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.

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies the furnishing, installation, connection, testing and commissioning of wind energy electrical power generation systems.

B. 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 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Requirement for seismic restraint for nonstructural components.//

E. Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS: Requirements that apply to all sections of Division 26.

F. Section 26 05 19, LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES: Low-voltage conductor requirements.

G. Section 26 05 26, GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS: Requirements for personnel safety and requirements for providing a low impedance path for possible ground fault currents.

H. Section 26 05 33, RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS: Requirements for boxes, conduits, and raceways.

I. Section 26 08 00, COMMISSIONING OF ELECTRICAL SYSTEMS: Requirements for commissioning the electrical system, subsystem, and equipment.

J. Section 26 29 21, DISCONNECT SWITCHES: Requirements for disconnect switches.

1.3 DEFINITIONS

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

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 Structural Engineer (PE). 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, hail, 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.

D. If paralleling arrangement is required, the system shall have anti-islanding capability such that it is incapable of exporting power to the utility distribution system in the absence of utility power if stipulated by the utility. Otherwise, islanding may be considered. Paralleling must be approved by serving electric utility. Provide written correspondence from the utility confirming its requirements.

E. 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. All proposals for wind turbines, regardless of whether they are on airport property or not, should be filed as Off Airport Construction filings so they can be processed by the FAA's Obstruction Evaluation Group. Contractor shall familiarize himself with the most current FAA requirements. Contractor is responsible for filing all appropriate paperwork with the FAA and for obtaining all approvals and permitting.

F. Investigate whether the //Resident Engineer// //COR// or local environmental entities 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 inquiries and comply with all applicable regulations.

G. Investigate any other local ordinances that may apply to wind turbine installations in the proposed location.

H. Warranty: The wind energy electrical power generation system shall be subject to the terms of FAR Clause 52.246-21, except that the warranty period shall be as noted for the items below:

1. Wind Turbine: Furnish manufacturer’s 10-year warranty.
2. Inverter System: Furnish manufacturer’s 10-year warranty.

1.5 SUBMITTALS

A. Where proposed system is a net meter project, prepare appropriate applications and submittals to the //Resident Engineer// //COR//. Where proposed system is to be connected before the serving electrical utility’s meter, prepare appropriate applications and submittals to the //Resident Engineer// //COR//. In all cases, the serving electric utility may have a requirement for further electrical studies, which may include or not be limited to 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 the serving electric utility, these requirements shall be fulfilled by the Contractor. Provide written documentation confirming the utility’s approval of the interconnection of the wind energy electrical generation system with the utility system.

B. Submit six copies of the following to the //Resident Engineer// //COR// in accordance with Section 26 05 11, REQUIREMENTS FOR ELECTRICAL INSTALLATIONS.

1. Shop Drawings:
   a. Submit sufficient information to demonstrate compliance with drawings and specifications.
   b. Include electrical ratings, dimensions, mounting details, materials, required clearances, terminations, weight, wiring and connection diagrams, accessories, and nameplate data.
   c. Include shop drawings for towers, foundations, and other support structures, including supporting geotechnical data.
2. Product Data:

a. 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. Switchgear.
   9. DC and AC disconnects.
   10. Combiner boxes.
   11. Monitoring and control systems, including appropriate interfacing with existing facility data collection systems.

SPEC WRITER NOTE: Include the following paragraph for projects in moderate-high, high and very high seismic zones as listed in Table 4 of VA Handbook H-18-8, Seismic Design Requirements.

//b. Certification from the manufacturer that the substations have been seismically tested to International Building Code requirements. Certification shall be based upon simulated seismic forces on a shake table or by analytical methods, but not by experience data or other methods.//

3. Manuals:
   a. Submit, simultaneously with the shop drawings, complete maintenance and operating manuals including technical data sheets, wiring diagrams, and information for ordering replacement parts.
      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. Parts identification
14. Testing equipment and special tool information
15. Warranty information
16. Testing and performance data
17. Contractor information

b. If changes have been made to the maintenance and operating manuals originally submitted, then submit updated maintenance and operating manuals two weeks prior to the final inspection.

4. Certifications: Two weeks prior to final inspection, submit the following.
   a. Certification by the manufacturers of all major items of the wind energy electrical power generation system that the system conforms to the requirements of the drawings and specifications, and that they have jointly coordinated and properly integrated their equipment and controls to provide a complete and functional installation.
   b. Certification by the Contractor that the wind power system has been properly installed, adjusted, tested, commissioned and warrantied. Contractor shall make all necessary field measurements and investigations to ensure that the equipment and assemblies meets contract requirements.
5. Estimated Annual Power Output: Calculate the estimated annual power output, considering annual wind data for the specific location.

C. If equipment submitted differs in arrangement from that shown on the drawings, 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 //Resident Engineer// //COR//.

D. Submittals and shop drawings for independent items, containing applicable descriptive information, shall be furnished together and complete in a group. Final review and approval will be made only by groups.

