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NAVFAC PTS-D50 (September 2022)  
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Preparing Activity: NAVFAC SUPERSEDING PTS D50 (December 2018)  
  
PERFORMANCE TECHNICAL SPECIFICATION  
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SECTION D50  
  
ELECTRICAL  
09/22

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NOTE: This section is intended to be used as a guide and contains requirements that are common to fitness centers; however, not all requirements and equipment items will be applicable to all projects. In addition, there may be special requirements for a particular project that are not addressed at all. The RFP preparer may have to incorporate additional information to address these special requirements in this PTS and corresponding Part 3 ESR. If the RFP preparer chooses to delete building elements that are not required for the project, do not change the remaining Uniformat paragraph designations (example - A102001). Uniformat designations are unique to the products they are assigned to. However, the subparagraph numerical extensions (example - 1.2 or a,b,c) of the Uniformat designations may change if subparagraphs are deleted.  
  
This guide specification is formatted utilizing Uniformat II, an industry recognized standard, ASTM E 1557. When the RFP preparer chooses to add a paragraph that does not apply to an existing building element already included in the specification, refer to the Uniformat/WBS located on the NAVFAC Design-Build Website for a listing of Uniformat II designations and definitions.  
  
NOTE: The RFP preparer may view or hide the criteria notes in this PTS section by modifying the WORD preferences for "Hidden text". To view the criteria notes, choose "File" then "Option". Click "Display" then check the "Hidden text" box under "Always show these formatting marks on the screen". In the same section, check the box for "Print hidden text" under "Printing options" to print the criteria notes.  
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NOTE: The Table of Contents is intended for navigation purposes only for the RFP writer and should not show up in the printed document.  
  
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**D50 GENERAL**

RFP Part 3, including the Engineering System Requirements (ESR) provides project specific requirements. The RFP Part 4, Performance Technical Specifications (PTS), provides generalized technical requirements that apply to multiple facility types and include more requirements than are applicable to any one project. Therefore, only the RFP Part 4 requirements that apply to the project and further define the RFP Part 3 project specific requirements are required.

**D50 1.1 NARRATIVE**

This section covers installations inside the facility and out to the five foot line. See PTS Section G40, *Site Electrical*, for continuation of systems beyond the five foot line.

**D50 1.2 ELECTRICAL DESIGN GUIDANCE**

Provide the design and installation in accordance with the following references. This Performance Technical Specification (PTS) adds clarification to the fundamental requirements contained in the following Government Standards. The general requirements of this PTS section are located in PTS Section Z10, *General Performance Technical Specification*.

When all product Quality Control information is included in the Unified Facility Criteria (UFC) and there are requirement options identified in the ESR, then the Uniformat Level 4 titles (and possible subtitles) are included without additional verbiage. One example of this is D501090, OTHER SERVICE AND DISTRIBUTION.

**D50 1.2.1 Government Publications**

UNIFIED FACILITIES CRITERIA (UFC)

|  |  |
| --- | --- |
| UFC 1-200-01 | General Building Requirements(A reference in this PTS section to UFC 1-200-01 requires compliance with the Tri-Service Core UFCs that are listed therein, which includes the following significant UFC(s):UFC 3-501-01, Electrical Engineering) |
| UFC 1-200-02 | High Performance and Sustainable Building Requirements |
| UFC 3-580-10 | Navy and Marine Corps Intranet (NMCI) Standard Construction Practices |

UNIFIED FACILITIES GUIDE SPECIFICATIONS (UFGS)

|  |  |
| --- | --- |
| UFGS 26 23 00 | Low-Voltage Switchgear |
| UFGS 26 24 13 | Switchboards |
| UFGS 26 29 23 | Adjustable Speed Drive (ASD) Systems Under 600 Volts |
| UFGS 26 32 15.00 | Engine-Generator Set Stationary 15-2500 kW, with Auxiliaries |
| UFGS 26 36 23 | Automatic Transfer Switches and By-pass/Isolation Switch |
| UFGS 28 20 10 05 | Electronic Security Systems (ESS) |

**D50 1.3 QUALITY ASSURANCE**

Submit Qualifications, Certifications, and Test Plans indicated herein 45 calendar days prior to the expected date of execution. Notify the Contracting Officer 14 calendar days prior to all testing. Submit test results within 7 calendar days of completion of testing.

The Designer of Record is responsible for approving the submittals listed below.

