equipped with a 2 1/2 x 2 1/2 x 3/16 inch structural steel tubing receiver capable of accepting a standard Class 2 drawbar and hitch pin to accommodate tandem towing. The rear hitch receiver shall be reinforced and welded to a 7 Gauge (3/16-inch) CNC formed steel plate rear cross member. Tandem trailer towing using rear hitch receiver is intended for off road use only and is subject to local laws and regulations!

3.1.1.3 The trailer tongue shall consist of 2 1/2 x 2 1/2 x 3/16 inch structural steel tubing. The tongue shall bolt into the tongue receiver to facilitate easy removal of the tongue for repair, transportation, or security purposes. The trailer tongue shall be equipped with a 2,000-pound minimum capacity swivel-type top-wind screw jack with a formed steel footpad.

3.1.1.4 Trailer frame shall be equipped with tie down points to facilitate securing unit to utility trailer or truck deck for transport.

##### **3.1.2 Suspension**

3.1.2.1 Trailer shall be equipped with an independent suspension, torsion-type axle with a 2,200 pound overall capacity. Axle load capacity shall be set at 1,400 pounds.

3.1.2.2 Axle wheel spindles shall be equipped with spindle bearing caps with grease fittings to accommodate wheel bearing lubrication.

##### **3.1.3 Coupler**

3.1.3.1 Trailer tongue shall be capable of accepting a 2-inch ball coupler, a 2 1/2-inch pintle ring, an optional removable combination coupler (2-inch ball coupler & 2 1/2-inch pintle ring), or an optional adjustable height coupler (2-inch ball coupler and/or 2 1/2-inch pintle ring).

3.1.3.2 Trailer shall be equipped with 1/4-inch safety chains with snap-type hooks for secure attachment to tow vehicle hitch.

3.1.3.3 All coupler and safety chain configurations shall comply with SAE J684 standards for Class II (2) trailers.

##### **3.1.4 Surface Preparation and Finishing**

3.1.4.1 Trailer chassis and superstructure shall be completely cleaned and deburred prior to finishing. All metal surfaces shall be prepared for finishing using an iron phosphate wash-down process.

3.1.4.2 A polyamide epoxy primer shall be applied to a dry film thickness of 2.5 mils.

3.1.4.3 A high gloss federal safety orange aliphatic acrylic urethane finish shall be applied to a dry film thickness of 2.5 mils.

### 3.1.5 Lighting

3.1.5.1 Trailer shall be equipped with sealed flush-mounted combination stop, tail and turn lights.

3.1.5.2 Trailer shall be equipped with a lighted license plate holder.

3.1.5.3 Trailer wiring harness shall be completely sealed and water resistant.

### 3.1.6 Fenders

3.1.6.1 Trailer shall be equipped with unbreakable, molded, solid color, UV-stabilized HDPE (High Density Polyethylene) fenders, completely closed on the inside.

3.1.6.2 Fenders shall be secured to trailer frame with zinc-plated steel thread forming screws and fender washers so as to facilitate easy repair or replacement.

### 3.1.7 Leveling Jacks

3.1.7.1 Trailer shall be equipped with four telescoping jacks consisting of 2 x 2 inch x 12 gauge perforated galvanized steel tubing equipped with a 3 x 3 x 3/16 inch x 6 inch wide steel foot plate.

3.1.7.2 Jack stands shall be inserted into 2 1/4 x 2 1/4 inch x 12 gauge galvanized steel tubing, welded to the trailer frame at a 45 degree angle.

3.1.7.3 Jack stands shall be locked into position by 3/8-inch zinc-plated steel tab lock pins secured to trailer frame by nylon-coated stainless steel lanyards.

3.1.7.4 Jack stands and tongue jack shall be configured such that unit can be set up on jack stands, level, in operating position, with the trailer wheels raised completely off the ground, permitting removal of wheels and tires for additional security.

3.1.7.5 Jack stands shall be configured such that, when in the operating position, they create a footprint of at least 93 inches, front to rear, and 56 inches, side to side, to provide adequate stability of unit in high winds.

### 3.1.8 Tires and Wheels

3.1.8.1 Tires shall be B78-13 Load Range C.

3.1.8.2 Wheels shall be 13-inch x 4 1/2-inch, 5-lug pattern (4 1/2-inch bolt circle), white spoke dress wheel.

3.1.8.3 Wheels and tires shall be sized according to load requirements of trailer and axle.

## 3.2 Arrow Panel Support

3.2.1 Trailer superstructure shall provide complete support of the arrow panel in the transport (down) position. Cantilevered support of arrow panel is not acceptable!

