PORTSMOUTH - KITTERY
16189B

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S P E C I A L P R O V I S I O N

SECTION 677 – INTELLIGENT TRANSPORTATION SYSTEMS (ITS) EQUIPMENT

Solar Power System for ITS Devices

Description

1.1 This work shall consist of furnishing, installing, wiring, and testing solar power systems, support poles, foundations, mounting hardware, and associated equipment at the locations indicated and in conformity with the lines, grades, dimensions and details shown on the Contract Documents, or as directed by the Engineer, all in accordance with these Specifications. The work shall include calculating the power load requirements and furnishing, installing, and testing all ancillary items needed to establish a complete, functional solar power system.

Materials

2.1 General Standards Requirements.

2.1.1 Materials provided for this contract shall comply with the following standards. If no revision date is specified, the most recent revision of the standard applies.

2.1.1.1 Structural Integrity – The solar array support pole and foundation shall be designed and constructed to comply with all applicable sections of the current *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals* with all published addendums.

2.1.1.2 Material Certification – All materials and products shall be manufactured in the United States of America, and comply with applicable *ASTM, AASHTO* and the latest version of the *NHDOT Standard Specifications for Road and Bridge Construction* (NHDOT Standard Specifications) Section 550. Mill test reports and Certificates of Compliance shall be supplied in compliance with the material specifications.

2.1.1.3 Fabricator Qualification – The Fabricator shall have ample experience and shall be qualified and certified in accordance with Section 550.3 the NHDOT Standard Specifications. Proof of qualification will be required.

2.1.1.4 Steel Welding – All steel welding shall be in accordance with the current *AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries and*

Traffic Signals, AWS D1.1 and Section 550.3 of the NHDOT Standard Specifications. All circumferential welded pole and arm splices shall be ultrasonically or radiographically inspected.

2.1.1.5 Electrical Components – All electrical materials shall meet all applicable state, local and public utility codes and requirements as well as the National Electrical Code (NEC).

2.2 Technical Submittal. The Contractor shall provide a complete technical submittal and shall not proceed with manufacturing, fabricating or construction until the Engineer has approved the submittals in accordance with Section 105.02.

2.2.1 Drawings, manufacturer's specifications, and applicable catalog cuts for all materials and components for this work shall be submitted in accordance with Section 105.02. An additional set of final approved documents, to total 6 sets, shall be supplied to the Engineer.

2.2.2 The Department will give no guarantee as to the completeness of the plan details and the Contractor shall be required to furnish, install, and test any other equipment and materials required to provide a complete and operational solar power system.

2.2.3 The submittal for the solar power array support pole shall include the following for approval in accordance with Section 105.02:

2.2.3.1 Design calculations for the support pole signed and stamped by a Professional Engineer licensed in the State of New Hampshire.

2.2.3.2 Manufacturer's specifications and applicable catalog cuts for all materials and components.

2.2.3.3 Complete sets of shop drawings for the pole signed and stamped by a Professional Engineer licensed in the State of New Hampshire.

2.2.3.4 Elevations and dimensions.

2.2.3.5 If not provided with the Contract Documents, the Contractor shall submit cross-section(s) and plan view(s) showing the pole(s) location, the foundation(s) and the proposed slopes plotted on cross-sections showing no interference with utilities, drainage pipes or structures and showing cofferdams with sheeting left-in-place if needed for construction of foundation.

2.2.4 Top of foundation reactions of the preliminary solar array pole design shall be submitted to the Department for the foundation design, in accordance with special provision Section 2.2 *prior* to submittal of the shop drawings or fabrication.

2.2.5 When more than one Engineer is responsible for the design of separate components (i.e. pole, solar array, attachment information), the Contractor shall make one submittal containing all of the components unless otherwise allowed by the Department.

2.3 Solar Power System

2.3.1 The Contractor shall provide a solar panel array and associated equipment to provide the necessary power for all equipment at the ITS Device.

2.3.1.1 The solar power system shall be designed to operate correctly over a free air temperature range of -30°F to +122°F. Solar power system components installed within the ground mounted cabinet shall be designed to operate correctly over a temperature range of -30°F to +165°F.

2.3.1.2 Solar panels and battery storage shall be provided as needed to provide two (2) days, minimum, autonomy under no-light conditions when the batteries are fully charged, and to provide 24 hours per day of operation, seven (7) days per week, 365 days per year with no loss of operation. The Contractor shall submit for approval a solar calculation which demonstrates compliance with this requirement. The solar calculation shall include the manufacturer's specified loads of each piece of equipment to be powered. The solar calculation shall take into account the full required operating temperature range.

