Title: Standard Operating Procedure for the Measurement of Wind Speed and Direction Using Ultrasonic Systems		
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1. INTRODUCTION AND SCOPE

This procedure describes the operation and maintenance of an ultrasonic wind speed and direction sensor assembly. Data collected from these sensors is typically used for air quality assessments, meteorological and climate trend reporting and inclusion in the provincial and national meteorological databases. These systems provide instantaneous data signals at a rate of once per second. Restrictions on data capture or averaging may come from the data acquisition system used to collect the signal data.

This method adheres to the requirements of the current Air Monitoring Directive (AMD). In some cases the limits and specifications exceed the requirements of the current AMD. It should be considered that the current and any future amendments of the AMD will be used as the benchmark for requirements and criteria for ambient air monitoring practices conducted in the Province of Alberta. Information used to write this procedure was also taken from sources identified in the reference section.

2. PRINCIPLE OF THE METHOD

The ultrasonic wind sensor is a solid-state instrument capable of measuring wind speed and wind direction in the U and V axes. Sonic pulses are generated at the transducers and are received by opposing transducers. Transit time ,the time it takes the sonic pulse to travel from the sending transducer to the receiving one, is measured on both the U and V axis. Under calm conditions, the transit time for both axis is the same. As wind speed increases, depending on the direction, the transit time ratios increase or decrease. The degree of increase or decrease in the sonic signals derives the wind direction. The sensor uses a microprocessor-based, digital electronic measurement system to control the sample rate and compute the wind speed and wind direction. Both wind speed and direction signals are output from the sensor to be recorded on a data acquisition system or chart recorder

3. MEASUREMENT RANGE AND SENSITIVITY

The Wind Speed and Direction sensors used in this method are commercially available models. The measurement range of wind speed can be up to 200 kilometers per hour (kph) depending on the model ordered. The wind direction is 1 to 360° (degrees). See the operations manual for further information on range settings and signal outputs.

The manufacturer specifies the detection limit of the wind speed and direction sensors. For the wind speed sensor, a threshold of typically 0.4 Kph is set in the microprocessor. The wind direction threshold is typically 1 degree..

4. EQUIPMENT AND APPARATUS

The following are commercially available sensors suitable for use in this method which are currently used in the AENV Network:

Met One Model 50.5 wind sensor

Vaisala Windcap model WS425

Handar Ultrasonic model 425A & 425AH

5. INTERFERENCES

Interferences with measurement accuracy can be caused by improper location of the sensors relative to objects that affect airflow.

Ice and snow build up on the transducers can cause inaccuracy of measurements or render the sensor totally unresponsive.

6. PRECISION AND ACCURACY

The measurement precision is generally considered to be the “repeatability of the measurement”. Precision of the data output by the sensor is established by the manufacturer, but confirmed during weekly observations and annual calibrations. Refer to section 10 of this document for more information on weekly checks and annual calibration procedures and how precision is reported.

The accuracy of the sensor is generally considered the “deviation from true”. This means how close it is to what it should be. The benchmark of “what it should be” is provided by the Alberta Environment Audit Program staff and the use of transfer standards. As with precision, accuracy is confirmed by the weekly and annual system checks. Refer to the sections identified above for further information on accuracy relating to calibration and audit procedures.

7. SITE REQUIREMENTS

Site location of the Wind Speed and Direction monitoring station should be determined according to the intended application of the monitoring data. The detailed requirements for selection of sites for monitoring ambient Wind Speed and Direction in Alberta can be found in the Station Site Criteria section of the AMD. The US EPA Siting Requirements for Meteorological Equipment – Volume II, Section 2.0.8 is also a useful resource.

Wind Speed and Direction sensors are sited and operated in accordance with the guidelines outlined by the AES Guidelines for Co-operative Climatic Autostations Guide 89-1.

8. INSTALLATION REQUIREMENTS

All the installation requirements as specified by the manufacturer in the installation procedures of the operations manual as well as the general requirements below must be followed.

8.1 Trees

Trees and vegetation can cause disturbance of airflow patterns which affect Wind Speed and Direction measurements. To minimize this effect, the distance between the Wind Speed and Direction sensors and the drip line of the tree must be at least twice the height of the tree above the sensor or at least 10 metres away whichever is greater.

