

**EXHIBIT D.5.1**  
**WIND TURBINE SPECIFICATIONS**

**1.0 REQUIRED FEATURES**

- 1.1 All available OEM turbine upgrade and enhancement options available at the time of TSA execution, including but not limited to software, controller parameters, blade attachments, and power curve enhancements.
- 1.2 “Cold weather package” that allows for turbine operation to at least minus 30 degrees C (-30°C).
- 1.3 Lockable tower door keyed alike.
- 1.4 No exterior light fixtures attached to the tower.
- 1.5 Internal tower lighting located at each tower deck, along the full length of the tower ladder, within the nacelle and at control cabinet locations to fully illuminate the work areas.
- 1.6 240 VAC electrical receptacles at all tower deck locations, NEMA 10-30 or 14-50 size.
- 1.7 120 VAC and 240 VAC electrical receptacles in the nacelle and tower entry platform areas.
- 1.8 Steel cable safety system centrally located on the tower ladder and secured at base and tensioned.
- 1.9 Electric motor platform lift (3S or equivalent) if available for specific turbine model, otherwise Power Climber 100 percent load relief continuous loop type climb assist with remote control for start, stop, load control and integrated power supply.. All equipment shall be permanently attached to the turbine or ladder system except for a remote control device.
- 1.10 Tool/equipment hoist located at the yaw deck or within the nacelle and extends its reach to the tower entry deck level or exterior ground level.
- 1.11 Capacitors shall be used in place of batteries in electric motor pitch systems if available from the turbine manufacturer.
- 1.12 Blades shall have an external nameplate or markings along with hub slot position number.
- 1.13 Main bearings supplied by SKF, Timken or FAG/Schaeffler, or Owner approved equivalent.
- 1.14 Gearbox meeting IEC 61400-4 CDV international standard "Design Requirements for Wind Turbine Gearboxes".
- 1.15 Gearbox oil water content less than 200 ppm and particulate to the ISO 4406 cleanliness standard of -/16-13 at Wind Turbine final factory acceptance test.
- 1.16 Hydraulic oil water content less than 500 ppm and required to meet cleanliness levels of 21/19/16 according to ISO 4406: 1999 at Wind Turbine final factory acceptance test.
- 1.17 Gearbox oil filtration package with a 10-micron full flow filter and 3-micron kidney loop filter or equivalent to meet the cleanliness standards in the preceding section.
- 1.18 Gearbox oil particle counter manufactured by Poseidon Systems capable of being integrated into the SCADA or CBM system.

- 1.19 Ceramic generator bearings or grounding system that eliminates all static discharge through the bearings.
- 1.20 A backup mechanical anemometer with an ultrasonic anemometer as the primary supply. The controls shall be wired to transfer upon failure of the ultrasonic unit.
- 1.21 One mechanical wind vane resistant to ice fall damage.
- 1.22 Liquid applied blade leading edge erosion protection. Erosion protection shall be from blade mid-point to the blade tip and shall be applied at a thickness recommended by the coating manufacturer, but not less than 12 mils. The coating shall fully protect the pre-coated blade surface for a minimum of 10 years.
- 1.23 Transformer – Up tower transformer room shall have arc flash and access protection systems. The access door shall have a hasp and lock keyed alike.
- 1.24 Zero voltage ride-through
- 1.25 Reactive power capability when tower is off-line (if available from manufacturer)
- 1.26 Central Automatic Greasing System
  - (1) Pre-filled greasing units shall be provided that are permanently, externally, and non-intrusively mounted at the locations listed below in each turbine. The units shall be pump driven and capable of mixing the grease to prevent separation. Units in the hub shall be supplied with spring loaded pump units.
    - (a) Main bearings (3pt mount turbines only)
    - (b) Generator bearings
    - (c) Yaw bearing (if greasing is required)
    - (d) Yaw gear teeth
    - (e) Pitch bearing
    - (f) Pitch gear teeth (if applicable)
  - (2) Each pump shall provide at minimum a pump failure alarm signal capable of being integrated into the SCADA or CBM system.
  - (3) All lines and cables shall be oil and grease resistant, cold weather flexible, and routed in existing trays or routes that are clear of all walkways and maintenance points.
  - (4) Grease catch units shall be provided that are permanently, externally, and non-intrusively mounted on the yaw gear in each turbine.
- 1.27 Condition Based Monitoring System
  - (1) Hardware

Sensors shall be permanently, externally, and non-intrusively mounted at the following locations. Additional sensors shall be added as needed to provide a comprehensive diagnostic system. A list with exact sensor locations and sensor specifications shall be provided.