**D50 1.3.1 Qualified Testing Organization**

Engage the services of a qualified testing organization to provide inspection, testing, calibration, and adjustment of the electrical distribution system and equipment listed in paragraph entitled "Acceptance Tests and Inspections" herein. Organization must be independent of the supplier, manufacturer, and installer of the equipment. The organization must be a first tier subcontractor.

Submit name and qualifications of organization. Organization must have been regularly engaged in the testing of electrical materials, devices, installations, and systems for a minimum of 5 years. The organization must have a calibration program, and test instruments used must be calibrated in accordance with NETA ATS.

Submit name and qualifications of the lead engineering technician performing the required testing services. Include a list of three comparable jobs performed by the technician with specific names and telephone numbers for reference. Testing, inspection, calibration, and adjustments must be performed by an engineering technician, certified by NETA or the National Institute for Certification in Engineering Technologies (NICET) with a minimum of 5 years' experience inspecting, testing, and calibrating electrical distribution and generation equipment, systems, and devices.

**D50 1.3.2 NEC Qualified Worker**

Provide in accordance with NFPA 70. Qualified Workers are allowed to be assisted by helpers on a 1 to 1 ratio, provided such helpers are registered in recognized apprenticeship programs. Submit a certification confirming NEC Qualified Worker requirements.

**D50 1.3.3 Qualified PV Installer**

Installation of photovoltaic (PV) systems must be performed by experienced and trained installers. At minimum the PV installation supervisor must hold a "PV Installer Certification" as issued by the North American Board of Certified Energy Practitioners (NABCEP) and hold a Certified Solar Roofing Professional (CSRP) credential issued by RISE "Roof Integrated Solar Energy Inc".

**D50 1.3.4 Qualified Telecommunications Worker**

All installers assigned to the installation of telecommunications systems or any of its components must be Building Industry Consulting Services International (BICSI) Registered Cabling Installation Technicians or have a minimum of 3 years experience in the installation of the specified copper and fiber optic cable and components. Include names and locations of two projects successfully completed using optical fiber and copper communications cabling systems. Include written certification from users that systems have performed satisfactorily for not less than 18 months. Include specific experience in installing and testing structured telecommunications distribution systems using optical fiber and Category 5e cabling systems.

**D50 1.3.5 Material Standards**

Ensure service support and provide manufacturer's nameplate in accordance with PTS Section Z10, *General Performance Technical Specification*.

**D50 1.3.5.1 Warning Labels**

Provide arc flash warning labels in accordance with UFC 3-560-01, *Electrical Safety, O & M*.

**D50 1.3.5.2 Field-Required Nameplates**

Provide laminated plastic nameplates for each switchboard, switchgear, panelboard, equipment enclosure, motor controller, relay, and switch. Each nameplate must identify the function and, when applicable, the position. Provide melamine plastic nameplates, 0.125 inch (3 mm) thick, white with black center core. Surface to be matte finish with square corners. Accurately align lettering and engrave into the core. Minimum size of nameplates is 1-inch by 2-1/2 inches (25 mm by 65 mm). Minimum size of lettering is 0.25 inch (6.35 mm) high normal block style.

**D50 1.3.6 Factory Testing**

The Government reserves the right to witness all factory testing. The manufacturer must have a calibration program that assures that all test instruments are maintained within rated accuracy.

**D50 1.3.7 Electrical System Startup and Testing**

Submit test plans for approval. Tailor test plans to the systems provided.

As part of the test plan, list make and model and provide functional description of the test instruments and accessories and describe the setup of the tests to be conducted. Test instruments must be capable of measuring and recording or displaying test data at a higher resolution and greater accuracy than specified for the equipment's performance.

**D50 1.3.7.1 Factory Trained Engineer**

Provide a factory trained engineer to supervise start-up and testing as required in referenced specifications.

**D50 1.3.7.2 Performance Verification Testing**

Perform in-service demonstration that all circuits and devices are in operating condition. Tests must confirm that each item of control equipment will function not less than five times. Provide all necessary test equipment, tools, fuel, load banks, labor, and materials for testing. As a minimum, test all systems in accordance with manufacturer's recommendations. Additional testing requirements for the various systems are described with those systems, hereinafter. Assure that all test instruments are maintained within rated accuracy. Dated calibration labels are to be visible on all test equipment.

