SECTION 48 15 00
WIND ENERGY ELECTRICAL POWER GENERATION SYSTEM

SPEC WRITER NOTES:
Delete between // --- // if not applicable to project. Also delete any other item or paragraph not applicable in the section and renumber the paragraphs. The spec writer shall review the Physical Security Design Manual for VA Facilities to determine and include in this section any Mission Critical or Life Safety requirements called out.

PART 1 - GENERAL

1.1 DESCRIPTION
A. The requirements of this Section apply to all sections of Division 48 related to wind energy electrical power generation systems.

1.2 RELATED WORK
A. Section 01 00 00, GENERAL REQUIREMENTS: General construction practices.
B. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES: Submittals.
C. Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS: General requirements for commissioning.
D. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: General electrical installation requirements.
E. Section 26 05 21, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES (600 VOLTS AND BELOW): Requirements for current conductors.
F. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for grounding.
G. Section 26 05 33, RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS: Requirements for boxes, conduits, and raceways.
H. Section 26 08 00, COMMISSIONING OF ELECTRICAL SYSTEMS: Requirements for commissioning the electrical system, subsystem, and equipment.
I. Section 26 29 21, DISCONNECT SWITCHES: Requirements for disconnects.

1.3 DEFINITIONS
A. Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, shall be defined in IEEE 100.

B. Unless otherwise specified or indicated, wind turbine generator system terms used in these specifications, and on the drawings, shall be defined in IEC 60050-415.
1.4 QUALITY ASSURANCE

A. Wind Energy Electrical Power Generation System installer(s) shall demonstrate that they have successfully installed at least four projects that, in aggregate, equal or exceed the size of the proposed project. References shall be provided for each of these installed projects.

B. Refer to Paragraph, QUALIFICATIONS, in Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

C. Wind energy device mounting system design shall be provided by the manufacturer or shall be prepared under the signature of a licensed Professional Engineer (PE).

D. Where applicable, such as roof top installations, a licensed PE shall also provide adequate review and structural analysis of the existing structure that will be supporting the proposed wind energy system. Among the documents that shall be submitted by the licensed engineer are environmental loading analyses (including wind, snow and, where applicable, seismic) and substrate’s ability to withstand these environmental forces. In the instance where the wind energy generation device is installed on the ground, adequate information shall be presented to demonstrate the earth’s ability to support the proposed design.

E. If paralleling arrangement is required, the system shall have anti-islanding capability thereby incapable of exporting power to the utility distribution system in the absence of utility power.

F. Submit Wind Energy Electrical Power Generation System data package for the following items:
   1. Troubleshooting guide for wind energy systems
   2. Wind turbine warranty
   3. Operation instructions
   4. Preventive maintenance and inspection data, including a schedule for system operators

G. Wind turbine warranty:
   1. Furnish manufacturer’s five-year warranty against defects in materials and workmanship.
   2. Furnish manufacturer’s warranty with respect to power output.
   3. Wind turbines shall be UL approved.

H. Where applicable, the batteries supplied shall be intended for use in wind energy systems.
1.5 SUBMITTALS

A. Where proposed system shall be a Net Meter project, prepare appropriate applications and submittals to the //Resident Engineer (RE)// //Contracting Officer’s Technical Representative (COTR)//. Where proposed system shall be connected in front of the meter and tied directly to the grid, prepare appropriate applications and submittals to the //RE// //COTR//. In all cases, the local utility may have a requirement for further electrical studies, which may include power factor analysis, short circuit protection studies, grid wiring adequacy or capacities of upstream switches or transformers. If such requirements exist and are required by said utility, these requirements shall be fulfilled by the Contractor.

B. Submit six copies in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES, and with requirements in the individual specification sections, to the //RE// //COTR//.

C. Contractor shall make all necessary field measurements and investigations to assure that the equipment and assemblies will meet contract requirements.

D. If equipment submitted differs in arrangement from that shown on the submittals, provide drawings that show the rearrangement of all associated systems. Approval will be given only if all features of the equipment and associated systems, including accessibility, are equivalent to that required by the contract and acceptable to the //RE// //COTR//.

E. Prior to submitting shop drawings for approval, Contractor shall certify in writing that manufacturers of all major items of equipment have each reviewed drawings and specifications from the applicable other manufacturers, and have jointly coordinated and properly integrated their equipment and controls to provide a complete and efficient installation.

F. Submittals and shop drawings for independent items, containing applicable descriptive information, shall be furnished together and complete in a group. Coordinate and properly integrate materials and equipment in each group to provide a completely compatible and efficient installation. Final review and approvals will be made only by groups.

