TYPICAL MET TOWER INSTRUMENTATION CONFIGURATION

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1. INTRODUCTION

The aim of the this document is to provide a general description of a typical instrumentation package for a Met Tower to be installed in the Maryland WEA by US Wind Inc. Basic configuration includes:

- Wind Measurement Equipment;
- Meteorological Equipment;
- EHS Equipment;
- Power Supply System;
- Data Logging & Telemetry System.

2. INSTRUMENTATION

2.1 Wind Measurements

The purpose of the wind measurements is to estimate the wind characteristics and the wind energy resources at the location where the wind mast is located. The data shall be collected and analyzed by the overall data acquisition system. The following parameters shall be measured at the mast:

1. Wind speed at five (5) heights above mean sea level (13 sensors)
2. Wind direction at three (3) heights above mean sea level (3 sensors)
3. Air temperature at three (3) heights above mean sea level (3 sensors)
4. Air pressure at two (2) heights above mean sea level (2 sensors)
5. Precipitation at two (2) heights above mean sea level (2 sensors)

Based on the measurements it shall be possible to determine the following parameters:

- Mean wind speed
- Daily and monthly wind speed variations
- Wind speed frequency distribution
- Turbulence intensity
- Wind shear
- Wind gust
- Wind direction frequency distribution
- Air temperature gradient
- Air density
- Precipitation statistics
- Wind energy content

A separate wind measurement system (Vertical Lidar), completely independent of the main system, shall be installed at the top of the tower. This system will act as backup system for the main wind monitoring system. The following parameters shall be measured:

1. Two (2) wind speeds at 328 feet (100 m) above mean sea level
2. Two (2) wind directions at 328 feet (100 m) above mean sea level
3. Atmospheric pressure at 328 feet (100 m) above mean sea level
4. Air temperature at 328 feet (100 m) above mean sea level

The data shall be collected by a separate data logger with a log frequency of 1 Hz. The following data shall be stored by the system:

- 10 minute mean values of wind speed, wind direction, air pressure and temperature.
- Turbulence intensity of the wind speed.
- Minimum and maximum wind speed (3 sec average) within each 10 minute interval.

The storage capacity of the system shall correspond to at least six (6) months of data. The system shall be powered by the main power system. A power back-up system with a capacity corresponding to one (1) week measurements shall be included.

Wind Speed, Functional Requirements

The wind speed shall be measured at five (4) levels by the main system:

1. At 98 feet (30 m) above mean sea level, platform side, over deck;
2. At 164 feet (50 m) above mean sea level, mast;
3. At 246 feet (75 m) above mean sea level, mast and
4. At 328 feet (100) m above mean sea level, top of mast.

The wind speed shall be measured by three (3) anemometers at each level. This means totally twelve (12) anemometers.

Wind Direction, Functional Requirements

The wind direction shall be measured at two (2) levels: 164 feet (50 m) and 328 feet (100 m) above mean sea level. The wind direction is measured by two (2) vanes at each level above plus one spare set. In total five (5) wind vanes.

Air Temperature, Functional Requirements

The air temperature shall be measured at two (2) levels: 164 feet (50 m) and 328 feet (100 m) above the mean sea level. The air temperature is measured by one sensor at each level. Total of two (2) air temperature sensors are needed.

Air Pressure, Functional Requirements

The air pressure shall be measured at 328 feet (100 m) above the mean sea level. The air pressure is measured by one (1) sensor at each level. A Total of two (2) air pressure sensors are needed, one as spare.

Precipitation, Functional Requirements

The liquid precipitation shall be measured at 328 feet (100 m) above mean sea level. The precipitation is measured by one sensor.

Relative Humidity, Functional Requirements

This Relative Humidity (RH) at deck and tower top will be used to correlate with other environmental data including temperature data, rain fall intensity and atmospheric pressure. The RH sensors shall be of the solid state capacity element type with liner amplifier. The sensor shall be concealed in a ventilated sun shield with high reflectiveness, low heat retention and low thermo-conductivity.

2.2 Other Measurements

Visibility Sensor

The sensor will record the local visibility around the platform in order to gain data for navigation studies at the platform location. The Visibility Sensor shall be based on forward scattering of infra-red light. To avoid false scattering from surrounding objects, the sensor must have free horizontal distance of at least 6 inches (15 cm) and a free vertical distance of more than 3.3 feet (1 m).

Lightning Detection

The purpose of the measuring lightning is to determine the frequency of lightning in the area and to establish a design basis for the lightning protection of wind turbines installed in the area.

Bat Detection

A Bat Detection system shall be installed. A typical system is shown below.

D240X Ultrasound Bat Detector

Very popular heterodyne and time expansion detector with backlit, large digit, accurate digital display, showing the tuned frequency in the heterodyne mode. The frequency and volume controls are on the side of the case, making it easy to adjust. Using stereo headphones, the heterodyne signal is heard on the left channel and the time expansion signal on the right channel. When the built-in speaker is used, a switch is used to select the heterodyne or time expansion signal.