Submit a separate electrical field test plan in accordance with manufacturer's recommendations and that conforms to NETA ATS for each piece of Electrical Distribution Equipment and System requiring Performance Verification Testing.

The following items identify specific test requirements. Additional test requirements are contained in the applicable UFGS.

a. Panelboards - Field test each GFI and AFI circuit breaker with a UL 1436-certified outlet circuit tester to verify correct operation.

b. Motor control centers – Test motor control centers and motor starters in accordance with NETA ATS.

c. Surge Protective Devices (SPD) -  
  
1) Inspect for physical damage and compare nameplate data with the drawings and specifications, if applicable. Verify from the nameplate data that the SPD equipment is appropriate for the system voltage.   
  
2) Verify lead length between the SPD equipment and the circuit connection is less than one foot.   
  
3) Verify wiring between the SPD equipment and the circuit connection does not include high-inductance coils or sharp bends.   
  
4) Confirm circuit breaker used for SPD circuit connection is sized in accordance with SPD manufacturer's requirements.   
  
5) Ensure SPD equipment is grounded in accordance with SPD manufacturer's requirements. Check the ground lead on each device for individual attachment to the ground bus or electrode.   
  
6) Check tightness of connections in accordance with NETA ATS.   
  
7) For SPD equipment with visual indications of proper operation, verify that it displays normal operating characteristics.

d. Receptacles – Test GFI receptacles with a UL 1436-certified outlet circuit tester to verify correct operation.

e. Lighting - Aim photocell switches and locate light level sensors in accordance with the manufacturer's recommendations. Verify that equipment operates in accordance with user's requirements and in accordance with manufacturer’s recommendations. Fluorescent lamps on electronic dimming ballast control must be burned in at full light output for 100 hours before dimming.

f. Telecommunication - Test telecommunications systems in accordance with applicable EIA/TIA requirements.

g. Public address and intercommunications systems - Tests must include originating and accepting messages at each station, at proper volume levels, without cross-talk or noise from other links or non-designated units. Utilize the phonetically balanced monosyllabic work intelligibility test in accordance with ANSI S3.2 (ASA 85). In order to be acceptable, a score of at least 75 percent must be obtained for each system test.

h. Community Antenna Television Systems - Confirm design and installation is in compliance with NCTA-02, 47 CFR 76.605 and in accordance with FCC proof of performance requirements. Test plan must ensure that the system meets technical, operational, and performance specifications. Test plan must test for signal leakage.

i. Electronic security systems (ESS) – Test ESS in accordance with UFGS requirements.

j. Grounding systems - Test the grounding system in accordance with NETA ATS.

k. Lightning protection - Upon completion of the installation, furnish the UL Lightning Protection Inspection Certificate certified to NFPA 780 for the system.

l. Emergency lighting - Test emergency lighting that is intended for means of egress in accordance with NFPA 101, Section 5-9. Confirm the emergency lighting system operates for a minimum of 90 minutes and emergency illumination satisfies NFPA 101, Section 5-9, specified levels.

m. Building Integrated or Mounted Photovoltaic(BIMPV) System - Start up report including system performance. Compare system performance to expected performance and include at a minimum solar irradiance, DC energy, AC energy, ambient air temperature and PV cell temperature. Measure and report system performance for at least one full day. If the performance monitoring of the installed array indicates the array is not meeting its required performance predictions it must be corrected at the Contractor's expense. Following correction, performance monitoring must again be performed until the array meets required performance predictions. Measurements made under actual installation and temperature must be normalized to Standard Test Conditions(STC).

**D50 1.3.7.3 Acceptance Tests and Inspections**

The Government reserves the right to witness all Acceptance Tests and Inspections, review data, and request other such additional inspections and repeat tests as necessary to ensure that the system and provided services conform to the stated requirements.

The Qualified Testing Organization must provide the Acceptance Tests and Inspections test plan and perform the acceptance tests and inspections. Test methods, procedures, and test values must be performed and evaluated in accordance with NETA ATS, the manufacturer's recommendations, and paragraph entitled "Field Quality Control" of each applicable specification section. Tests identified as optional in NETA ATS are not required unless otherwise specified. Place equipment in service only after completion of required tests and evaluations of the test results have been completed. Contractor must supply to the testing organization complete sets of shop drawings, settings of adjustable devices, and other information necessary for an accurate test and inspection of the system prior to the performance of any final testing. Perform acceptance tests and inspections on Diesel-Electric Generators, Automatic Transfer Switches, and Switchboards and Switchgear.

