UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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DIVISION 48 - ELECTRICAL POWER GENERATION

SECTION 48 15 00

WIND GENERATOR SYSTEM

05/17

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Preparing Activity: NAVFAC

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SECTION 48 15 00

WIND GENERATOR SYSTEM
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NOTE: This guide specification covers the requirements for wind generator systems.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

PART 1 GENERAL

1.1 REFERENCES

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 325	(2017) Steel Construction Manual

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16	(2017; Errata 2018; Supp 1 2018) Minimum Design Loads and Associated Criteria for Buildings and Other Structures
ASCE/AWEA RP2011	(2011) Recommended Practice for Compliance of Large Land-based Wind Turbine Support Structures

AMERICAN SOCIETY OF SAFETY PROFESSIONALS (ASSP)

ASSP Z359	(2013) Fall Protection Code

AMERICAN WIND ENERGY ASSOCIATION (AWEA)

AWEA O&M RP	(2013) AWEA Operations and Maintenance Recommended Practices

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE 80	(2013) Guide for Safety in AC Substation Grounding
IEEE 100	(2000; Archived) The Authoritative Dictionary of IEEE Standards Terms
IEEE 142	(2007; Errata 2014) Recommended Practice for Grounding of Industrial and Commercial Power Systems - IEEE Green Book
IEEE 242	(2001; Errata 2003) Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems - Buff Book
IEEE 519	(2022) Standard for Harmonic Control in Electrical Power Systems
IEEE 1547	(2018) Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces

IEEE C2	(2023) National Electrical Safety Code
IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

INTERNATIONAL CODE COUNCIL (ICC)

ICC IBC	(2021) International Building Code

INTERNATIONAL ELECTROTECHNICAL COMMISSION (IEC)

IEC 61400-SER	(2014) Wind Turbine Generator Systems - ALL PARTS

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2023) National Electrical Code

1.2 DEFINITIONS

Unless otherwise specified or indicated, electrical and electronics terms used in these specifications, and on the drawings, are as defined in IEEE 100.

Unless otherwise specified or indicated, wind turbine terms used in these specifications, and on the drawings, are as defined in IEC 61400-SER.

1.3 ADMINISTRATIVE REQUIREMENTS

1.3.1 Pre-Installation Meetings

Comply with Section 01 30 00 ADMINISTRATIVE REQUIREMENTS and hold a pre-installation meeting [no earlier than][1][2][_____] weeks prior to start of installation work.

1.3.2 Scheduling

Provide a delivery and installation schedule to the CO [no later than] [30][60][_____] days prior to start of installation work to allow internal coordination.

1.4 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets

following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force, and NASA projects, or choose the second bracketed item for Army projects.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

****

NOTE: Permits are assumed to be obtained by firm holding design responsibility. Ensure this is clarified in contract bid package.

****

SD-01 Preconstruction Submittals

Commissioning Plan; G[, [_____]]

Commissioning Schedule; G[, [_____]]

SD-02 Shop Drawings

****

NOTE: Submittal is for diagrams and instructions from a manufacturer or fabricator for use in producing the product and as aids to the Contractor for integrating the product or system into the project and prepared by or for the Contractor to show how multiple systems and interdisciplinary work will be coordinated.

****

Shop Drawings, Drawings, Schedules; G[, [_____]]

****

NOTE: Control diagram and software documentation to include software/Contractor's manual, program listing, and applicable hierarchy diagrams. The

software manual must describe the functions for all wind turbine system control and monitoring software and must include all instructions necessary for proper loading, testing, debugging, and operations. Software description must include the following as a minimum: general system descriptions, including control system operating philosophies, sequence of operations, and interface definitions; explanation of program error messages; Data format, entry retrieval, archiving, and trending capabilities.
****

Site Plan Drawings; G[, [_____]]

Riser Diagram; G[, [_____]]

Installation ands Assembly Drawings and Details; G[, [_____]]

SD-03 Product Data

Wind Turbine System; G[, [_____]]

Sample Warranty Certificate; G[, [_____]]

Manufacturer Data Sheet; G[, [_____]]

Submit for all materials to be provided. Submit data sufficient to indicate conformance to specified requirements.

SD-05 Design Data

Wind Turbine System; G[, [_____]]

Towers/Support Structures; G[, [_____]]

Foundations; G[, [_____]]

Visual Impact Analysis & Mitigation; G[, [_____]]

Static Loading and Dynamic Response Analysis; G[, [_____]]

Noise Analysis & Mitigation; G[, [_____]]

Wildlife Impact Analysis & Mitigation ; G[, [_____]]

Groundings System Analysis; G[, [_____]]

SD-06 Test Reports

Work Plan; G[, [_____]]

Factory Test Plan; G[, [_____]]

Factory Tests Report; G[, [_____]]

Functional Performance Testing Results; G[, [_____]]

SD-07 Certificates

Certificate of Completion; G[, [_____]]

Commissioning Agents Qualifications; G[, [_____]]

Seismic Certification; G[, [_____]]

Wind Certification; G[, [_____]]

SD-08 Manufacturer's Instructions

Operations Manuals; G[, [_____]]

System Startup, Shutdown, and Emergency Procedures; G[, [_____]]

Definition and Use of All System, Command, and Application Software; G[, [_____]]

Alarms and Alarm Presentation; G[, [_____]]

Recovery and Restart Procedures; G[, [_____]]

Contractor Commands (Control Consoles, Indicating/Control Panels, and Peripheral Devices); G[, [_____]]

SD-10 Operation and Maintenance Data

Data Package 5

Corrective Maintenance Manuals; G[, [_____]]

Preventative Maintenance Manuals; G[, [_____]]

Recommended Multi-Year Operations and Maintenance (O&M) Requirements Schedule; G[, [_____]]

Special Tools and Equipment; G[, [_____]]

Special tools if required must be identified by part number and function/description.

SD-11 Closeout Submittals

Training Materials; G[, [_____]]

Training Course; G[, [_____]]

Commissioning Report; G[, [_____]]

Decommissioning Plan; G[, [_____]]

Warranty; G[, [_____]]

As-built Drawings; G[, [_____]]

1.5 OPERATION AND MAINTENANCE MANUALS

****

NOTE: Review AWEA website for updated O&M

requirements for wind turbines.
****

Submit Operation and Maintenance (O&M) Data specifically applicable to this contract and a complete and concise depiction of the provided equipment, product, or system, stressing and enhancing the importance of system interactions, troubleshooting, and long-term preventative maintenance and operation in accordance with Section 01 78 23 OPERATION AND MAINTENANCE DATA, Data Package 5. Comply with AWEA O&M RP.

Include manufacturer's standard wind turbine system operations manuals that integrate operational instructions for the installed equipment. The wind turbine system manual must fully describe all wind turbine system operational aspects including, but not limited to:

a. Control and monitoring configuration and instruction.

b. System performance capabilities and equipment specifications.

c. System startup, shutdown, and emergency procedures.

d. Definition and use of all system, command, and applicable software.

e. Alarms and alarm presentation.

f. Recovery and restart procedures.

g. Contractor commands.

h. Detailed step-by-step instructions must be provided for user interfaces, such as control consoles, indicating/control panels, and peripheral devices.