A digital recorder can be connected to the D240X to record the time expanded calls for analysis on a PC. If the recorder has a "voice activated" recording mode, a fully automatic bat recording system is obtained, which can be left in the field for unattended recording of bat calls.

Specifications

Type:	Heterodyne and time expansion (x10 or x20 - selectable via switch)
Microphone:	Advanced electret
Frequency range:	10 - 120 kHz (min.)
Display accuracy:	±0.15 kHz (min.)
Bandwidth:8 kHz	(± 4 kHz), -6 dB
Battery:	1 x IEC 6LF22 (9 V)
Quiescent current:	30 mA typ. (replay) including LCD backlight
Comment switch:	Yes
Memory size:	1M x 8
Sampling frequency:	307 kHz
Resolution:	8 bits
Storage time:	3.4, 1.7 or 0.1 sec. (selectable via switch)
Trigger modes:	Manual, level - broadband, level - narrowband
Pre-trigger:	50% of the selected storage time
Size:	119 x 60 x 25 mm including knobs
Weight:	170 g including battery
Outputs:	2 x 3.5 mm jacks for headphones and tape recorder

3. EHS Equipment

3.1 USCG PATON Navigation Lighting

The offshore tower shall be marked so as to be conspicuous by day and night, with consideration given to prevailing conditions of visibility and vessel traffic. The tower shall be fitted with lights visible from all directions in the horizontal plane and in accordance with the USCG District 5 PATON regulations.

3.2 USCG PATON Racon System

If the local USCG District 5 PATON regulations call for a Racon system then one shall be fitted on the Met Tower deck. The purpose of a Racon (radar beacon) is to be used as a navigation aid, identifying the tower on a shipboard marine radar display. The Racon shall comply with the Recommendation on Marine Radar Beacons (Racons) IALA Recommendation R-101r1 December 2000.

A Racon model will be used which provides dependable service to all marine radars, including those with narrow band receivers. The PATON regs will determine its range and code. For temporary adjustment, the Racon can be coded with the Morse letter "D" and show a signal length of one nautical mile CPA on the radar display.

The Racon, if required, shall comply with the following typical functional requirements:

- Automatic operation.
- Automatic suppression of responses to side-lobes.
- Possibility for reprogramming of key parameters in the field by a programming unit which shall be supplied with the Racon.
- Prepared and equipped for remote control and function monitoring to a manned base station.
- Automatic power management reducing power to stand by power consumption for periods when no local radar is detected

3.3 USCG PATON Fog Signal

If required by PATON regulations a Fog Signal will be installed on the Met Tower Deck. The purpose of fog signal is to create audible warning for vessels, identifying the tower as an obstacle. The tower shall be equipped with a Fog Signal, which emits sound during periods with low visibility. The Fog Signal shall be supplemented by a Visibility Detector, which shall detect low visibility and activate the Fog Signal.

3.4 Aviation Lighting

If required the Met Tower will be equipped with the necessary aviation lighting. The purpose of aviation lighting is to warn air traffic. The aviation lighting shall comply with ICAO Annex 14 and FAA recommendations. The tower shall be fitted with aviation marking in form of aeronautical obstruction lights.

3.5 Video Camera System

A video camera system is being considered for the Met Tower deck area. The purpose of the use of video cameras is to monitor the platform area as access control. The CCTV camera system shall view the deck area.

The camera system could be supplied with software package which shall provide the following functions:

- View the deck area.
- Record continuously the view for at least one (1) month on a hard disc of a computer.
- Transmit the view as Webcam to a remote location. (Shore data reception station)
- Remote operation of zoom and focus.

4. POWER SUPPLY

The maximum power draw of the instrumentation/sensor package is quite low and would not require an on-board generator. Solar power packs or small scale wind units charging a battery bank would be more than adequate. If possible Solar power units alone are the preferred option as they would require less maintenance than the wind turbines.

Solar Power System

The purpose of the solar power system is to provide supply to instruments. The design qualifications and type approval of the solar cells/modules shall comply with IEC 61215 or IEC 61646.

The solar power systems shall consist of:

- Solar cells/modules
- Charge controller
- Batteries
- Power panel
- Inverter
- Remote Monitoring

Small Wind Turbine

Small scale wind turbines could be used to supplement charging of batteries. Currently this is viewed as an alternative, back-up power production device.

5. DATA LOGGING & TELEMETRY

The complete data set gathered on the Met Tower from all sensors will be routed to an on-board data logging system where local ROM storage will ensure that the data packages are safe and intact for the required period of time. A high speed microwave communication system will be established to send select data packages in real time back to a shore data reception station located in Ocean City MD. (This is more fully explained in Section 2.2.1.4 Operational Activities) In addition to the microwave telemetry system a Local Area Network or LAN system will be configured on board the Met Tower whereby the locally stored data can be down loaded via a Wi-Fi connection from a maintenance vessel in close proximity to the Met Tower.

The data arriving at the shore data reception station will also be available via a secure web-based data port link.