**D50 1.4 DESIGN SUBMITTALS**

Submit design submittals in accordance with PTS Section Z10, *General Performance Technical Specifications*, Part 2 Section 01 33 10.05 20, *Design Submittal Procedures*, FC 1-300-09N, *Navy and Marine Corps Design Procedures*, and UFC 3-501-01, *Electrical Engineering*.

In addition, UFGS sections listed below or in the body of the PTS text are to be used by the Designer of Record (DOR) as a part of the design submittal. If the UFGS products or systems are applicable to the project, the DOR shall edit these referenced UFGS sections and submit them as a part of the design submittal specification. Edit the specification sections in accordance with the limitations stated in PTS Section Z10, *General Performance Technical Specifications*.

UFGS 26 23 00, *Low-Voltage Switchgear*

UFGS 26 24 13, *Switchboards*

UFGS 26 29 23, *Adjustable Speed Drive (ASD) Systems Under 600 Volts*

UFGS 26 31 00, *Facility-Scale Solar Photovoltaic (PV) Systems*

UFGS 26 32 15.00, *ngine-Generator Set Stationary 15-2500 kW, with Auxiliaries*

UFGS 26 36 23, *Automatic Transfer Switches and By-pass/Isolation Switch*

UFGS 28 10 05, *Electronic Security Systems (ESS)*

**D50 1.4.1 Sustainable Design Submittal**

Submit sustainable design submittals in accordance with Part 2 Section 01 33 29, *Sustainability Requirements and Reporting*.

**D50 1.5 CONSTRUCTION SUBMITTALS**

Submit construction submittals in accordance with PTS Section Z10, *General Performance Technical Specifications*. In addition to the PTS Section Z10 requirements, the Designer of Record (DOR) must approve the following construction submittals as a minimum:

Electrical Equipment, OMSI information for equipment, and Quality Assurance Submittals listed above.

Provide certification that all adjustable protective device settings have been set in accordance with the coordination study for the as-built equipment and configuration.

**D50 1.5.1 Sustainable Construction Submittal**

Submit sustainable construction submittals in accordance with Part 2 Section 01 33 29, *Sustainability Requirements and Reporting*.

**D5010 ELECTRICAL SERVICE AND DISTRIBUTION**

**D501001 MAIN TRANSFORMERS**

Provide pad mounted distribution transformers in accordance with PTS Section G40, *Site Electrical Utilities*.

**D501002 SERVICE ENTRANCE EQUIPMENT**

When a switchboard is required, the Designer of Record must utilize UFGS Section 26 24 13 for the project specification, and submit the edited specification section as a part of the design submittal for the project.

When low voltage switchgear is required, the Designer of Record must utilize UFGS Section 26 23 00 for the project specification, and submit the edited specification section as a part of the design submittal for the project.

When digital metering is required for connection to the Direct Digital Controls (DDC) system, the Designer of Record must utilize UFGS Section 26 24 13 to specify the digital metering requirements and submit the edited specification section as a part of the design submittal for the project.

**D501003 INTERIOR DISTRIBUTION TRANSFORMERS**

**D501004 PANELBOARDS**

Provide panelboards that comply with UL 67 and UL 50. UL 869A applies if used as service entrance equipment. Panelboards for non-linear loads must be UL listed, including heat rise tested, in accordance with UL 67, except with the neutral assembly installed and carrying 200 percent of the phase bus current during testing.

Provide molded case circuit breakers in accordance with UL 489. Ground fault circuit interrupting circuit breakers must comply with UL 943. Arc fault circuit breakers must comply with UL 489 and UL 1699.

**D501005 ENCLOSED CIRCUIT BREAKERS**

Provide molded case circuit breakers in accordance with UL 489. UL 869A applies if used as service entrance equipment. Provide with solid neutral when grounded conductor is present.

**D501006 MOTOR CONTROL CENTERS**

**\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*   
NOTE: Motor control centers should be specified for groups of large motors requiring coordinated control. In other applications, individual controllers or motor control panelboards should be used. Generally, motor control centers should be NEMA Class I, Type B. Coordinate controller specifications and motor requirements with the mechanical equipment specifications.   
\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***

Provide motor control centers that comply with UL 845, NEMA ICS 2, and NEMA ICS 3. Motor controllers must comply with UL 508. Provide disconnecting means capable of being locked out for machines and other equipment to prevent unexpected startup or release of stored energy in accordance with 29 CFR 1910.147.