1.5.1 Preventative Maintenance Manuals

Preventative Maintenance Manuals must include as a minimum, the applicable visual examinations, software and hardware tests, and diagnostic routines and resultant adjustment procedures necessary for periodic maintenance of control equipment. Instructions on how to load and use the test and diagnostic program and special or standard test equipment must be an integral part of the manuals.

1.5.1.1 Corrective Maintenance Manuals

Corrective Maintenance Manuals must include as a minimum, detailed logic diagrams and flow charts must also be provided, as necessary, for trouble-shooting analysis and field repair actions. For mechanical items required field repairs, information on tolerances, clearances, and wear limits, and maximum bolt down torques must be supplied. Information on the loading and use of special off-line diagnostic program tools, tests equipment, and any cautions or warnings that must be observed to protect personnel and equipment, must also be included.

1.5.2 Spare Parts

Provide a spare parts list (Data Package 5) and Special Tools and Equipment list required for maintaining total system availability at [95] percent. Parts list must include, as a minimum, part description, recommended quantity, shelf life, storage conditions, manufacturer, model number, and

estimated delivery times. Parts must be identified on a list or drawing in sufficient detail for procurement of any repairable or replaceable part. These parts must be identified by their individual by the industrial, generic part numbers, and must have second source referencing whenever possible.

1.6 QUALITY ASSURANCE

1.6.1 Regulatory Requirements

In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears. Interpret references in these publications to the "authority having jurisdiction," or words of similar meaning, to mean the Contracting Officer. Provide equipment, materials, installation, and workmanship in accordance with the mandatory and advisory provisions of NFPA 70 unless more stringent requirements are specified or indicated.

1.6.2 Qualifications

Provide materials and equipment that are standard products of manufacturers regularly engaged in the manufacture of such products, which are of a similar material, design and workmanship. Standard products must have been in satisfactory commercial or industrial use for 2 years prior to bid opening. The 2-year use must include applications of equipment and materials under similar circumstances and of similar size. The product must have been for sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2 year period.

1.6.3 Drawings

Submit minimum of three hard copies of drawings for government approval prior to manufacturing and equipment construction or integration. Submit Shop Drawings, Drawings, Schedules at a minimum of 11 by 17 inches in size using a minimum scale of 1/4 inch per foot, for the exception of drawings not requiring scale. Submit site plan drawings and Riser Diagram and general design notes at a minimum of 24 by 36 inches. Submit Installation ands Assembly Drawings and Details at a minimum of 24 by 36 inches. Submit installation details at minimum scale of 1/2 inch per foot for overview and 2 inches per foot for detail.

1.6.3.1 Product Drawings

Submit complete detailed product drawings for the wind turbine system consisting of Shop Drawings, Drawings, Schedulesand Manufacturer Data Sheet. Include in the shop drawings [one][three][four] wire diagrams, utility interconnection diagrams, switchboard and switchgear drawings, equipment enclosures, conduits, monitors, meters, and all other accessories associated with the installation of the PV system. Provide equipment dimensions, weights and structural mounting details.

Include nameplate data, size, and capacity of each wind turbine. Include all assumptions such as applicable wind speed, snow and seismic loads. Include applicable federal, military, industry, and technical society publication references.

1.6.3.2 Installation and Assembly Drawings and Details

Submit site plan drawings, Riser Diagram and general notes and Installation ands Assembly Drawings and Details prior to start of construction. Include sufficient drawing detail for all parts of the work to enable the Government to check conformity with the requirements of the contract documents. Include in the site plan drawings: topographic and utility survey; bore logs; soils report; site plan(s); site construction details; structural drawings; structural construction details; site electrical plan; and site electrical construction details. Include in the installation and assembly drawings and details: parts lists; assembly drawings; interconnection wiring diagrams; wire and cable schedules; wire and cable termination schedules; instrument plan; instrument and control wire, conduit and cable schedules; instrument wire and cable termination schedule; control diagrams; control sequence of operation; seismic restraint details; and wind restraint details.

1.6.3.3 "As-Built" and Record Drawings

After completion of construction, submit "As-built" Drawings prepared and certified by the construction contractor, showing in red ink, on-site changes to the original construction details and all underground utilities measured from field benchmarks, accurate to within 1" of centerline of the utility. Immediately record for inclusion into the as-built drawings all modifications to original drawings made during installation. Indicate adequate clearance for operation, maintenance, and replacement of operating equipment devices. Prepare "As-built" Drawings on a minimum of 24 by 36 inches vellum using red ink.

After submittal and approval of "As-built" Drawings, submit Record Drawings, prepared and by the project engineer(s) and architect(s), of the original design drawings reflecting all design changes and contractor noted changes in the "As-Built" drawings.

1.6.4 Factory Acceptance Testing

Prepare Work Plan and Factory Test Plan. Conduct Factory Acceptance Testing during manufacturing of the wind generators as follows:

a. Tower: mil certificate for steel plates, dimensional inspection report, non-destructive test report, coating inspection report, non-conformance reports, inspection certificate from certifying agency;

b. Electrical Parts: generator, wind turbine generator transformer, converter system, and controller;

c. Nacelle: gear box, lubrication system, main shaft installation, yaw drives and system; blade pitch system, cooling system; and major castings.

Prepare Factory Test Reports after completion of testing.

1.6.4.1 Work Plan

Submit [6][_____] copies of schedules of dates for factory tests, installation, field tests, and operator training for the UPS system. Furnish a list of instrumentation equipment for factory and field test reports.

1.6.4.2 Factory Test Plan

Submit [6][_____] copies of factory test plans and procedures at least [21][_____] calendar days prior to the tests being conducted. Provide detailed description of test procedures, including test equipment and setups, to be used to ensure the UPS meets the performance specification and explain the test methods to be used. As a minimum, the test procedures to include the test required under the paragraph entitled "Factory Testing."

1.6.4.3 Factory Tests Report

Submit [6][_____] copies of factory test report within [45][_____] calendar days after completion of tests. Receive approval of test prior to shipping unit. Factory test reports must be signed by an official authorized to certify on behalf of the UPS manufacturer of that the system meets specified requirements in accordance with the requirements set forth in paragraph entitled "Factory Testing". Provide test reports in booklet form tabulating factory tests and measurements performed, upon completion and testing of the installed system. Reports to state the Contractor's name and address, the name of the project and location, and list the specific requirements which are being certified.

1.7 DELIVERY, STORAGE, AND HANDLING

Handle, store, and protect equipment and materials to prevent damage before and during installation in accordance with the manufacturer's recommendations, and as approved by the Contracting Officer. Replace damaged or defective items.