3.2.2 Trailer superstructure shall be completely assembled with removable fasteners to accommodate quick, easy maintenance and repair.

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

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

#### 3.2.5 Arrow Panel Lifting Mechanism

3.2.5.1 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.

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

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

3.2.5.4 Arrow panel shall be secured in the operating (up) position by two stainless steel, spring-loaded, locking pins. Locking of the arrow panel in the down position shall not be required; however, available as an field installable option.

3.2.6 Trailer superstructure shall provide for support and operation of solar array, with solar array positioned to accommodate charging in both the operating and the traveling positions.

3.2.7 Solar array shall fold flat and flush onto back of arrow panel when arrow panel is in the transport (down) position so as to minimize wind resistance without the need for an air deflector or spoiler.

3.2.8 Trailer superstructure shall be equipped with a formed steel upper rear crossmember and formed steel upper side members to reinforce the arrow panel and solar array support frame.

3.2.9 Trailer superstructure shall be equipped with an integral sighting device, welded in place, to accommodate proper alignment of the arrow panel with oncoming traffic, during setup.

## **4. Arrow Panel**

### **4.1 Dimensions**

4.1.1 Width Overall - 96 in. (244 cm)

4.1.2 Height Overall - 48 in. (122 cm)

4.1.3 Depth Overall - 3 in. (7.6 cm)

### **4.2 Construction**

4.2.1 Arrow panel frame, including internal braces, shall consist of 3 x 1 x 1/8 inch extruded 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.

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 700 candela typical, 500 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 12 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 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 and surge protection.

5.1.2 Control module shall be enclosed in a weather resistant, lockable, molded HDPE (High Density Polyethylene) enclosure secured to the trailer chassis.

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 a single control to switch power on and off and to select the desired arrow panel pattern.

5.2.2 Control module shall be equipped with multi-colored 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 0.67 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 Molex Compodre, or equivalent, with a 45-Amp 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, <9 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 Battery Bank**

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

6.2.2 Battery type - 6-Volt, heavy duty, deep cycle

6.2.3 Energy capacity - 300 Amp-Hours nominal - upgradeable to 600 Amp-Hours. Sufficient energy capacity to operate the arrow panel, displaying a single flashing arrow for more than 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 four (4) BCI Group GC-2 batteries.

### **6.3 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 - 50 Watts std. - upgradeable to 75 Watts (peak)

6.3.5 Entire unit shall tilt back and rest on jack stands for fast, easy cleaning and maintenance

6.3.6 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.

6.3.7 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 10 AWG minimum.

6.4.6 Battery power and solar array power cables shall be equipped with Molex, Inc. 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

### **7.3 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 Solar Array - 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 - Full warranty, parts and labor - One year

9.1.2 Electrical and Electronic Components, Control Console - Two years

9.1.3 LED Lamps - Ten years

9.1.4 Solar Panels - Ten years

**9.2 Extended Warranty** - Consult factory**10. Options****10.1 Battery Charger**

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 30-Amp - 20 hours

10.1.3.2 45-Amp - 12 hours

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

**10.2 Combination Coupler**

10.2.1 Combination coupler shall provide for quick easy selection of a 2-inch ball coupler or a 2 1/2-inch pintle ring.

10.2.2 Combination coupler shall provide for the quick, easy removal of coupler and safety chains for additional security.

10.2.3 Combination coupler shall install on front of tongue, secured with 1/2-inch diameter hitch pins locked into place with locking-type (rue ring) pins for maximum safety and reliability.

10.2.4 Combination coupler shall comply with SAE J684 standards for Class II (2) trailers.

**10.3 Adjustable Height Coupler**

10.3.1 Adjustable height coupler shall accommodate hitch heights ranging from 18 to 28 inches.

10.3.2 Adjustable height coupler shall accept a 2-inch ball coupler or a 3-inch pintle ring.

10.3.3 Adjustable height coupler shall install on front of trailer tongue, secured with 1/2-inch diameter hitch pins locked into place with locking-type (rue ring) pins or with 1/2-inch diameter, grade 8 bolts and all metal (stover) lock nuts.

10.3.4 Combination coupler shall comply with SAE J684 standards for Class II (2) trailers.