2.3.1.3 The batteries shall be sealed AGM type, and shall be spill proof.

2.3.1.4 The battery storage shall be designed such that, after two (2) days of continuous operation under no-light conditions, the batteries still retain at least fifty (50) percent of their full design capacity.

2.3.1.5 The solar panel array shall be of the monocrystalline or polycrystalline type.

2.3.1.6 The mount for the solar panel array shall provide for adjustment of the angle of the face of the solar panels. The Contractor shall adjust the position of the solar panel array in a manner that maximizes solar exposure.

2.3.1.7 The Contractor shall locate the solar panel array in a location that results in no shadows being cast on the solar panels whatsoever at any time of the year. The Contractor shall consider the effects of leaves on trees, regardless of whether or not there are any leaves on trees at the time of installation.

2.3.1.8 A ground mounted cabinet in general accordance to the requirements of Item 677.541 shall be provided for housing batteries and all needed solar system control devices. The cabinet shall meet NEMA 3R environmental requirements. The control devices shall include, but not be limited to charge control circuitry that prevents overcharging of the batteries, low voltage disconnect devices which disconnect the batteries to prevent damage in the event of a very low state of charge, and an inverter that provides 120 VAC power to the ITS device cabinet. The inverter shall provide 120 VAC power with three (3) percent or less total harmonic distortion, and with output voltage regulation of plus or minus five (5) percent or better. The charge control circuitry shall be temperature compensated such that battery charging voltage is automatically

adjusted based on temperature variations so as to maximize battery life. The control devices shall also include a system monitoring device which allows maintenance personnel to assess critical system parameters such as battery condition and solar panel output. The ground mounted cabinet shall include overcurrent protection devices that limit overcurrent in the solar power system to safe levels in the event of a malfunction of the solar power system.

2.3.1.9 The Contractor shall propose a foundation design for the cabinet in accordance with the solar equipment manufacturer's recommendations. The minimum size for the foundation shall be the footprint of the cabinet, plus 6 inches in width and length, with minimum buried depth of 38 inches.

2.3.1.10 The solar power array shall be Underwriter's Laboratory (UL) approved. UL certification shall be provided with the catalog cuts and working drawings in the Technical Submittal.

2.4 Solar Array Support Pole

The solar array support pole and all associated members shall be designed by a NH licensed Professional Engineer and designed and fabricated in accordance with the current *AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals* and *NHDOT Standard Specifications* Section 550, except as noted below:

Basic Wind Speed: 1700-year Mean Recurrence Interval (MRI) basic wind speed of 130 mph (209 km/hr) or as shown in *AASHTO LRFD Specifications, Fig. 3.8-2b*. The maximum-recorded wind speed in this area shall be used as the basic wind speed if it is greater than the basic wind speed of 130 mph (209 km/hr).

Design Life: 50 Years

Fatigue Importance Category: Cantilevered Category I

2.4.1 The pole shaft shall be one-piece construction and shall conform to ASTM A595 Grade A with a minimum yield strength of 55 ksi or ASTM A572 with a minimum yield strength of 65 ksi.

2.4.2 The pole shaft and all associated ancillary members shall be steel, galvanized in accordance with the current *AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals* and NHDOT Standard Specifications Section 550, 2.9.

2.4.3 The solar array support pole shall be designed to support a solar array and all hardware subsidiary to the solar power system necessary to power all devices. The support pole shall be designed for the number of solar panels as indicated by the approved solar power calculations. Close consideration shall be given to the effective projected area of the complete solar power system to be mounted on the pole along with the weight of attached hardware when

designing the pole to meet the performance criteria, including consideration for all possible loading combinations including wind and ice loads; and the design stresses and allowable stresses for all components which comprise the proposed structure.

2.4.4 The calculations shall include a pole, base plate, and anchor bolt analysis. The pole calculations shall be analyzed at the pole base and at 5-foot pole intervals along the full height of the pole. At each of these locations, the following information shall be provided by the Contractor:

2.4.4.1 The pole's diameter, thickness, section modulus, moment of inertia, and cross sectional area.

2.4.4.2 The centroid, weight, projected area, drag coefficient, velocity pressure, and wind force of each trapezoidal pole segment.