1.8 PROJECT/SITE CONDITIONS

1.8.1 Environmental Requirements

****

NOTE: An initial visual, noise, and wildlife analysis may occur in initial planning stage for site down-select; however, site specific analysis is required for the final site design and selected turbines.

****

The wind turbine system must conform to applicable federal, state, regional, and local regulations regarding visual impact, noise pollution control, and wildlife impact. Perform and submit Noise Analysis & Mitigation, Visual Impact Analysis & Mitigation, and Wildlife Impact Analysis & Mitigation to [Contracting Officer][_____] for review and approval prior to mobilization in accordance with Section 01 57 19 TEMPORARY ENVIRONMENTAL CONTROLS.

1.8.2 Existing Conditions

Location	[_____]
Elevation	[_____] meters [_____] feet above sea level.
Seismic Zone	Site is in ICC IBC
	Seismic Use Group [_____]

Importance Factor [_____]

Temperature Range	[_____] to [_____] degrees C [_____] to [_____] degrees F
Average Humidity	[_____] percent
Lightning	[_____] annual average strikes
Rainfall	[_____] in. mean total annual rainfall

1.8.2.1 Available Utilities

****
NOTE: Early utility interconnect coordination is critical, as is an approved power agreement.
****

Utility power is presently supplied by [utility] from a [_____]kV line transformed down to [_____]kV for local distribution. Coordinate with the utility company for the available fault current value at the new wind farm transformer located at [TBD], and to design the wind turbine system to meet or exceed the available fault current values at the individual wind turbine points of connection (step-up transformer at the base of each turbine).

1.8.2.2 Wind Resource Data

The prevailing wind is from the [compass direction] with average annual wind speeds estimated to be [_____] m/s [_____] mph at [60][_____] meters [197][_____] ft above ground level at the preferred locations for these new wind turbines. Peak 15 minute average wind has been recorded from the [compass direction]at [25][_____] m/s [56][_____] mph. Summary average annual wind data results from past wind resource assessments are included in Attachment 1 of this specification. Validate the site(s) wind resource characteristics and design wind turbine system specifically for site conditions.

Validate the Wind Farm system's components and design parameters with respect to wind loading and survival wind speed. [Additional wind resource assessment data is available upon request.] The wind turbine system will be designed to maintain structural integrity and safe operation under specified environmental conditions, without damage to life or property for the [20][_____] year life of the wind turbine system.

1.8.2.3 Site Equipment Limitations

****
NOTE: Reference any known site limitations, such as bridge weight limitations, height restrictions, etc.
****

Identify and provide any special crane requirements for shipping, off-loading and erection of the wind turbine and its components.

1.9 WARRANTY

Wind turbine system must provide reliable operation, free from breakdowns(not excluding normal maintenance), for the design life of the

wind turbine system[[20][_____] years].

1.10 CERTIFICATIONS

Provide Seismic Certification and Wind Certification, prepared by a licensed professional engineer or National Recognized Testing Laboratory, (NRTL) for all components and assembled systems in accordance with ICC IBC, ASCE 7-16 state and local building codes. Seismic and wind certifications shall demonstrate system shall withstand wind and seismic requirements as installed and remain remain online and functional after a seismic or wind event.

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

The wind turbine system must be furnished as totally coordinated assemblies which, after site installation and testing, shall comply with the design and performance requirements of this specification.

2.2 DESIGN REQUIREMENTS

All materials used in construction must be noncombustible wherever practical, and must be new materials.

Analysis of all required erection equipment loadings (i.e., on gin poles, winches, cranes, cables, earth anchors) must be performed as required for erection and/or maintenance purposes. Reference IEC 61400-SER and wind turbine manufacturer's standards. Provide UV resistant exposed cables and stainless steel cable ties.

2.2.1 General Requirements

General requirements for the wind turbine system includes:

a. The wind turbine system should consist of a [horizontal] [vertical]. axis, upwind active yaw control configurations, with a minimum of three rotor blades.

b. Rotor controls must be supplied to provide an active variable pitch (power/torque) air-foil design.

c. Operational RPM's must be variable, no less than [minus 10][_____] percent to [plus 5][_____] percent of synchronous RPM's.

****

NOTE: 80 meter hub height has been the standard. Newer technology is allowing higher hub heights. Ensure correct hub height is used for specification and permitting.

****

d. Wind turbine hub height of [80][_____] meters [263][_____] feet maximum, due to FAA height and other design issues, and energy production requirements.

e. Rotor diameter of [_____] meters [_____] feet minimum to [_____] meters [_____] feet maximum.

f. Low-voltage ride-through capability (see IEEE draft standard and/or European REE and EON grid code requirements.)

g. Reactive power support capability of [0.96][_____] inductive to [0.98][_____] capacitive power factor range, or approved equal.

2.2.2 Controls

The wind turbine controls will utilize standard "soft start" technologies to minimize the impact to electrical power systems. The design must include active power factor and load leveling controls to help reduce the need for supplemental active VAR control and to stabilize and/or minimize the system frequency/power changes due to wind variability respectively. The design requirements for the wind turbine subsystem components must be as described below.

2.2.3 Enclosures

All wind turbine equipment, controls, terminations, etc., supplied with the wind turbine system, which are intended to be located outside the nacelle, must be located in NEMA 12 (or equal) gasketed minimum rated enclosures for improved corrosion and environmental protection. If temperature control is required within the wind turbine control enclosures, provide all equipment, devices, and controls necessary to maintain the required temperature.

2.2.4 Rotors

Wind turbine rotors must consist of nonmetallic composite airfoils of a design resistant to abrasion related efficiency losses and must be non-EMI conductive/reflective. The rotor design must be optimized to provide maximum wind turbine output performance based on the specific wind regime characteristics[given in the supplied wind data]. Further, the rotor controls must be designed to provide a minimum of one level of safety beyond the primary systems.

2.2.5 Reduction Gear Assemblies

High-efficiency, reduction gear assemblies (if required) must be supplied that are designed for low temperature rise, low levels of vibration, long life, and low noise emissions. Further, the gear assembly designs must provide reliable operation, free from breakdowns (not excluding normal maintenance), for the design life of the wind turbine system[([20][_____] years)].

2.2.6 Bearings and Seals

The drive train must utilize tapered roller bearing technology, wherever possible, to maintain parallelism and axial tolerance of the drive train during all operating conditions.

Maintenance-free sealing must be installed on all shafts to prevent leaking of gear lubrication and intrusion of dirt and dust.

2.2.7 Foundations

Determine soil and foundation load requirements and comply with applicable requirements of ASCE/AWEA RP2011.

2.2.8 Towers/Support Structures

The tower must be a free-standing construction consisting of tubular steel (or approved equal), with provisions for safely climbing and servicing the turbine. The tower must be provided with a catwalk or maintenance platform just below or within the turbine to provide for turbine servicing as per manufacturer's standard design. Determine proper height of tower assembly for optimum operation of the wind turbines. Tower construction using self erecting crane systems are encouraged, and should be considered in cases where the height limitations of the installation may severely limit the performance of the offered system. Establish and maintain all precautions with regards to wind turbine installation and safeguarding the cranes for all possible wind conditions. Comply with IEC 61400-SER, ASCE/AWEA RP2011, and wind turbine manufacturer's standards.

