TECHNICAL AND GENERAL BID REQUIREMENTS

The following specifications are similar to those used by several utilities in procuring photovoltaic systems. These specifications help insure the bidders turn in all relevant documents and are aware of expectations should they be awarded the contract.

Each section is split into two parts – a Should Include and a Could Include. Although any portion of these specifications may be deleted or altered, those in the Should section are considered most critical to obtaining the best systems and information. Those in the Could section are additional features to the agreement an organization may want to consider. The words in the *italics that are underlined* are parts of the agreement that should be changed to best suit your organization's needs. Comments in brackets describe a particular option. The term "contractor" refers to those submitting a proposal. The term "Purchasing Organization" refers to the group issuing the RFP.

1. GENERAL INFORMATION

Should Include:

1.1 These specifications cover the procurement of equipment, hardware, documentation, labor and supervision required for the installation of a maximum of *five (5)* nominal *4 kW_p* grid-connected PV systems as part of the *Purchasing Organization* Photovoltaic (PV) project. There will be *no* energy storage devices (e.g. batteries) used in these systems.

1.2 Bids must list all the equipment necessary to complete system installations. In addition, documentation on the design, configuration, installation, *operation and maintenance* of the complete system must be included.

1.3 All systems should be designed for outdoor installation in the *City* area. *Central Florida* is subject to long-term high humidity and temperature conditions. Annual ambient temperatures can range from *30° F to 100° F*. Supplied equipment must be rated and warranted to withstand and operate under these conditions.

1.4 Each PV system will be installed at *site*. The Contractor shall provide *mounting (e.g. free standing, roof-mounting, etc.)* the array in a manner that is acceptable with the *Purchasing Organization*. This structure shall *mounting specifics (e.g. have a 30-degree fixed tilt plane, be mounted parallel to roof, etc.)* to be oriented either to the *South or the West*, as local conditions dictate.

1.5 A total of *five (5) identical 4 kW_p* systems are to be quoted. *Purchasing Organization* estimates these units will be installed within *eighteen (18) months* of award of the contract.

1.6 System complexity adds to the labor and material costs of installing a system. *Purchasing Organization* will consider this factor in evaluating bids.

1.7 Each PV system will be connected to *Purchasing Organization*'s utility electric grid through a grid-interactive power conditioner (inverter). The design and specification of the PV modules, power conditioners, utility interconnections, PV system electrical design, and PV array mechanical design are described in the following sections.

1.8 Contractors should be aware of all the documentation and procedural issues required prior to submitting bid. These are listed below.

1.9 The successful Contractor shall have a Florida Solar Contractor's License and will have taken the course, "Installing Grid-Connected Photovoltaic Systems," conducted by the Florida Solar Energy Center.

1.10 *Purchasing Organization* will incorporate required manufacturer's and vendor's drawings into its as-built drawings for its own records and those of the *owners of the site*. Therefore, all drawings submitted for bid evaluation shall be provided within *three (3) weeks* after the award.

Could Include:

1.11 All drawings will be submitted within *three (3) weeks* in an electronic format that may be imported into AutoCAD drafting software. Proper credit of the source of these drawings will be noted on *Purchasing Organization*'s drawings.

1.12 Supplier may include any value-added services in their quotations, as long as they are not bound to the mandatory portions of this specification.

1.12.1 The Contractor will provide *an option for* an Extended Service Contract, thereby extending labor, technical assistance and routine maintenance. Routine maintenance is defined as the act of making sure the PV system operates properly. This includes changing blown fuses, diodes, or other minor equipment. This does not extend the warranties of factory-warrantied components such as the modules or inverters, but includes any labor required to change out these or other components that fail during the Extended Service Contract.

1.12.2 The Contractor will conduct a routine site visit every *six (6)* months to make sure the system is operating properly. During this visit, the Contractor will conduct tests similar to those made during the original system acceptance test. This includes measurements of short-circuit current and open-circuit voltage. This also includes the instantaneous measurement of DC and AC current and voltage while the system is in operation. Irradiance and module temperature should be taken during all testing procedures. Forms for these tests will be provided by *Purchasing Organization*.

1.13 It is desirable that the system be so designed that, should *Purchasing Organization* choose to do so, a *2 kW_p* array could be constructed and operated using the same PCS and Balance-of-System (BOS) components and half of the modules.