2.4.4.3 The axial force, shear force, primary moment, total moment, axial stress, bending stress, allowable axial stress, allowable bending stress, and combined stress ratio (CSR) at each elevation.

2.4.4.4 The pole's angular and linear and angular deflection at each location.

2.4.5 Base Plate: Base plates shall conform to ASTM A36 or A572 Grade 42.

2.5 Solar Array Support Pole Foundation: The solar array support pole foundation will be designed by NHDOT in accordance with the current AASHTO *LRFD Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals* and the NHDOT Standard Specifications. Foundations shall be cast in place. No precast foundations shall be permitted.

2.5.1 Concrete for foundations shall be Class B and shall conform to Section 520 and shall be constructed against undisturbed material.

2.5.2 The foundation shall be placed in a dewatered drilled hole or in an excavated hole using the proper forms.

2.5.3 Anchor rods shall conform to the requirements of ASTM F1554 Grade 55 (minimum). Do not use ASTM A615 reinforcing steel. Galvanize the entire rod per ASTM A153. Each anchor rod shall be supplied with a minimum of two hex nuts (ASTM A563 or ASTM A194) and a minimum of two flat hardened washers (ASTM F436). Lock washers shall not be used.

2.5.4 Structural fill shall conform to Section 508.

2.5.5 Trenches for the conduits shall be hand dug near the proposed footing, disturbing as little soil as possible in placing of the conduits (approximately 2.4 ft. maximum down from the

existing ground surface). The resulting trenches shall be backfilled with structural fill conforming to Section 508.

2.5.6 Where fill embankment is to be constructed above the existing ground, the embankment shall be built prior to constructing the shafts. Placement and compaction of the fill shall be in accordance with Section 203.

2.5.7 All reinforcing steel shall conform to AASHTO M31/ 31M, Grade 60 (420), and Section 544, unless noted otherwise.

2.5.8 If the drilled hole method is performed and the soils are found to be unsuitable, an excavated hole shall be completed as approved by the Engineer.

2.5.9 Grout shall not be used between the opening of the structure base plate and the top of the foundation. The grout on existing foundations have cracked, allowing water and salt to stay in the cracks and not dry out which has led to corrosion of the anchor rods.

2.5.10 A stainless steel standard grade wire cloth (1/4" (6.4 mm) maximum opening with minimum wire diameter of AWG No. 16) shall be installed around the space between the structure base plate and concrete foundation with a 2-inch (51 mm) lap and ¾" stainless steel banding, secured in a manner that will permit its removal for maintenance. The screen is to eliminate debris beneath the base plate, keep animals out and to protect electrical wires if no other base protection is provided.

2.5.11 The top of the foundation should be placed at least 3" (76 mm) higher than adjacent highest soil but not more than 6" higher than adjacent highest soil, unless otherwise specified in the Contract Documents.

2.5.12 The connection of the pole to the foundation shall be a double-nut joint moment connection.

2.5.13 The distance from the top of the concrete footing to the bottom of the pole base plate shall be the nut height plus 1-inch (preferred) or nut height plus the anchor rod diameter (maximum). (Note the nut height equals the rod diameter.)

Construction Requirements

3.1 All solar power system and electrical installations shall comply with the requirements specified herein, state, local and utility codes, and the National Electrical Code (NEC).

3.2 Geotechnical Engineering Services. All Geotechnical services for these items will be provided by NHDOT Materials and Research.

3.3 General Installation Requirements for Solar Power Array Foundation. - See Appendix A of Book 2 - Technical Provisions for additional installation requirements of the support pole, anchor rods and foundation.

3.4 Solar Array Support Pole.

3.4.1 Solar power array poles shall not be placed on the leveling nuts until the foundation concrete has cured for at least seven (7) days or attained a minimum of at least 80 percent of its design compressive strength.

3.5 Grounding and Bonding - The Contractor shall supply and install a grounding system at the base of the solar array support pole. The grounding system shall be connected to the pole through an appropriate ground clamp. A #4 AWG solid copper ground wire shall be installed between the support pole and the battery cabinet providing a common ground system for each terminus. A minimum one-inch conduit through the foundation to the inside of the pole shall provide the means to connect the ground wire from the inside of the pole to the ground rod(s).

3.5.1 Additional ground rods shall be installed to meet the manufacturer's recommended resistance to ground, or a maximum of 25 ohms, whichever is less.