All tower components including, but not limited to, or tube elements, anchors, supports, rails, ladders, etc., will be of a corrosion resistant steel construction, or coated with certified [10]-year surface coatings as per Section 09 90 00 PAINTS AND COATINGS.

2.2.8.1 Wind Ratings

The wind turbine system must be capable to withstand winds of Category [1][2][3][4] or [5] as defined by the Saffir-Simpson Hurricane Wind Scale. Provide wind certifications for all components and assemblies.

The tower assembly (and all associated components subject to fluctuating/cyclic loading) must be designed to withstand all operating conditions for the specific wind region characteristics based on, but not limited to, the supplied wind data. Static loading and dynamic response analysis must be submitted for review, for all loads imposed on the wind turbine system. The analysis must also include all required erection equipment loadings (i.e., on gin poles, winches, cranes, cables, earth anchors), as required for erection and/or maintenance purposes.

2.2.8.2 Seismic Ratings

All structures and structural elements must be suitable for Seismic Design Category [_____] in accordance with ICC IBC, ASCE 7-16, and all other applicable building codes and standards pertaining to the erection of such structures.

All bolted connections must meet AISC 325 standards for loading and torque specifications.

2.2.9 Brakes

A brake system, active yaw control, and/or airfoil system, in combination with brakes, must be supplied as required to support:

a. Manual shutdown during design wind conditions;

b. Over-speed shutdown;

c. Parking for maintenance; and

d. Loss of electrical grid power during rated wind operations.

Main shaft type braking is the preferred technology, although other types

of technologies are not excluded provided they can be shown to meet the functional and performance requirements defined herein. The braking system must provide maintenance-free braking operations for a minimum of five years (i.e., no new brake pads), with significant use of pitch and yaw controls to minimize braking requirements. The braking system must be configured to prevent any type of runaway conditions that could exist whether grid power is available or not. The braking system must be capable of providing sufficient braking force for parking, normal stopping, and emergency stopping of the wind turbine system, as described below. A braking system other than those described below may be submitted for "or equal" substitute based upon performance.

2.2.9.1 Parking Brakes

A parking brake must be supplied capable of preventing rotor rotation at wind speeds up to the survival wind speed and/or as required for maintenance support, and capable of being used when there is no power.

2.2.9.2 Normal Stopping Brake System

A normal stopping brake system (or equal) must be supplied to dissipate the kinetic energy of the rotating machinery at the design over speed condition, while suffering no irreparable damage. The braking system must include fail-safe automatic operational mode in the event of a power out condition (i.e., loss of utility power while operating at rated wind speed).

2.2.9.3 Emergency Brake

An emergency brake must be supplied that is designated to meet the same requirements of the normal stopping brake above. In addition, upon activation, the emergency brake must alarm and require manual resetting prior to resuming automatic operation of the wind turbine.

2.2.10 Electrical Systems

Perform an independent stability and reliability study with a focus on determining the impacts to the installation's site facilities. Operate the wind-farm in strict adherence to IEEE 519 guidelines for controlling voltage, current, and harmonic distortions. Operate the wind-farm with all the power conditioning equipment necessary to maintain a stable power factor. Operate the wind-farm in a manner that does not diminish the capacity of existing installation facilities. Operate the wind-farm with appropriate controls and equipment that will automatically separate the wind-farm from the installation, or the installation and the Utility so that installation's site operations are not compromised in the event of equipment, and/or system failures. Operate the wind-farm with standing agreements cooperating jointly in maintenance processes and procedures.

2.2.10.1 Equipment

All generators, motors, and related electrical systems must meet the requirements of NFPA 70, IEEE C2, and/or IEC requirements for all construction. Wind turbine generators must be high-efficiency, continuous rated machines, with a minimum of Class F insulation and temperature rise. The generator efficiency will be a minimum of 90 percent for all loads greater than 10 percent of rated load. The generator must include embedded temperature protection with solid state sensors.

2.2.10.2 Power Distribution

Isolation breakers must be provided for key system assemblies to facilitate maintenance without interruption operation of other wind turbine systems. All fuses, circuit breakers, power supplies/regulators, and line conditioners necessary for wind turbine operations within the specified service conditions must be provided for all wind turbine equipment and assemblies. Power to the wind turbine control and monitoring subsystems must be distributed from a central point within one of the wind turbine system cabinets located within each nacelle. Voltage and current requirements must be identified and documented in the submittals to facilitate the design and transformer sizing.

2.2.10.3 Overcurrent Protection and Disconnect

A [circuit breaker][switch] must be installed as the primary means disconnecting the wind turbine incoming power cables/lines from the wind turbine system. The [circuit breaker][switch] must be capable of being locked in the open position and located conveniently for maintenance and operating personnel. The rating of the [circuit breaker][switch] must be sized per NFPA 70 for the maximum rated load current expected at the wind turbine. All electrical equipment supplied must be rated or protected to withstand and/or interrupt (without damage) the maximum available fault current expected at the point of connection to the wind turbine system. The fault current available at the wind farm site is initially estimated at approximately [_____] kAIC symmetrical at [_____] kVAC at each tower base, to be more closely determined during wind farm electrical modeling and design.

2.2.10.4 Step-up Transformer

A step-up transformer may be required and must be provided by others if the wind turbine output does not match the planned collector/distribution system voltage of [34.5][_____] kV (where the turbine is to be interconnected), or if the planned system is not suitable for the wind turbine standard design requirements. Modify as appropriate for step-up transformer requirements in accordance with Section 33 73 00.00 40 UTILITY TRANSFORMERS.

2.2.10.5 Surge Suppression

External power input connections must be surge protected against IEEE C62.41Category B transients.

2.2.10.6 Harmonics

The wind turbine generated harmonics measured at the wind generator system ac output must not exceed the levels required to conform with IEEE 519.

2.2.10.7 Grounding

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NOTE: The possible exposure to a corrosive environment should be carefully examined. Even when the correct conductor size and the selected joining (connecting) method have satisfied all the IEEE 837 test requirements, it may be prudent to choose a larger conductor size to compensate for some gradual reduction in the conductor cross section during the

design life of the installation where the soil environment tends to promote corrosion. Coordinate soil environment with Geotechnical Engineer.

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Grounding must conform to NFPA 70, IEEE 80, IEEE 142, IEEE 242 and IEEE C2, except that grounds and grounding systems shall have a resistance to solid earth ground not exceeding 5 ohms. Provide ground grid for maximum permissible touch and step voltages as per IEEE 80.

Provide inner ring electrode around the foundation and bond it through the foundation to the turbine tower. Provide additional ring electrodes of gradually increasing depth and diameter in order to reduce touch and step voltages at the edges of the system. Provide a Groundings System Analysis.