- (a) Main Bearing – 1 sensor per bearing.
  - (b) Gearbox – 3 sensors to detect low, intermediate, and high-speed shafts.
  - (c) Generator – 2 sensors, drive, and non-drive end bearings.
  - (d) Drive train – 1 Proximity Induction sensor.
  - (e) The data collection / signal processing unit shall be installed in a serviceable location in the nacelle and connected via the turbine network to the server.
  - (f) All cables shall be oil and grease resistant, cold weather flexible, and routed in existing trays, conduit or routes.
- (2) Server and Software

A rack mounted server shall be installed in the turbine SCADA rack and meet the following requirements:

- (a) Windows Server latest version with SQL database.
- (b) Ability to communicate with other servers and backup devices via Modbus TCP, OPC-UA, PI, or similar protocols.
- (c) Capable of quickly running the provided analysis software.
- (d) Capable of storing 1 year of data.
- (e) Unrestricted access to Windows Server and SQL server without user count-based licensing.
- (f) Any connection to Company network shall be in accordance with Company Cybersecurity standards and policies.
- (g) Analysis software shall be pre-installed and meet the following requirements:
  - 1. Unrestricted access and configuration ability without individual user licensing. This shall include the ability to modify, add, and delete all configurable points such as gearbox models, bearing frequencies, sensor parameters, alarm points, etc.
  - 2. High level display to view all turbines' status on 1 page.
  - 3. Detailed display for each turbine.
  - 4. Record data at least once per day.

5. Access to all raw data.

(3) Monitoring Service

- (a) 2 years of full fault monitoring, analysis, and evaluation service shall be included, and all materials covered under the turbine warranty. Provide next business day alarm response reports with specific fault locations and recommended corrective actions. Phone and/or webcast conferences shall be used to discuss results when necessary, during normal business hours, Monday through Friday excluding Holidays. Conferences shall not be expected to last more than 15 minutes each.
- (b) Provide a monthly summary report detailing activity for the previous month.
- (c) All data obtained shall remain the property of Owner.

**2.0 MINIMUM SCADA FEATURES**

- 2.1 Owner Enterprise network standards require a dedicated room for network, security, and IT hardware. Space shall meet the requirements of Owner Technology Communications Construction Requirements & Infrastructure Standards. If possible, Wind turbine operation and control shall be from a central server located in the O&M building SCADA room. Server rack shall be an open-air rack. A remote operator station shall be connected and placed in the O&M building break room. Network architecture or servers that require dongle authentication shall be capable of authentication within a virtual session such as RDP or VNC.
- 2.2 Main control server with 3-year minimum data storage and access to live and historical data via OPC-UA protocol or equivalent and ODBC.
- 2.3 Remote access server
- 2.4 Single display with 4 channel KVM switch
- 2.5 GPS time sync server
- 2.6 Backup UPS power supply
- 2.7 All applicable software licenses without individual user licensing
- 2.8 Unrestricted access and configuration ability to all hardware, servers, software and control logic. This shall include the ability to modify, add, and delete all configurable points.
- 2.9 Automatic backup software
- 2.10 Software to modify SCADA screens.
- 2.11 Microsoft Office Excel on each server with lifetime license
- 2.12 Substation monitoring screen(s) integrated with the SCADA system. Display all alarms and statuses along with a 1-line overview of breaker position and MWs, volts, amps, and VARs at all metered locations. For clarification purposes, metered locations include relays or other equipment that monitors the listed values.

- 2.13 Remote alarm notification capable of sending emails.
- 2.14 Power curtailment at the substation level over full output range.
- 2.15 Analog signal capability with local/remote selection for power and voltage/VAR control.
- 2.16 Actual possible power signal the value of which is based on actual on-site wind speed.
- 2.17 Power ramp rate control
- 2.18 Substation level VAR control
- 2.19 Substation level voltage control
- 2.20 Substation capacitor and reactor bank control
- 2.21 Frequency control
- 2.22 Line droop compensation
- 2.23 Aviation light monitoring and failure alarm integrated with the SCADA.
- 2.24 Met mast interface module

### **3.0 SUBMITTALS**

- 3.1 All Turbine Supplier commissioning and testing procedures, checklists, inspection reports, punch lists and other records related to wind turbine assembly, inspection, commissioning and testing shall be submitted to Owner.
- 3.2 Turbine Supplier, Contractor and Subcontractor(s) commissioning and testing procedures, checklists, inspection reports, punch lists and other records related to wind turbine assembly, inspection, commissioning and testing shall be submitted to Owner.
- 3.3 Subcomponent list of drivetrain major components down to bearing level, which includes, but not limited to, make, model, and serial number of each subcomponent.
- 3.4 Recommended spare parts list.
- 3.5 One full electronic detailed and comprehensive set of turbine electrical schematics, control system wiring diagrams, mechanical (fluids) schematics, and turbine operation and maintenance manual.
- 3.6 One full electronic detailed and comprehensive set of schematic diagrams of SCADA electrical schematics and control wiring diagrams.
- 3.7 Complete turbine alarm list and associated warning and alarm limit set points.
- 3.8 As-built data report for all serialized components including, but not limited to, make, model, part number, serial number.

- 3.9 Gearbox oil analysis report including ISO particle counts, contaminates, additives and water levels which includes the limits of values acceptable to the turbine and oil manufacturers shall be submitted to Owner.
- 3.10 Pictures of all punch list items before and after the repairs are completed shall be submitted to Owner.
- 3.11 The final resolution of all component damage noted on component inspection receiving reports shall be documented. This documentation shall include, but not be limited to, inspection reports, repair procedures and before and after pictures.
- 3.12 See Exhibit A.5 (*Submittal Requirements*) for additional information.