G. Shop Drawings: Include wind turbine tower and other structural supports such as guy wires, mounting assemblies and related hardware, //wind
turbine control sequences, monitoring instruments and controls, battery back-up systems, interconnections and all other components, parts and pieces required to complete the functioning assembly. Where applicable, include shop drawings for foundations or other support structures.

H. Product Data: Include detailed information for components of the wind energy system.
1. Wiring
2. Wiring Specialties
3. DC-AC Inverter
4. Wind Energy Storage Battery Option
5. Wind Turbines
6. Wind Turbine Supports
7. Instrumentation
8. Switch gear
9. DC and AC disconnects, where applicable
10. Combiner boxes, where applicable
11. Monitoring and control systems, including appropriate interfacing with existing facility data collection systems.

I. Certificates: Submit technical representative’s certification that the wind energy system installation has been implemented as intended by the system designer and where applicable, recommended by the manufacturer.

J. Manufacturer’s Operating Instructions

K. Operation and Maintenance Wind Energy Systems Data Package:
1. Safety precautions
2. Operator restart
3. Startup, shutdown, and post-shutdown procedures
4. Normal operations
5. Emergency operations
6. Environmental conditions
7. Preventive maintenance plan and schedule
8. Troubleshooting guides and diagnostic techniques
9. Wiring and control diagrams
10. Maintenance and repair procedures
11. Removal and replacement instructions
12. Spare parts and supply list
13. O&M submittal data
14. Parts identification
15. Testing equipment and special tool information
16. Warranty information
17. Testing and performance data
18. Contractor information

L. Closeout Submittals:
   1. Posted operating instructions for wind energy system: provide for wiring identification codes and diagrams of wind energy systems, operating instructions, control matrix, and troubleshooting instructions.
   2. Wind energy system verification certificate per IEC 61400.

1.6 APPLICABLE PUBLICATIONS

A. Publications listed below (including amendments, addenda, revisions, supplements and errata) form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

B. American Wind Energy Association (AWEA):
   9.1-09............... Small Wind Turbine Performance and Safety Standard

C. Institute of Electrical and Electronics Engineers (IEEE):
   100-00............... The Authoritative Dictionary of IEEE Standards Terms, Seventh Edition
   519-92............... Recommended Practices and Requirements for Harmonic Control in Electric Power Systems
   1547-03............... Standard for Interconnecting Distributed Resources with Electric Power Systems
   1561-07............... Guide for Optimizing the Performance and Life of Lead-Acid Batteries in Remote Hybrid Systems
   1776-08............... Recommended Practice for Thermal Evaluation of Unsealed or Sealed Insulation Systems for AC Electric Machinery Employing Form-Wound Pre-Insulated Stator Coils for Machines Rated 15,000V and Below

D. International Code Council (ICC):
   IBC-12............... International Building Code

E. International Electrotechnical Commission (IEC):
   60050-415-99......... International Electrotechnical Vocabulary – Part 415: Wind Turbine Generator Systems; Ed 1.0
Wind Turbines – Part 1: Design Requirements; Ed 3.0
Wind Turbines – Part 2: Design Requirements for Small Wind Turbines; Ed 2.0
Wind Turbines – Part 11: Acoustic Noise Measurement Techniques; Ed 2.1
Wind Turbines – Part 12: Power Performance Measurements of Electricity Producing Wind Turbines; Ed 1.0
Wind Turbines – Part 13: Measurement of Mechanical Loads; Ed 1.0
Wind Turbines – Part 14: Declaration of Apparent Sound Power Level and Tonality Values; Ed 1.0
Wind Turbines – Part 21: Measurement and Assessment of Power Quality Characteristics of Grid-Connected Wind Turbines; Ed 2.0
Wind Turbines – Part 24: Lightning Protection; Ed 1.0

F. International Organization for Standardization (ISO):
Wind Turbines – Part 4: Design and Specification of Gearboxes

G. National Electrical Manufacturer’s Association (NEMA):
Enclosures for Electrical Equipment (1,000 Volts Maximum)

H. National Fire Protection Association (NFPA):
National Electrical Code (NEC)

I. Underwriters Laboratories (UL):
Standard for Power-Limited Circuit Cables; Ed 3
Thermoset-Insulated Wires and Cables; Ed 17
Thermoplastic-Insulated Wires and Cables; Ed 14
Standard for Lightning Protection Components; Ed 5
Standard for Specialty Transformers; Ed 13
Standard for Industrial Control Equipment; Ed 17
Busways; Ed 13
Standard for Electric Generators; Ed 1
PART 2 - PRODUCTS

2.1 GENERAL

A. Provide materials to fabricate functioning wind energy system assemblies in accordance with this section. At the Contractor's option, provide factory-prefabricated wind energy equipment packages which include wind turbines, support structure, batteries or other energy storage devices, inverters, and controls which meet the requirements of this section.