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NOTE: The possible exposure to a corrosive environment should be carefully examined. Even when the correct conductor size and the selected joining (connecting) method have satisfied all the IEEE 837 test requirements, it may be prudent to choose a larger conductor size to compensate for some gradual reduction in the conductor cross section during the design life of the installation where the soil environment tends to promote corrosion. Coordinate soil environment with Geotechnical Engineer.

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2.2.10.8 Equipment Labeling

Install permanent labels on all major switches, controls, electrical panels, cabinets, disconnects, motor starters, major equipment, or components. Weatherproof labels must be either laminated black phenolic plastic with white engraved letters, or engraved (or embossed) stainless steel nameplates. Lettering for panels and equipment must be minimum [12][_____] mm [1/2][_____] inch high. Labels must be permanently installed by gluing or screwing to equipment covers. Labels must show panel or load name and circuit fed from.

2.2.10.9 Power Factor (PF) Correction

Active pf control must be installed as a integral portion of each wind turbine electrical system, and must include control provisions to maintain a minimum power factor of [0.95][_____] at rated load (adjustable range of 0.9 to 1.0). Additional (supplemental) pf correction equipment utilizing capacitor technologies is not excluded (i.e. must be integrated and cannot be included in lieu of active pf control); however, the capacitors must incorporate provisions for disconnection and safe controlled bleed off of electrical energy to support safe maintenance, as required.

2.2.11 Control and Monitoring Systems

Wind turbine control and monitoring system electronics (both local and remote) must be microprocessor-based, provide control of all critical functions, and include (but not be limited to) fail-safe automatic shutdown in the event of any component malfunction, rotor over speed condition, or excess vibrations. The system must be designed with on-line diagnostic capabilities to allow technicians to trouble-shoot subsystem problems down to the module or board level. Provide controls for manual

and automatic indicated wind turbine starts. Contractor control panels will be supplied both at ground level and within the nacelle control compartment; and each will be equipped with all the vendor standard control switches, indicators, and metering necessary to support normal wind turbine operations. In addition, the Contractor panel(s) will include a serial communications interface or Ethernet port to communicate directly to the wind turbine microprocessor control system via[IBM][_____] compatible, portable laptop computer.

The wind turbine control system must provide normal operations monitoring to start and stop the wind turbine based on available wind, and to support automatic shutdown in the event an abnormal operating condition occurs. Automatic shutdown must be provided for the system failures identified above as a minimum.

2.2.11.1 Control System Modularity

All system controls and indicators must be solid state, modular, plug-in construction, so that any module may easily be removed from the system and replaced without breaking or making solder type connections. Subassemblies and modules performing identical functions must be interchangeable without making wiring changes. The number of types and sizes of modules must be kept to a minimum, in order to reduce the extent and cost of required spare parts.

2.2.11.2 Variable Speed/Load Leveling

To maximize reliability, impact on energy security, and reduce life cycle costs, the wind turbine generator control systems are preferred that include active variable speed technologies (variable rotor, pitch, and/or rotor-generator speeds) and active machine damping to reduce/limit peak torque effects due to wind gusts and/or grid supply fluctuations.

2.2.11.3 Assembly Wiring

Internal assembly wiring, including jumpers, must be color coded or permanently labeled using heat shrinkable, sleeve type markers[[Brady B321][_____] or approved equal,] as indicated on system schematics. Label identifications must be typed or printed. Wiring terminal strips must be provided and clearly identified for all equipment. Power and signal terminal strips must be separated. Provide [20][_____] percent spare terminals for all electrical connections where possible.

Label all furnished cables, cable terminations and connections. Cables and connections must be located in easily accessible areas. Signal and power wiring must be routed in separate bundles and kept separate by providing separate terminal blocks and connectors. Wires must be terminated using calibrated crimp ring lugs. Internal wiring and cabling must conform to NFPA 70 and IEC 61400-SER.

2.2.11.4 Ground Level Controls

Provide a standard ground level control panel(s) with the following functional characteristics as a minimum:

a. Allow local manual isolation of, or set it in a safe maintenance mode for, the wind turbine unit both from the normal power supply and from remote Contractor initiated controls to support safe maintenance activities.

b. Allow local ground level manual controls to initiate shutdown of the wind turbine system.

c. Supplied to allow the Contractor to access the standard diagnostic functions, provide software and interface to allow direct connection of a portable, laptop computer to directly access the master microprocessor system (or control interface/PLC, etc.).[The new system must be capable of being integrated with (i.e., interface directly to), and/or be an extension of, the existing wind farm monitoring and control system.]

d. Allow ground level monitoring (without the need of the serial communications interface) of the following status and metered functions as a minimum (or equivalent functions):

(1) Discrete indicators (lights or approved equal),

(a) Wind turbine system READY,

(b) Wind turbine system FAULT,

(c) Wind turbine system ON LINE;

(2) Meters/selectable Liquid Crystal Displays (LCDs) (for approval);

(3) Grid Voltage,

(a) Line to Line volts - Phases AB, BC, and CA;

(4) Wind turbine output power,

(a) Kilowatts and kilowatt hours;

(5) Power Factor,

(a) Percent PF showing 0.5 - 1 - 0.5 (both leading/lagging);

(6) Rotor RPM;

(7) Pitch monitoring for active pitch turbines;

(8) Manual start/stop;

(9) Emergency stop (latching mushroom head switch with shield);

(10) Automatic and emergency shutdown indicators (lights or approved equal) with shutdown/manual reset; and

(11) Local/remote selector.

2.2.11.5 Remote Monitoring and Control Work Stations

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NOTE: Review Agency network security requirements if an Agency remote terminal is desired.

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Wind farm remote monitoring and control (SCADA) workstations are to be

installed at the remote facilities/rooms as shown in the contract drawings as part of the wind farm/turbines project. The remote monitoring system must include two desktop computers, with modems, running Windows operating systems, and interfacing with the wind turbines using standard turbine manufacturer's supplied software. The new wind turbines must have remote control and monitoring software installed on the wind turbine workstations, and must be able to be accessed via fiber optic connection to support internet access through the SCADA computer for monitoring and reporting of Wind Farm power production. The workstations must be able to access the wind turbines for remote monitoring and control via fiber optic cable system. No DOS based software allowed in the installation of the new systems.

The new wind turbines must also have communications accessibility via dedicated external fiber optic cable, DSL connection, satellite connection, or other for manufacturer's warranty purposes, depending on the requirements of the wind turbine manufacturer. Determine, supply and define the SCADA system, for the Installation Contractor to install, to support the above wind turbine communications and monitoring hardware and software (Procure the fiber optic cable and related components). Provide Definition and Use of All System, Command, and Application Software.