2. PV MODULE AND ARRAY SPECIFICATIONS

Should Include:

2.1 Size of the array *is/is not* a consideration. The PV modules should be framed flat-plate *crystalline/amorphous* silicon modules. Thin- film modules *will/will not* be considered for this project.

2.2 The PV array should be sized to achieve a nominal *4 kW_p* DC STC output for the entire system under peak sun conditions (1000 W/m^2). In general, AC output should be around 70% of the DC kWp rating.

2.3 The PV modules shall meet or exceed the requirements of *Underwriter Laboratories (UL) Standard 1703 Standard for Safety for Flat-Plate Photovoltaic Modules* and either *IEEE Standard 1262-1995 IEEE Recommended Practice for Qualification of Photovoltaic (PV) Modules and Panels* or *IEC 1215 Crystalline Silicon Terrestrial Photovoltaic (PV) Modules- Design Qualification and Type Approval.*

2.4 Each PV module shall include bypass diodes installed in the module junction box.

2.5 Each PV module shall be warrantied by the manufacturer for at least *90%* of its rated power for *10* years and *80%* of its rated power for *20* years from the date of system acceptance. {Though these numbers may be changed, most Manufacturers offer this warranty for crystalline silicon modules which is currently the most commonly used type}

Could Include:

2.6 Modules shall be made in the U.S.A.

2.7 The PV modules' electrical characteristics including current-voltage (I -V) curves and temperature coefficients of module power, voltage, and current shall be characterized by a research laboratory such as the Florida Solar Energy Center, the National Renewable Energy Laboratory, Sandia National Laboratories, or Arizona State University.

3. OTHER COMPONENT SPECIFICATIONS

Should Include:

3.1 The PCS for each system must use *a single/multiple* inverter(s), designed specifically for utility grid interconnection of photovoltaic arrays and be capable of automatic, continuous, and stable operation over the range of voltages, currents, and power levels for the size and type of array used.

3.2 Each PCS shall be compliant with IEEE Std. 929-2000 (Recommended Practice for Utility Interface of Photovoltaic Systems) and have UL1741 (Standard for Static Inverters and Charge Controllers for Use in Photovoltaic Power Systems). The PCS shall also comply with IEEE Std. 519 (Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems) and the latest applicable ANSI and FCC standards and addenda dated prior to the award of the purchase order for this procurement.

3.3 The PCS must have an automatic visual indicator showing whether the system is on-line or not.

3.4 The PCS must have at least a two-year repair or replacement warranty from the manufacturer covering parts and labor.

3.5 The PCS, AC and DC disconnects, and any other required electronics shall be installed near the array, where they may be exposed to weather and possible vandalism. The contractor will provide a suitable *pad-mountable*, lockable enclosure for housing these components. This enclosure shall provide any venting and weather sealing required by the electronics enclosed. All electrical enclosures shall be rated as NEMA 3R or better and have superior strength and corrosion resistance properties.

3.6 Batteries will be used for base *loading/peak-load shaving/back-up power*. {Specify either the number of Wh of power you wish to have or the kind of load you wish to have supplied}. Battery selection *is/is not* constrained by battery size or type. {If either are constraints, specify}

Could Include:

3.7 The aforementioned enclosure (section 3.5) (or an additional enclosure) is to have adequate additional space to house a *Campbell Scientific CR 10 datalogger, power supply and terminal board*. The *space/enclosure* should be *16 inches by 20 inches, and 8 inches deep*. *Contractor/Others* will supply the datalogger and its associated hardware.

4. PV SYSTEM ELECTRICAL DESIGN

Should Include:

4.1 The electrical design and installation instructions for the PV systems shall conform to the 1999 National Electric Code (NFP A 70). Article 690 of the NEC applies specifically to photovoltaic system safety, protection, control and interface with other sources. Other articles of the NEC also apply. The PV system electrical design shall also comply with the IEEE Std. 1374-1998 (Guide for Terrestrial Photovoltaic Power System Safety).

4.2 All electrical components, including overcurrent protection, disconnect, surge suppression devices, conduit, wiring and terminals must have UL or equivalent listing and have appropriate voltage, current and temperature ratings for the application. Special attention should be given to appropriate ratings for components used in DC circuits.