**D501006 1.1 VARIABLE FREQUENCY DRIVES (VFD)**

When Variable Frequency Drives are required, the Designer of Record must utilize UFGS Section 26 29 23 for the project specification, and submit the edited specification section as a part of the design submittal for the project.

**D501090 OTHER SERVICE AND DISTRIBUTION**

**D501090 1.1 SURGE PROTECTIVE DEVICE (SPD)**

**D5020 LIGHTING AND BRANCH WIRING**

**D502001 BRANCH WIRING**

Provide wiring and connections for special outlets where required.

All homerun circuits must contain no more than 3 phase conductors.

Provide switches that comply with NEMA WD-1 and UL 20.

**D502002 LIGHTING EQUIPMENT**

Install in accordance with manufacturer's recommendations and the additional requirements for "Severe Seismic Disturbance" contained in ASTM E 580. Fixture support wires must conform with ASTM A 641/A 641M, galvanized regular coating, soft temper.

**D502002 1.1 BALLASTS**

Electronic ballasts must include a 5-year warranty.

**D5030 COMMUNICATIONS AND SECURITY**

**D503001 TELECOMMUNICATIONS SYSTEMS**

**D503002 PUBLIC ADDRESS SYSTEMS**

**D503003 INTERCOMMUNICATIONS SYSTEMS**

**D503004 TELEVISION SYSTEMS**

**D503004 1.1 CLOSED CIRCUIT TELEVISION (CCTV) FOR VIDEO TRAINING**

**D503004 1.2 COMMUNITY ANTENNA SYSTEM (CATV)**

**D503005 SECURITY SYSTEMS**

**D503005 1.1 ELECTRONIC SECURITY SYSTEMS (ESS)**

When an ESS system is required, the Designer of Record must utilize UFGS Section 28 10 05, *Electronic Security Systems (ESS)*, for the project specification and submit the edited specification section as a part of the design submittal for the project.

**D503006 INDUSTRIAL CONTROL SYSTEMS (ICS)**

**D503090 OTHER COMMUNICATIONS AND ALARM SYSTEMS**

**D5090 OTHER ELECTRICAL SERVICES**

**D509001 GENERAL CONSTRUCTION ITEMS (ELECTRICAL)**

**D509002 EMERGENCY LIGHTING AND POWER**

**D509002 1.1 EMERGENCY LIGHTING**

**D509002 1.2 EMERGENCY GENERATORS**

When an emergency generator is required, the Designer of Record must utilize UFGS Section 26 32 15.00 for the project specification, and submit the edited specification section as a part of the design submittal for the project.

**D509002 1.3 AUTOMATIC TRANSFER AND BYPASS/ISOLATION SWITCHES**

When an Automatic Transfer Switch is required, the Designer of Record must utilize UFGS Section 26 36 23 for the project specification, and submit the edited specification section as a part of the design submittal for the project.

**D509003 GROUNDING SYSTEMS**

**D509004 LIGHTNING PROTECTION**

When a lightning protection system is required the designer of record must utilize UFGS section 26 41 00 and submit the edited specification section as a part of the design submittal for the project.

**D509005 ELECTRIC HEATING**

**D509006 ENERGY MANAGEMENT CONTROL SYSTEM**

**D509007 PHOTOVOLTAIC ENERGY SYSTEM**

When a photovoltaic system is required, provide a grid tied photovoltaic energy system including roof mounted crystalline photovoltaic panels, combiner boxes, inverters, and support system. The Designer of Record must utilize UFGS Section 26 31 00 for the project specification, and submit the edited specification section as a part of the design submittal for the project.

**D509007 1.1 CODES AND STANDARDS**

The PV system hardware and services must meet or exceed all applicable local, State and utility requirements, conform to the applicable codes and standards, and have passed the listing and qualification tests, listed below. (Comply with the most recent version of each document).

a. IEEE 1262 "Recommended Practice for Qualification of Photovoltaic Modules".

b. PowerMark certification for PV modules.

c. IEEE Standard 928-1986, Recommended Criteria for Terrestrial Photovoltaic Power Systems (PV system performance criteria).

d. IEEE 1547 Standard for Interconnecting Distributed Resources with Electric Power Systems.

e. Underwriters Laboratories 1741 (UL Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources).

f. Underwriters Laboratories 1703 (UL Standard for Listing Photovoltaic Modules).

g. Certification of PV Equipment: All PV modules, inverters, and electrical components must be listed or recognized by an appropriate and recognized United States Safety Laboratory (for example: UL or ETL).