3.6 Guaranties and Warranties.

3.6.1 The Contractor shall unconditionally guaranty all system modules, including all equipment and hardware as specified in the Contract Documents to be free of defects for a period of one (1) year from the date of Final Acceptance of each project site by the Engineer. The guaranty shall cover all materials, equipment, tools, transportation, supplies, parts, and incidentals required to facilitate response maintenance as necessary to repair and replace any defective modules, system(s) or subsystem(s) of the completed facility within the one-year time period. Additionally, the Contractor shall guarantee availability of compatible replacement equipment (to the field replaceable unit level) for a ten year time period from the date of Final Acceptance. Acceptance of any system or subsystem during the construction contract, or any modifications to the system design proposed by the Contractor and approved by the Engineer shall not relieve the Contractor of the requirements of this guaranty. The guaranty period shall be considered to start concurrent with the date of Final Acceptance of each project site.

3.6.2 It shall be the Contractor's responsibility to secure all guaranties that are customarily issued by the equipment manufacturers for the specific equipment included in the system. The form in which such guaranties are delivered to the Contractor shall include the provision that they are subject to transfer to the maintaining agency as named by the Engineer, and shall be accompanied by proper validation of such fact. Transfer of guaranties shall occur at the time of Final Acceptance of the work (or equipment) by the Engineer.

3.6.2.1 The foregoing warranty or guaranty supersedes all other warranties whether written, oral, or implied. This warranty or guaranty provision does not relieve the Contractor of the requirements of any other portion of the NHDOT Standard Specifications.

3.6.3 The terms of guaranties shall be stipulated by the manufacturers of the equipment provided under this Contract when submitting to the Engineer, equipment submittals for construction projects. Terms shall include a specified service performance generally with provisions for repair parts and labor, or for replacement. Provisions shall define the equipment, "installation" date in service for such guaranty to be in effect. For construction projects, the "installation" date shall be the first day of equipment "burn-in". For warehouse purchases, the "installation date" shall be the date of visual inspection approval; not to exceed 10 days after the delivery date.

3.6.4 When a guaranty is available, a written and signed guaranty shall accompany the manufacturer's billing invoice. The Engineer or inspecting agent shall sign and retain the original, and provide a copy to the maintaining agency and a copy to the manufacturer.

3.6.5 The Contractor shall be responsible for repairs during the guaranty period. Repair is defined as all activities that shall be performed for the system to remain in, or return to, operation as specified in the Plans and Specifications. The work consists of the repair of defective devices that fail during the normal course of operation, and does not include repairs or replacements made necessary by damage resulting from vandalism, traffic accidents, or acts of God.

3.6.6 The Contractor shall maintain a log of all response maintenance and repair activities performed during the guaranty period by the Contractor. The log shall be kept in a database management system utilizing NHDOT approved database software, and include, as a minimum, the following information:

Date and time defect reported
Entity reporting the defect
Description of the reported defect
Technician responding to reported defect
Arrival time at the site of the technician
Technician performing defect repair or replacement
Description of observed defect
Corrective actions taken
Model and serial number of any module repaired or replaced
Date and time defect rectified

3.6.7 The Contractor shall maintain records, which show the itemized material, equipment, and labor cost incurred to provide response maintenance during the guaranty period. These records shall be provided to the Engineer on a semi-annual basis within fourteen (14) days after the end of each six-month period. The purpose of this requirement is to provide the Engineer with information to estimate the response maintenance budget needed for the system after the guaranty period. These records will not be used as a Basis of Payment to the Contractor. The Contractor shall assure that these cost records are as complete and accurate as practicable. The Engineer may perform an audit to verify the accuracy of the cost records.

3.7 Concrete shall be constructed in accordance with Section 520. Reinforcing steel shall be constructed in accordance with Section 544.

3.8 Backfill shall be constructed in accordance with Section 209 or Section 508 as called for in the Contract Documents.

3.9 Testing and Training.

3.9.1 The Contractor shall perform testing in accordance with the requirements contained in the Special Provision 677. Testing shall include, but not be limited to, demonstration that the solar power system will properly power the ITS equipment for the required no-light autonomy time, while still retaining the required battery capacity after the completion of the test.

3.9.2 As part of the Contractor's training program for the ITS device, the Contractor shall provide a maintenance program consisting of the furnishing of educational training in the operation and maintenance of the solar power equipment for the ITS device, including hardware.

Method of Measurement

4.1 Solar Power Systems for ITS Devices will not be measured for payment, but shall be subsidiary to the ITS device being powered.