4.3 All wiring shall be listed for a minimum operation of 600 volts and temperature rating of 90° C in wet locations. All current carrying conductors *may/must* be enclosed in conduit, including module interconnections.

4.4 Ampacity calculations must take into account appropriate de-ratings as required. All conductors in the system are subject to a 125% NEC de-rate, and all DC source circuit conductors and overcurrent devices must include an additional 125% de-rate for solar radiation enhancement. Appropriate temperature de-ratings for conductors used in module junction boxes must be considered for peak module operating temperatures, as well as de-ratings for instances where more than three current-carrying conductors are enclosed in a conduit.

4.5 Voltage drop in array DC source circuits should be limited to no more than five percent (5%), including losses in conductors and through all fuses blocking diodes and termination points.

4.6 All overcurrent devices shall have trip ratings no greater than the de-rated ampacity of the conductors that it protects.

4.7 All series connected strings of modules (also known as panels, or source circuits) must include a series fuse as required by UL and NEC to prevent to wiring or other system components. Parallel connections of modules in individual source circuits are not permitted. Parallel-connected cells within individual modules are allowable as long as the module listing allows for the series fuse required for this configuration.

4.8 All series connected strings of modules (source circuits) *may/must* also include a blocking diode to prevent reverse currents. These diodes should have low voltage drop to meet the requirements above, and have a voltage and current ratings (at temperature) at least twice the open-circuit voltage and short-circuit ratings of the source circuits.

4.9 As some of these systems may be installed on the rooftops of dwellings, array ground-fault protection devices should be included as part of the PCS packages as required by the NEC. These devices must be capable of detecting array ground faults, shunting the fault current to ground, and disabling the array until the fault has been cleared.

4.10 All terminations must use listed box terminal or compression type connections. Twist on wire splices, crimped, soldered or taped connections are not permitted for the required field installed wiring. Proper torque specifications should be provided for all of the required field connections.

4.11 All module frames, panel/array support structures, metal enclosures, panel boards and the PCS cabinet should be provided with connections for bonding to a common grounding conductor and terminating at the ground rod at the utility service entrance point. In addition, provisions for grounding the neutral of the PCS output shall be provided. The DC negative circuit may be common to the AC neutral in the PCS design and under no circumstances should multiple connections to ground be specified for current carrying conductors in the system.

4.12 Since distribution panels and location conditions vary, *Purchasing Organization's Utility* will provide the utility service connection for each system, and *Purchasing Organization* will provide watt-hour meter to record the array power and energy performance and disconnect device if one is not included with the PCS. A licensed electrician must make the final connection.

4.13 Loss of Line: The PCS shall not operate without the line voltage present. The PCS shall sense a "loss of line" (utility) condition and shall automatically disconnect from the line. In the event of multiple PCSs and/or balanced load on a common line, the PCS shall contain circuits (such as Sandia Voltage Shift and Sandia Frequency Shift) that will cause the PCS voltage or frequency to drift downwards under loss of line conditions and cause it to cease energizing the grid within two seconds after loss of line. The PCS restart shall occur automatically after restoration of line voltage and frequency for at least five minutes.

Could Include:

4.14 The PCS shall be capable of completely automatic operation, including "wake-up," "sleep" mode and shutdown after loss of utility power. In the automatic mode, the PCS shall monitor the available PV array power and voltage, and when a predetermined amount of power threshold of 200 watts maximum is available and the array voltage is within the normal starting voltage, the wake-up sequence shall be initiated. The PCS shall monitor the AC line voltage and frequency and, when the AC voltage is within the normal operating range (106 to 127 V for nominal 120 V or 212 to 254 for nominal 240 V) and the frequency is between 59.5 and 60.5 Hz, the synchronization process shall be initiated prior to establishing line-tie. The shutdown sequence to place the PCS in "sleep" mode shall not be initiated above 200 watts of array power. The DC power source and/or the AC circuit may remain connected in the "sleep" mode to provide monitoring and instrumentation power during nighttime operation. {The reason this is a Could Include as opposed to a Should Include is that most inverters that fit the other criteria above will also contain these features}

5. PV ARRAY MECHANICAL DESIGN

Should Include:

5.1 The Contractor shall provide the *mechanical hardware* for mounting the photovoltaic arrays. The Contractor shall provide all other hardware required for assembling the photovoltaic modules and panels and structurally attaching them to the *base support structure/roof*.