B. Wind energy system shall comply with all applicable Federal Aviation Administration (FAA) requirements, including Subpart B (beginning with Section 77.11) of Part 77 of Title 14 of the Code of Federal Regulations regarding installations near airports.

C. The //RE// //COTR// or local environmental entities may require environmental impact studies which may include, for example, effects upon wildlife or noise studies. The Contractor shall determine which entity has jurisdiction over environmental matters and shall make appropriate inquiry and comply with all applicable regulations.

2.2 GROUNDING

A. Shall ground according to manufacturer instructions and the NEC.

2.3 SWITCH/DISCONNECTING MEANS

A. Shall be in accordance with the NEC, as shown on the drawings, and as specified.

B. Means of disconnect shall be UL-listed and shall have suitable enclosures (i.e. NEMA 3R for outdoor installation).

C. Refer to //RE// //COTR// for exact locations.

2.4. WIND TURBINE ELECTRIC SYSTEM CIRCUIT COMBINER BOX:

A. Shall include internal overcurrent protection devices with dead front.

B. Shall be contained in non-conductive NEMA Type 4X enclosure per NEMA 250.

C. Up to 48 volts DC: Shall use DC breakers.

D. Up to 600 volts DC, parallel arrangement: Shall use finger safe fuses instead of breakers.
E. Shall be listed to UL Standard 1741.
F. Where applicable, combiner box shall be a disconnecting combiner box.

2.5. DIVERSION CHARGE CONTROLLER

A. Shall be required to control the battery charging process. Charge controller’s adjusting mechanism shall be accessible only to qualified persons.
B. Shall be equipped with two, reliable, independent means to prevent overcharging of the battery. An interconnected utility service shall not be considered to be a reliable diversion load.
C. Shall be capable of withstanding at least 150% of the maximum power output rating of the small wind electric system.
D. Shall be listed to UL 1741.
E. Shall include maximum power point tracking (MPPT) and temperature compensation.
F. Shall be manufactured in ISO 9001 facility.

2.6 WIRING SPECIALTIES

A. Direct Current Conductor:
   1. If Exposed: Shall use USE-2, UF (inadequate at 60°C [140°F]), or SE, 90°C [194°F] wet-rated and sunlight-resistant.
   2. If in Conduit: Shall use RHW-2, THWN-2, or XHHW-2 90°C [194°F], wet-rated conductors required.
B. Conduits and Raceways:
   1. Shall use solid steel conduit listed per UL 6, UL 1242, UL 797 (as appropriate) except for tracking modules. Weather tight EMT installations shall be allowed for DC wiring in weather protected areas.
   2. Shall use expansion joints on long conduit runs.
C. Weather impacted enclosures: Shall be rated to NEMA 3R or better per NEMA 250.
D. Cable Assemblies and Junction Boxes:
   1. Shall be UL-listed.
   2. Shall be rated IP65 or IP67 per IEC 60529.
   3. Shall be rated to 5VA flammability per UL 94.
E. Prohibited Wiring Materials: Not UL-listed, or listed materials used in unapproved environments.

2.7 DC-AC INVERTER

A. Shall have stand-alone, paralleling arrangement, or combined capabilities.
B. Shall be listed to UL 1741, per IRC M2302.4.
C. Shall comply with IEEE 519 and IEEE 1547.
D. Shall be listed per FCC Part 15 Class A (commercial) or Class B (residential): Unintended radiators.
E. Shall include maximum power point tracking (MPPT) features.
F. Shall include anti-islanding protection if paralleling arrangement is required.
G. Shall have 95% or greater efficiency (with isolation transformer).

2.8 WIND TURBINES
A. Minimum Performance Parameters as per AWEA 9.1.
B. Wind Turbine and System Identification
   1. Main Service Disconnect: per NEC and IFC 605.11.1.3.
   2. Identification Content and Format: per NFPA 70 NEC 694.50.
   3. Identification for DC Conduit, Raceways, Enclosures, and Cable Assemblies: IFC 605.11.1, IFC 605.11.1.4
   4. Identification for Inverter: per NFPA 70 NEC 694.60, inverter shall be identified and listed for the application.
C. Lightning Protection: refer to NFPA 70 NEC 694.40(C)(4).