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 CD-13.....The Authoritative Dictionary of IEEE Standards Terms

519-14.....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-15.....International Building Code

E. National Electrical Manufacturer’s Association (NEMA):

250-14.....Enclosures for Electrical Equipment (1,000 Volts Maximum)

F. National Fire Protection Association (NFPA):

70-14.....National Electrical Code (NEC)

G. Underwriters Laboratories (UL):

13-15.....Standard for Power-Limited Circuit Cables

44-14.....Thermoset-Insulated Wires and Cables

83-14.....Thermoplastic-Insulated Wires and Cables

96-05.....Standard for Lightning Protection Components

506-08.....Standard for Specialty Transformers

508-99.....Standard for Industrial Control Equipment

857-09.....Busways

1004-4-11.....Standard for Electric Generators

1562-13.....Standard for Transformers, Distribution, Dry-Type – Over 600 Volts

1741-10.....Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources

5085-1/2/3-06.....Low Voltage Transformers

H. American National Standards Institute (ANSI):

6006-A03-10.....Design and Specifications of Gearboxes for Wind Turbines

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide materials to fabricate functioning wind energy system assemblies in accordance with AWEA, IEEE, ICC, IEC, ISO, NEMA, NFPA and UL, as specified in this section, and as shown on the drawings.

B. 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 are acceptable.

2.2 GROUNDING

A. Ground the wind energy electrical generation system according to manufacturer’s 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 for the installed environment.

2.4. WIND TURBINE ELECTRIC SYSTEM CIRCUIT COMBINER BOX:

A. Listed per UL 1741.

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

C. Shall be contained in non-conductive NEMA Type 4X enclosure.

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

E. Up to 600 volts DC, parallel arrangement: Shall use finger safe fuses instead of breakers.

F. Where applicable, combiner box shall be a disconnecting combiner box.

2.5 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. All exposed conductors shall be rated for wind turbine applications.

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. Enclosures subject to weather shall be rated NEMA 3R or better.

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.
4. Seal all cable entries from top of junction box. Seal per junction box rating.
5. Verify all connections and integrity of printed circuit boards in all applicable junction boxes.

E. Prohibited Wiring Materials: Not UL-listed, or listed materials used in unapproved environments.

2.6 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.

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).

2.7 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 NEC.
3. Identification for DC Conduit, Raceways, Enclosures, and Cable Assemblies: Per IFC 605.11.1, IFC 605.11.1.4
4. Identification for Inverter: Per NEC, inverter shall be identified and listed for the application.

C. Lightning Protection: Refer to NEC. Special attention should be placed when evaluating and installing the lightning protection system. Consult with manufacturer prior to designing and installing the system.

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

E. Guy wires shall incorporate bird deterrent devices as recommended by the U.S. Fish and Wildlife Service (USFWS) or //Resident Engineer// //COR//.

2.9 INSTRUMENTATION

A. 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.

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

//2.10 DIVERSION CHARGE (DUMP LOAD) CONTROLLER

A. Listed per UL 1741.

B. Shall be required to control the battery charging process. Charge controller’s adjusting mechanism shall be accessible only to qualified persons.

C. 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.

D. Sizes and numbers of diversion charge controllers must be calculated based on the maximum theoretical output of the system. Providing the

proper size and number of controllers is the responsibility of the manufacturer.

E. Shall be capable of withstanding at least 150% of the maximum power output rating of the small wind energy electrical generation system.

F. Shall include maximum power point tracking (MPPT) and temperature compensation.//

//2.11 BATTERY

A. General: Comply with NEC. Flooded lead-acid, captive electrolyte lead acid and nickel-cadmium are acceptable. Consider climate and temperature when selecting battery type. Batteries must be rated for wind turbine applications, so primary batteries are not permitted.

B. Off-Grid: High-quality, industrial-grade, deep-cycle batteries.

C. Grid-Interactive with Battery Backup: 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. Confirm that all terminal connections are properly tightened.
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.//

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install the wind energy electrical generation system in accordance with this section, the manufacturer’s requirements, and the NEC.

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. All cabling shall be mechanically fastened. Ensure breakers in combiner box are in the off position (or fuses removed) during combiner box wiring. Comply with all NEC 70E requirements during installation of wind turbine system.

C. Instrumentation: Install instruments as recommended by the manufacturer.

D. Provide safety signage per NEC at the equipment and any affected panelboards or switchgear.

3.2 FIELD QUALITY CONTROL

A. Field Inspection: Perform in accordance with manufacturer’s recommendations. Prior to initial operation, inspect the system for conformance to drawings, specifications, and NEC. In addition, include the following:

1. Visual Inspection and Tests:
   a. Compare equipment nameplate data with specifications and approved shop drawings.
   b. Inspect physical, electrical, and mechanical condition.
   c. Verify required area clearances.
   d. Verifying tightness of accessible bolted electrical connections by calibrated torque-wrench method, or performing thermographic survey after energization.
   e. Verify the correct operation of all sensing devices, alarms, and indicating devices.

B. Tests: Provide equipment and apparatus required for performing tests. Correct defects disclosed by the tests and repeat tests. Conduct tests in the presence of the //Resident Engineer// //COR//.

1. Operation Tests: Perform tests 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. Comply with the requirements of Section 01 91 00, GENERAL COMMISSIONING REQUIREMENTS.

B. If the system is grid-tied, the Contractor shall coordinate with the serving electric utility to establish an interconnection agreement.

C. Connect the wind turbine(s) to the electrical utility grid only after receiving prior approval from the //Resident Engineer// //COR//, and the utility company.

D. 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 date requested by the //Resident Engineer// //COR//.

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