2.2.11.6 Local Nacelle Monitoring and Controls

Provide manufacturer's standard wind turbine system monitoring, controls, and alarms within the nacelle/base at the Contractor control panel with ability to remote monitor as required. All controls, meters, LCD displays, etc., must be located within NEMA 12 (or equal) gasketed enclosures. The nacelle Contractor panel will include service switches to prevent the operation of the turbine from the base control panel when service personnel are in the nacelle, as well as the basic Contractor functions identified in subparagraph, GROUND LEVEL CONTROLS of this section. In addition, system failures, malfunctions, and/or warning indications must be provided as identified below (as a minimum):

a. Loss of enclosure cooling (if cooling is required);

b. Under/over voltage;

c. Under/over frequency;

d. Out of phase sequence;

e. Phase current unbalance;

f. Excess vibration;

g. Generator problem,

(1) Generator excess power,

(2) Generator over current,

(3) Generator over temperature,

(4) Generator over speed,

(5) Generator cooling failure;

h. Yaw system failure;

i. Cable over twist (if cables are used);

j. Hydraulic system failure;

k. Loss of gear box oil pressure;

l. Gear box over temperature;

m. Pitch control system failure (as required); and

n. Communications systems failure.

2.2.12 Cable Over Twist Protection

If the proposed system utilizes cables between the yaw deck and the tower, the wind turbine system must incorporate the necessary cable twist sensors to detect and determine the net number of nacelle rotations to prevent cable damage due to over twist. In the event a cable over twist is sensed, the wind turbine system controls must operate to safely bring the rotor to a complete stop, untwist the cable by counter yawing, and restart the wind turbine system. This system must be tolerant of total power outages and not lose track of previous twist information.

2.3 PERFORMANCE REQUIREMENTS

The wind turbine system output performance must meet the minimum criteria given in paragraph, DESIGN REQUIREMENTS of this section (less 2.5 percent tolerance). The minimum annual gross energy production required to meet this specification was calculated using historical data and corresponding distribution with long-term annual average wind speed of [_____] m/s [_____] mph at [_____] meters [_____] feet AGL, tower/hub height of [_____] meters [_____] feet, wind sheer of [_____] between [_____] and [_____] meters [_____] and [_____] feet, altitude curve of [1.06][_____] kg/m^3 [6.617][_____] lb/ft^3 x 10^{-2} air density.

2.4 TESTS, INSPECTIONS, AND VERIFICATIONS

Perform pre-performance and performance tests, inspections, and verifications in accordance with IEC 61400-SER.

Submit all manufacturer's standard airfoil performance and mechanical stress/strength tests data under the maximum expected operating conditions.

All wind turbines controls must be tested to standard manufacturing and systems tests and must include but not be limited to:

a. Rotor controls (if required);

b. Yaw control (if required;)

c. Cooling system controls (if required);

d. Safety and shutdown systems; and

e. Braking systems.

Prepare and submit for review and approval a test plan and procedures for

factory and site testing. Tests must include an integrated control systems test where a minimum of the wind turbine generator and associated controls must be tested as a complete or mock assembly. These tests must be subject to witness by the Contracting Officer (or designated representative). Notify the Contracting Officer at least [30][_____] working days in advance of the tests. Should the Contracting Officer elect not to have a representative present during factory tests conducted by Contractor, the Contractor must still conduct such factory tests and inspections and submit test data and reports.

Data must be reported as taken during testing. Data format must be such that it can be included in performance test data submitted to the Contracting Officer.

Furnish the Contracting Officer [two][_____] copies of all shop and field test reports (and/or certificate of compliance) and [two][_____] additional information copies of these reports, clearly identified as such.

PART 3 EXECUTION

3.1 SITE PREPARATION

Evaluate and ensure site is accessible for the size and weight of planned equipment and facilities. Coordinate transportation routes to site.

Prepare site and lay down areas in accordance with approved contract documents.

3.2 WIND TURBINE SYSTEM PREPARATION

Ensure the wind turbine systems, remote work stations, control, power monitoring equipment, and all ancillary installed equipment are operational in accordance with this specifications section. All testing, both on site and at the factory, must be organized and supported by approved Commissioning plans. Submit a Commissioning Plan and procedures to the Contracting Officer for approval no later than [20][_____] business days after approval of the final design. The plan must state what equipment configuration will be tested, when it will be tested, which tests will be run, any special test equipment required, any required simulation software, and who will conduct and witness the tests as a minimum. The test procedures must define the operating steps and expected results to demonstrate compliance with the requirements of this specifications section. The Commissioning Report must record all test results and describe nonconformance events and corrective actions.

Ensure that the wind turbine components and associated subsystem must be tested by the manufacturer before shipment to verify proper assembly and function of all components/subsystems, and to ensure that the final assembled unit meets or exceeds the requirements of this specifications section. Component tests will be performed and/or Manufacturer's Factory certificates of compliance will be submitted indicating the equipment has been fully tested and meets the manufacture's standard design requirements. These tests must include (as a minimum):

a. Full Load Generator Tests - Full load test must be performed using the full load nameplate rating of the wind turbine generator unit. Full load testing must validate the vibration, temperature rise, and voltage and current outputs are within standard manufacturing limits (and/or meet) the manufacture's specifications.

b. Generator Insulation Tests - Generator insulation resistance and high potential tests must be performed with an insulation tester. Stator readings must be taken at the generator circuit breaker/switch. All results of insulation tests must be recorded. Readings must be within the standard manufacturing limits specified by the generator manufacturer.

c. Gearbox/Transmission Full Load Tests - Full load testing must validate the vibration, temperature rise, sealing, audible noise, gear tooth patterns, and lubrication systems are within the limits specified by the manufacturer. Full load test must be performed using the full load nameplate rating of the transmission or wind turbine generator unit (whichever is greater).

All factory component tests described above may be performed at the manufacturing facility.

3.3 ERECTION

Determine all hoisting and rigging and other installation requirements, and must make arrangements, if appropriate, for rent or purchase of any of these special installation tools.

Comply with ASSP Z359 Fall Protection Code during all construction, operations, and maintenance actions.

3.4 INSTALLATION

Install, test and commission wind turbine system. Provide detailed instructions and necessary oversight for installing all wind turbine system equipment. Notify the [CO][COR] of any errors in installation ensure that any and all installation errors are corrected in accordance with the manufacturer's instructions and specifications. Certify that the wind turbine system and wind turbine equipment are ready to operate. The Contracting Officer must receive [30][_____] working days' notice of the scheduled start up of the wind turbine system, with validation of the final schedule [21][_____] days prior to startup.

The scope of the Contractor's installation of the wind energy system must include, but not be limited to, the following activities:

a. Wind towers installation and setup support, including for hoisting, rigging, leveling, etc.;

b. Nacelle and rotor installations;

c. Control, monitoring, and terminal cabinet installations; and

d. Wiring connections/hookup.

3.5 SYSTEM INTERFACES

Wind turbine control and monitoring system is not authorized to interface with installation information network without approved software and hardware, and either an Authorization to Operate (ATO), Interim ATO (IATO), or Interim Authorization to Test (IATT). Permanent connection is not allowed without an Approval to Connect (ATC) or Interim ATC (IATC) authorization. Comply with IEEE 1547.