2.9 BATTERY OPTION
A. General: Adhere to NFPA 70 NEC 480, NEC 694 VIII.
B. Off-Grid: Always use high-quality, industrial-grade, deep-cycle batteries.
C. Grid-Interactive with Battery Backup: Best to use sealed-absorbed glass mat (AGM) batteries specifically designed for emergency standby or float service.
D. Optimize Performance and Life: Follow practices per IEEE 1561.
E. Safety and Ventilation:
   1. Use protective enclosure and proper ventilation per NEC.
   2. Exposed battery terminals and cable connections shall be protected, and live parts of batteries shall be guarded—the batteries shall be accessible only to a qualified person via locked room, battery box, or other container.
   3. Spacing around battery enclosures and boxes and other equipment shall be at least 915 mm [36 inches]; batteries shall not be installed in living areas, or below enclosures, panelboards, or load centers.
4. Prohibited are conductive cases for flooded, lead-acid batteries operating above 48-volt nominal. Battery racks shall have no conductive parts within 155 mm [6 inches] of the tops of cases.

5. To prevent electric shock, storage batteries in dwellings shall operate at less than 50 volts (48-volt nominal battery bank). Live parts of any battery bank shall be guarded.

F. Interconnection:
1. Battery cables shall be a standard building wire type conductor. Welding and automobile “battery” cables (listed and non-listed) are forbidden.

2. Flexible cables, listed for hard service use and moisture resistance, are permitted (not required) from battery terminals to nearby junction box and between battery cells. Flexible, highly-stranded building-wire type cables (USE/RHW and THW) are available. Consult with manufacturer data if battery terminals are compatible with flexible cables.

2.10 WIND TURBINE TOWER

A. Tower shall be of monopole construction to the extent practicable. If monopole construction is not practicable, a wind tower shall be of freestanding construction to the extent practicable. If monopole or freestanding construction is not practicable, a wind tower may be guyed.

B. Shall require a licensed Professional Engineer (PE) stamp on foundation design or other support structure design.

C. Where possible, shall have combiner boxes mounted directly to the tower itself.

D. Tower design shall adhere to IBC 1609 or //RE// //COTR//.

E. Guy wires shall not be required to be connected to an equipment grounding conductor.

F. Guy wires shall incorporate bird deterrent devices as recommended by the U.S. Fish and Wildlife Service (USFWS) or //RE// //COTR//.

2.11 INSTRUMENTATION

A. Charge Controller: See 2.5.

B. Sensors:
   1. Temperature sensor shall be a component in the Maximum Power Point Tracking control system.
2. May install additional data acquisition sensors to measure wind velocity and ambient temperatures. Any additional sensors shall require a conduit separate from the current conductor conduit.

C. Datalogger/Monitoring System: Shall be a packaged system capable of capable of monitoring and logging information of an individual wind turbine.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install the wind energy system in accordance with this section and the printed instructions of the manufacturer and per the NEC. Prior to system start-up, ensure no copper wire remains exposed with the exception of grounding wire in certain circumstances per manufacturer instructions.

B. Wiring Installation: Utilize on site measurements in conjunction with engineering designs to accurately cut wires and layout before making permanent connections. Locate wires out of the way of windows, doors, openings, and other hazards. Ensure wires are free of snags and sharp edges that have the potential to compromise the wire insulation. Ensure breakers in combiner box are in the off position (or fuses removed) during combiner box wiring.

C. Instrumentation: Install instruments as recommended by the control manufacturers. Locate control panels inside mechanical room.

3.2 FIELD QUALITY CONTROL

A. Field Inspection: Prior to initial operation, inspect the wind energy system for conformance to drawings, specifications and NFPA 70. Inspect the following information on each wind turbine:
   1. Manufacturer's name or trademark
   2. Model name or number
   3. Certifying agency label and rating.

B. Tests: Provide equipment and apparatus required for performing tests. Correct defects disclosed by the tests and repeat tests. Conduct testing in the presence of the //Contracting Officer// //QC Representative// //RE// //COTR//.
   1. Operation Tests: Perform tests on electrical systems, in accordance with the manufacturer’s written recommendations.

3.3 FOLLOW-UP VERIFICATION

A. Upon completion of acceptance checks, settings, and tests, the Contractor shall show by demonstration in service that the wind energy
electrical power generation system is in good operating condition and properly performing the intended function.

3.4 COMMISSIONING

A. Connect the wind turbine(s) to the electrical utility grid only after receiving prior approval from the //RE// //COTR// and the utility company.

B. Only qualified personnel shall connect the wind turbine(s) to the utility grid.

3.5 INSTRUCTION

A. A complete set of operating instructions for the wind energy electrical power generation system shall be laminated or mounted under acrylic glass and installed in a frame near the equipment.

B. Furnish the services of a factory-trained technician for one, 4-hour training period for instructing personnel in the maintenance and operation of the wind energy electrical power generation system, on the dates requested by the //RE// //COTR//.

---END---