5.2 The PV array, including modules, hardware and attachments shall be designed to withstand wind loads of *125 mph* or more and comply with all existing local and national codes.

5.3 Array mounting hardware supplied by the bidder should be compatible with the site considerations and environment. Special attention should be paid to minimizing the risk from exposed fasteners, sharp edges, and potential damage to the modules or support structure. Corrosion resistance and durability of the mechanical hardware should be emphasized – the use of stainless steel fasteners and an aluminum support structure is preferred. The use of ferrous metals, wood or plastic components are strongly discouraged. Galvanic corrosion should be avoided.

5.4 As these are high profile, publicly visible installations, the aesthetics of the overall installation is extremely important to *Purchasing Organization*. To create a uniform appearance of the array, spacing between individual modules and panels should be kept to a minimum. As much as possible, all mechanical hardware, conduit, junction boxes and other equipment should be concealed beneath and/or behind the array.

5.5 The array layout should be consistent with the ordering (and labeling) of source circuits in the array combiner boxes. Ease of access for array troubleshooting and maintenance is desired by allowing access to the back of the array for module junction box servicing, and removal/replacement of individual source circuits (panels) and modules if necessary.

Could Include:

5.6 In roof-mounted systems, it is desired that the array is mounted on stand-offs three (3) to five (5) inches off the roof, to allow array ventilation. This prevents excessive temperatures that decrease output and increase module degradation.

5.7 As there may be occasion to install some of these systems on *different rooftops/elsewhere*, the array mechanical hardware shall be designed to attach to *other type of rooftop/other structure*.

5.8 The Contractor shall provide an additional freestanding base structure for other locations equipped with a rigid frame, capable of receiving this same hardware.

6. INFORMATION TO BE SUPPLIED WITH BID

Should Include:

6.1 For the purposes of *Purchasing Organization's* design, conformance to specifications, system features, and bid comparison, the contractor shall supply the *FSEC PV Bid Review Checklist/other checklist*. These sheets shall not be retyped or revised, and must include the minimum information specified. These documents will be used to insure compliance with the technical and general specifications, and will be used in the design review process. These must include (at a minimum) the following information for the bid to be considered responsive:

6.1.1 The bid shall include the total bid price.

6.1.2 The bid shall include the required lead-time in delivery of equipment.

6.1.3 The bid shall include the required documentation package.

6.1.4 A price list for all replacement components, including individual modules and the PCS central unit shall be included. These prices are to remain in effect for one year after the date of acceptance.

6.1.5 Overview of major system components and principles of operation.

6.1.6 Complete parts lists, including all electrical components, mechanical hardware and other equipment required for installing the systems (must include description and make for all the equipment provided, model/part number and source are also required for the PV modules and the inverter).

6.1.7 Diagram indicating proposed layout of entire system, including PV array, and location of BOS hardware and PCS with respect to the array.

6.1.8 Electrical schematics and diagrams showing all major components and devices, including conductor types and sizes, connections of individual modules and array source circuits, terminations at junction boxes, connection to surge suppression devices and the PCS, and the PCS interface with the utility grid.

6.1.9 Mechanical drawings showing details of module/array mechanical support.

6.1.10 Warranty information on individual components as required in this bid document.

6.1.11 Proof of solar or electrical contractors license, with license number, type of license and expiration date.

6.1.12 Proof of successful completion of FSEC authorization exam.

6.1.13 All equipment manufacturer's specifications and *operations manuals*, including those for PV modules, PCS, overcurrent devices, disconnects and optional equipment.

6.2 Designs will be reviewed as part of the bid review process. The drawings and other technical information will be checked for completeness and accuracy. Bidders with insufficient design information may be requested for

additional supporting material or have their bid dismissed outright. A list of criteria that will be checked can be found in the appendix.

Could Include:

6.1.14 Complete assembly and installation instructions for mounting array, junction boxes and enclosures, routing conduit, wiring arrays, and terminating conductors at array, combiner boxes and PCS.

6.1.15 Procedure for commissioning, operating, disconnecting, servicing and maintaining complete system and individual components.