3.5.1 Power System Interface

The wind farm generator connections to the site power grid will be field located as shown in the contract drawings. Validate proper voltage drop of system after completion of the wind turbine Contractor submittals. Locate the wind turbine system ground level controls to enable safe manual ground level shutdown.

3.5.2 Dispatch Interface

The remote monitoring and control system must be integrated to allow the [UTILITY][Contractor's][User's] power dispatch, via the master workstations at the remote facilities, to monitor and control Wind Farm status and record aggregate power output and wind turbine status from the Wind Farm system.

3.5.3 Control System Interface

The wind turbine system must be supplied with a standard fiber optic, DSL, satellite or 56 kbit/s to 115 kbit/s minimum serial interface communications interface [by others] to link standard wind turbine control and monitoring functions with the existing remote monitoring/control system. The wind turbine communications interface will be capable of driving control signals, from the final locations recommended for the wind turbines to the remote facility workstations. The communications interface must include all the standard software drivers, installation and operation documentation, and programming support necessary to allow easy integration directly with the [Contractor's][user's] workstations located at the remote.

3.6 FINISHING, CLEANING, AND PAINTING

All surface finishes, cleaning, and painting must conform with Section 09 90 00 PAINTS AND COATINGS. All exposed surfaces that protect material must be UV resistant to maintain appearances through the design life of the system.

3.7 EQUIPMENT IDENTIFICATION

Each piece of equipment must be identified so that it can be easily correlated with the documentation. The means of identification must be uniform throughout the system. The identification mark must be permanently affixed to the part it identifies. This requirement includes internal wiring, terminal strips, input/output cables and connectors, input/output modules, power supplies, and other subsystem components and subassemblies.

3.8 NAMEPLATES

Each major piece of wind turbine system equipment must be furnished with a permanently attached 316 stainless steel nameplate, which contains a minimum of the following information:

a. Tag number;

b. Manufacturer name;

c. Model number;

d. Serial number; and

e. Purchase order number.

Each nameplate must be fully visible when the equipment is in operating condition and consist of a self-adhesive label having [_____] [6][_____] mm [1/4][_____] in embossed letters. Shipping container must be labeled with the same data.

3.9 FIELD QUALITY CONTROL

3.9.1 Manufacturer's Field Service

Provide the services of factory trained and approved field service engineer during system installation, testing, and commissioning.

3.9.2 Start Up Services

Carry out a checklist of startup requirements and conduct a series of safety tests to ensure proper installation, safe operation, and performance up to specification. Develop a Commissioning Report detailing all procedures, testing, and results.

After installation, prepare the new wind turbine systems for final testing and commissioning. The wind turbine systems must be fully debugged and operating in accordance with all requirements of this specifications section. Final start-up services must include, but will not be limited to, the following:

a. Final functional checks of all installed wind turbine systems, automated control modes, and associated controls and instrumentation.

b. Final verification and calibration of all wind turbine system control and instrumentation signals and digital readouts.

c. Final verification of the proper operation of all controlled shutdown functions and capabilities; and both automatic and ground level supported operating, monitoring, and related control functions.

d. Alarm systems.

3.9.3 Functional Acceptance Testing

After installation, conduct functional acceptance testing of the equipment and all accessories furnished to verify their proper performance under conditions of actual operation. Notify the CO at least [30][_____] working days in advance of the tests. Compliance with all requirements of this specifications section and all applicable standards (as amended) must be verified by an on-site startup/operational test.

3.9.4 Operational Testing

Support complete on-line operational testing on site to formally commission wind turbine operations, validate warranties, perform training, and initiate maintenance schedules. The wind turbine manufacturer will support the Installation Contractor who will be responsible for developing and implementing approved operational test procedures for testing all of the wind turbine operational and failure/failsafe systems. A certificate

of completion must be provided at the conclusion of system's construction, installation, and commissioning. Coordinate all formal correspondence and reporting required for approval of the test plan. Project implementation must require the installation, testing, and operation of the wind turbine generating units in parallel with the installation's [_____] kV distribution system. Installation and start-up support service submittals, test plan documents, and test schedule information must be submitted for review and approval.

Perform and submit field data reports for the following:

a. Verification of proper electrical power connection to all wind turbine system components.

b. Verification of proper termination of all system interconnect wiring and signal transmitter calibrations.

c. Verification of proper wind turbine system monitoring, controls, and environmental support system functionality.

d. Functional checks of all analog and digital signals, modems, and data communications systems associated with the wind turbine system.

e. Verification of wind turbine equipment alignments, torques and adjustments, and vibration block installations.

f. Functional checks (and correction if necessary) of all lubrication and cooling system levels and operations, shaft seals, and or other system fluid leaks.

g. All variations to documentation must be documented and submitted immediately to the CO and/or the COR.

3.10 COMMISSIONING

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NOTE: Section 01 91 00.15 BUILDING COMMISSIONING is intended for building systems, however, the basic requirements are applicable to PV commissioning processes. Section 01 91 00.15 will need to be tailored for PV systems when compiling project specifications.

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Conduct Commissioning, after the system is installed and is ready for operation, in accordance with Section 01 91 00.15 BUILDING COMMISSIONING, item (6)renewable energy generation, to verify that the completed and installed system meets the requirements of IEEE 1547. Tailor for non-building systems.

3.10.1 Commissioning Agent

Individual qualified in testing protective equipment (e.g., professional engineer, factory-certified technician, licensed electrician with experience in testing protective equipment) must perform or directly supervise commissioning tests. Provide Commissioning Agents Qualifications.

3.10.2 Commissioning Plan and Schedule

Develop and implement a commissioning plan and commissioning schedule in accordance with Section 01 91 00.15 BUILDING COMMISSIONING.

3.10.3 Start-up Pre-functional Checklists

Carry out a checklist of startup requirements and conduct a series of safety tests to ensure proper installation, safe operation, and performance conforming to specification.

3.10.4 Functional Performance Testing

Prepare test procedures and conduct functional performance testing of the installed system. Test on completion each individual wind turbine generator and then test on completion the complete wind power system plant. Test the complete wind power system for a minimum duration of 200 hours, of which 150 hours should be generator time with 85 percent availability.

Provide testing of the following:

a. Collector System

b. Collector and Substation Equipment

c. Ground Grid

d. Main Power Transformers

e. Circuit Breakers

f. Arrestors

g. Switches and Switchgear

h. Instrument Transformers

i. Wind Plant Relays

j. Wind Plant Energization

k. Turbine Transformer

l. Overhead Collection Circuits

m. Fiber Optics and Secondary Cables

n. Medium Voltage Cable Systems

o. Power Performance

p. Nacelle Anemometer Verification

q. Acoustic Noise

r. SCADA and Controls

s. Back Up/Black Start Generator(s)

t. Grid Synchronization and Interface

3.10.5 Functional Performance Testing Results

Coordinate, observe and record the results of the functional performance testing. Coordinate retesting as necessary until satisfactory performance is verified. Verify the intended operation of individual components and system interactions under various conditions and modes of operation.