**D509007 1.2 PHOTOVOLTAIC ROOFTOP APPLICATION ANALYSIS**

Provide a comprehensive "Photovoltaic Application Analysis" with a detailed description of system, application, site shading conditions and expected kW output of the rooftop photovoltaic applications. Utilize the Solmetric Suneye or the Solar Pathfinder shading analyzers to analyze the effects of the existing site shading conditions. Analysis must include estimated PV output in kWh per year. Coordinate rooftop application analysis with other equipment that is required to be placed on the roof to determine space available and proper solar orientation for photovoltaic equipment.

**D509007 1.3 TECHNICAL REQUIREMENTS**

The Contractor work responsibilities include at a minimum: system design, equipment selection, and PV system installations. System must be individually capable of providing peak power output of at least proposed PV system size, 208 or 480 volt, 3-phase, 4-wire power.

Configure system to allow automatic operation without operator intervention. Design system and specify equipment to minimize maintenance requirements. System must include metering incorporated with current AMI network (Advanced Metering Infrastructure) and planned energy metering projects.

Locate the inverter(s) disconnects and associated electrical equipment in an area that is accessible, weather-protected, and secure from vandalism and personal injury.

Mount disconnects and over current devices in approved boxes, enclosures, or panel boards. Disconnects and switches must be DC rated when used in DC applications. Bond metal enclosures and boxes to the grounding conductor.

At a minimum, electrical meters must capture the following data on individual system performance (minimum solar irradiance, DC power, AC real power, AC current, AC voltage, and power factor (recommend ION 8600 for AC); ambient air temperature, PV cell temperature, kW, and kWh). This data must be captured at hourly intervals for a minimum one year. Units of temperature, power, and current are to be in Fahrenheit, Watts, and Amps respectively.

Transformers, if required, must have a minimum efficiency based on factory test results of not less than the efficiency indicated in 10 CFR 431, Subpart K, paragraph 431.196(b). Transformers must be housed in NEMA 4X enclosures.

Layout of modules on roof must meet the requirements of NFPA-1 including labeling, roof access, and roof pathways. Coordinate roof venting requirements with fire protection engineer.

Mounting structures must be corrosion resistant to marine environment.

Provide permanent plaque or directory at each building service and power source identifying all other building services and power sources.

Refer to RFP Part 4, PTS B30 *Roofing*for additional layout and installation requirements.

**D509007 1.4 OPERATORS MANUALS AND TRAINING**

Operators manuals for each system component must include detailed instructions on how to operate the system, programming and installation instructions, emergency operating procedures, default program values and set points, listing of field programmed variables and set points, equipment wiring diagrams, product model number, with Name, Address and Telephone number of local representative, and starting, operating, and shut down procedures. Include normal and emergency shut down procedures, schedule of maintenance work, if any, recommended cleaning agents and methods, replacement parts list, including internal fuses, and warranty information.

Provide a formal 2-hour on-site training session instructing operators in the operation and maintenance of the new system, including operation and maintenance of inverters, disconnects and other system components. Instruct personnel in removal and installation of panels, including wiring and all connections. At the time of training furnish, for the equipment specified, operation and maintenance manuals, record drawings and recommended spare parts lists identifying components adequate for competitive supply procurement for operation and maintenance of system.

**D509007 1.5 FIELD QUALITY CONTROL**

Schedule connection of the photovoltaic system with the Contracting Officer such that the Contracting Officer can be present when the photovoltaic system is tied to the grid.

Provide test plan that meets the requirements of IEC 62446. Test plan must include expected values for testing. Provide test results.

Tests must include the following:

a. Verify that non-current carrying metal parts are grounded.

b. Verify that all components are labeled.

c. Verify mounting supports are installed properly, and all fasteners are installed correctly and torqued to manufacturer's instructions.

d. Test open circuit voltage of each string in full sunlight.

e. Test output of inverter. Measure solar irradiance. Perform calculations to show inverter output is consistent with the expected performance.

**D509090 OTHER SPECIAL SYSTEMS AND DEVICES**

-- End of Section --