7. INFORMATION TO BE PROVIDED BY CONTRACT AWARDEE BEFORE PROJECT COMPLETION

Should Include:

7.1 The Contractor is responsible for providing two complete copies of all *installation, operations and maintenance manuals*. {Also – any other materials listed above that the Purchasing Organization does not feel obligated to receive during the bid process but may require at a later date}

7.2 The Contractor will provide design, materials, installation, and permitting price information. The materials information will be broken down into four categories: modules, PCS, batteries, and other. These costs should be the costs to *Purchasing Organization*, and not wholesale or distributor costs, and should be similar or identical to those on the parts list mentioned above (Section 6.1.4). In the case of packaged PV systems (e.g. Siemens Earthsafe, AstroPower SunLINE, BP Solar PV Plus, etc.), the materials cost breakdown may not be possible, so the replacement cost of each component should be listed, along with the cost of any miscellaneous materials (e.g. wire, junction boxes, etc.). This information *may/will not* be shared with *utilities/research organizations*.

7.3 As-built diagrams indicating overall layout of entire system, including PV array, and location of BOS hardware and PCS with respect to the array.

7.4 A site survey of the intended array location should be completed before the installation begins. This will help the Contractor determine appropriate equipment locations and give all parties a better idea of the expected performance of the PV system. It is preferable to use the site survey form included in the appendix.

7.5 The *Florida Solar Energy Center/equivalent testing organization* must test the PV modules used in this project before the system is to be installed. The following modules have been tested so far: AstroPower AP 120, BP 585F, BP Solarex MSX64, Siemens SP75, and the Siemens SR100. If any other modules are used, four of them must be brought to the *Florida Solar Energy Center/equivalent testing organization* to receive a module rating.

7.6 A copy of the interconnection agreement between the owner and the utility must be provided, preferably the one provided in the appendix of this document. If the system is owned by the utility, no documentation is required.

7.7 An acceptance test must be performed on the system once the installation is complete. This includes measuring the short circuit currents and open-circuit voltages on all source circuits while measuring irradiance and module temperature. This also includes measuring the instantaneous DC input and AC output of the system to determine its efficiency. The acceptance test form included in the appendix of this document should be completed in its entirety. If the acceptance test is performed by FSEC, no acceptance test is required from the contractor.

7.8 A copy of the permit obtained from the appropriate legal authority for system installation.

7.9 A copy of the *minimum two-year* system warranty including parts and labor.

7.10 Array structural design information sealed by a professional engineer is *desired/required*.

Could Include:

7.11 An end-user agreement between *FSEC/other monitoring body* and the property owner of the PV system installation site. This allows *FSEC/other monitoring body* to inspect and monitor the system over the course of its operation. A copy of the end-user agreement is located in the appendix of this document.

7.12 A copy of the *FSEC PV Rebate Requirement Checklist /Other* shall be completed by the Contractor and turned in to the *Purchasing Organization and FSEC/Other* to signify completion of each task at the end of the project. *Purchasing Organization* may withhold payment to Contractor until all forms required for rebate are completed and received. A copy of the *FSEC PV Rebate Requirement Checklist /Other* may be found in the appendix.

8. PROJECT SCHEDULE

Should Include:

The Owner requires completion of this project by *Date*, based on the following schedule of the award:

Pre Bid Meeting: *Date*
Bids Due: *Date*
Conformed Contract Issued By: *Date*
Construction Completed and New Facilities Put In Service By: *Date*

9. BONDS

Should Include:

The Contractor will be required to provide a Performance and Payment Bond in the full amount of this contract.

10. LIQUIDATED DAMAGES

Could Include:

The Contractor and Owner recognize that time is of the essence of this Agreement and that Owner will suffer financial loss if the Work is not completed within the times specified, plus any extensions thereof allowed in accordance with the General Conditions. The parties also recognize the delays, expenses, and difficulties involved in providing the actual loss suffered by Owner if the Work is not completed on time. Instead of requiring any such proof, Owner and Contractor agree that as liquidated damages for delay (but not as a penalty) in achieving the milestone dates stipulated, Contractor shall pay the Owner the stipulated amount of *$500.00* U.S. for each day that expires after the time specified. {If date of completion is of importance, a liquidated damages clause will help insure the system is completed on schedule}