Document items of non-compliance in materials, installation or operation. Immediately address observed non-conformance and deficiencies in terms of notification to responsible parties, and provide recommended actions to correct deficiencies.

3.10.6 Final Commissioning Report

Prepare and submit final commissioning report. Summarize all of the tasks, findings, conclusions, and recommendations of the commissioning process in accordance with IEC 61400-SER. Include the results of all tests and a listing of the final settings.

3.11 CLOSEOUT ACTIVITIES

3.11.1 Demonstration

Provide hands on demonstration of wind turbine systems and controls as part of the training session. Minimum demonstration areas must include pre-startup inspections, system startup, grid connection; operations, operator initiated shutdown, emergency shutdown, and extreme conditions procedures.

Demonstrate, upon completion of functional acceptance tests, that all circuits and devices are in proper operating condition and performing as intended.

3.11.2 Training

Provide a [1][3][5] day comprehensive training course covering operations and maintenance, critical spares, and unique tools requirements, with complete training materials, at construction completion.

Provide recommendations and sources for advanced maintenance personnel training and certification programs.

3.11.3 Spare Parts

Provide a spare parts list in accordance with the manufacturer's recommendations that will ensure [95][_____] percent system availability for from one (1) year to two (2) years of operation for each wind turbine unit, (according to options awarded). The list must include/identify all required gaskets, seals, sealing materials required for maintaining the weather tight integrity of the wind turbine tower and nacelle.

3.11.4 Special Tools and Equipment

Identify special tools and equipment designed specifically for the wind turbine equipment operation and maintenance. Special tools and devices, including any metric wrenches or other hand tools that are not standard in

the United States, required for operation and maintenance of the equipment furnished under this specifications section, must be listed and clearly identified with the name of the equipment.

3.11.5 Site Restoration

Clean and restore temporary work areas to pre-existing conditions.

3.11.6 Decommissioning Plan

Provide a decommissioning plan to Contracting Officer for approval. Decommissioning plan must include actions necessary to restoring site and access roads to natural conditions and option to evaluate structure and components for life extension upgrades.

3.11.7 Warranty

Provide system and major component Warranty in accordance with Section 01 78 00 CLOSEOUT SUBMITTALS

3.12 OPERATION

3.12.1 Normal Operations

The wind turbine system must be operating in an automatic, unmanned mode, unless a failure alarm is detected in the wind farm control system, or maintenance is being performed on the system. Wind turbine system controls must be provided to optimize wind turbine system outputs under normal wind conditions, as described in paragraph, EXISTING CONDITIONS of this section. Standard wind turbine controls must be designed to keep the wind generating system operational within its normal operating limits over the design life of the wind farm system, producing efficient, optimized, electrical power. Should the wind turbine or its control system malfunction, the protection system/safety schemes must maintain it in a non-hazardous condition. Acceptable safety schemes must include braking, blade pitching, spoilers, and active yawing, as required by the turbine generator manufacturer. Provide wind turbine Operations Manuals, Alarms and Alarm Presentation, System Startup, Shutdown, and Emergency Procedures, and Contractor Commands (Control Consoles, Indicating/Control Panels, and Peripheral Devices).

3.12.2 Pre-Startup Inspections

Pre-startup inspections must be performed prior to initiating wind turbine system operations. To support automatic operations, the inspections will only be required following maintenance and/or abnormal shutdowns brought on by the automatic shutdown features of the controls. Pre-starting inspection will be performed using manufacturer's instructions and procedures to ensure that the wind turbine system is ready for on-line operations. The necessary instructions, procedures, checklists, etc. must be supplied as part of the documentation submittals as required herein.

3.12.3 Connection to Grid

To connect grid power to the associated wind turbine unit, coordinate with utility company grid operations to close the wind turbine switchgear breakers either manually at the site or remotely via the Contractor stations. Compliance with interconnection agreement requirements is mandatory.

3.12.4 Initiate Wind Turbine Operations

Once grid power is supplied to the wind turbine, the wind turbine control system will begin its internal system diagnostics, as necessary, to prepare the control system for active operations. All faults normally detected by the control system, or occurring as a result of automatic shutdown, will have to be manually reset prior to allowing active operations. When the fault indications have been reset, the controls will output a wind turbine "READY" indicator to notify that the wind turbine is ready to activate soft start operations.

3.12.5 Normal Operations

Final wind turbine connection to the grid for normal on-line operation will occur when the he ON-LINE command is initiated, either from the Contractor's panel or remotely via the serial communications/control link. Normal operation must include normal pitch, speed, and voltage controls to automatically optimize output while operating within normal wind speed parameters. ON-LINE operations will invoke normal operation where the wind turbines will begin soft start (solid state soft start, reduced voltage starting, or equal) operations (to reduce the impact of connecting the wind turbine to the grid) if adequate wind is available.

3.12.6 Normal Shutdown

All Normal shutdowns must result in immediate orderly shutdown, including a functional disconnect of the wind turbine generator from the grid at the wind turbine output control (or equal). The wind turbine control system must remain operational to maintain full control of the wind turbine shutdown (application of normal braking, required rotor and blade pitch operations, active yawing, etc.) as necessary to effect safe (non-damaging) shutdown of the wind turbine unit. Prior to beginning maintenance operations, shut down the system, applying the parking brake, open the switchgear breaker supplying the wind turbine system, open the wind turbine local disconnect breaker, and set the wind turbine operations switch into the LOCAL mode.

3.12.7 Emergency Shutdown

Emergency shutdown procedures/functions must be included as an integral part of the wind turbine basic operating capabilities. The emergency shutdown system must operate to disconnect the wind turbine from the grid and apply appropriate braking actions, require rotor and blade pitch operations, active yawing, etc., as necessary to effect safe (non-damaging) shutdown of the wind turbine unit in emergency, extreme operating conditions, survival wind speeds or a loss of grid power while operating. These include, but are not limited to, loss of grid power, breaker trip, over speed, contractor control, and other anomalies. Provide Recovery and Restart Procedures.

3.12.8 Extreme Operating Conditions

Peak wind speed, high temperature, and earthquakes all constitute extreme operating conditions, which may exist whether the wind turbine is in operation or not. The wind turbine system design analysis must consider the effects of extreme operating conditions; and the resulting design configuration must include the necessary safety elements to mitigate damage from the extremes (and still effect safe shutdown). Contractor

inspection and manual reset is expected before any operation following an extreme event.

3.13 MAINTENANCE

Contractor to create maintenance schedule and perform system and component maintenance in accordance with equipment manufacturers' recommendations and AWEA O&M RP. Provide a Recommended Multi-Year Operations and Maintenance (O&M) Requirements Schedule.

-- End of Section --