8.2 Data Acquisition System

A data acquisition system (DAS) should be connected to the translator to record or download the signal output from the sensors. For connection to record analog voltage signals, the system should be set to match the voltage range of the translator output. Generally this is 1V or 5V full scale and is scaled to convert the output signal to the system range outlined in section 3. See the DAS operations manual for instructions on configuring these channels.

8.3 Range Set

Range Set – the range of each system is identified in the operations manual. Typical ranges used for monitoring wind speed and direction are 0 to 120 Km/hr for wind speed and 1 to 360 degrees for wind direction. This is done as soon as the system is powered up after installation. Refer to the operations manual for instructions on this procedure.

9. OPERATIONAL REQUIREMENTS

The following table of activities must be performed when operating continuous Wind Speed and Direction sensors in the AENV network. The following documentation must be available to the operators on site: operational and maintenance manual(s), appropriate quality system documentation and station site documentation.

Table 2

Sensor Operational Requirements

Action	Time and Frequency	Procedure	Documentation	Action by
Set sensor and data system range (WS & WD	After installation	As per manufacturer's manual	Entry to log book	Station operator
Verification of operational parameters	Weekly	Visual Check	Entry to log book	Station operator
Sensor maintenance	As recommended by manufacturer	As per manufacturer's manual	Entry to log book and Work Order	Instrument Technician
Calibration	After installation or repair and as required thereafter	Remove sensor and translator and calibrate	Entry to log book; and Work Order	Instrument Technician

	Yearly			

10. CALIBRATION

Ultrasonic sensors are calibrated at the factory and do not require calibration in the field. The procedure for calibrating an ultrasonic sensor requires a wind tunnel. Calibrations of the entire wind system must be completed every two years at a minimum. This procedure involves removing the sensor from the tower or mast where it is installed, replacing the sensor with a spare unit, and returning the unit to the factory for calibration. Periodic checks can be completed in the field to assess proper operation. Please follow the procedure as outlined below.

10.1 System Verification Check

Before any hardware is disturbed, visually verify the operation of the wind speed and direction sensors by comparison to the data collected by the data system. Ensure all cables and connections from the sensors to the translators and data collection system are secure. Prior to removing the wind head from the tower, the alignment of the head must be verified. This can be completed using either a magnetic compass or the solar noon method. The Apparent noon method is outlined in the AMD Appendix A10, section 3.2. To use a magnetic compass, adjust the bezel of the compass to the appropriate declination depending on the co-ordinates of the sensor. Check the alignment to true north, not magnetic north. If it is not aligned correctly, document the deviation from true north so that collected data can be adjusted.

10.1.1 Zero Test

A zero test requires no air movement across the sensor array, so a means of covering the array is needed. A plastic bag can be placed over the array, using care not to contact the transducers or block the sonic paths between transducers. The bag should be spaced at least 2” above the transducers to avoid sonic reflections, which may affect readings. The bag can be tied at the bottom with a tie wrap or tape to prevent air movement from below. Keep in mind that wind can deflect the bag, causing air movement inside. The preferred method is to use a box insulated with foam to prevent reflections, and spaced so that the top is at least 2” above the transducers. Again, the bottom should be sealed around the sensor to isolate the array from ambient air movement. With no air movement across the array, the sensor should indicate 0.0 to 0.1 m/s wind speed. The wind direction output will wander to any value between 1 and 360 degrees.

10.1.2 Span Test
The sensor is designed to produce known default outputs if an object blocks the sonic signal path between the transducers. This feature is useful for verifying sensor operation and recorder scaling. For testing purposes, the sonic path can be blocked as described in the instruments operation manual.
NOTE: sensor outputs with blocked paths are described in appropriate operations manuals.

10.2 Document the results of the field test using the appropriate form.

10.3 Return the wind head to the tower insuring the wind head is aligned to true north as described above.

11. APPLICABLE DOCUMENTS

EM-017a Met One 50.5 Wind Sensor Operations Manual

EM-017b Vaisala Windcap Ultrasonic Wind Sensor Operations Manual

EM-017c Handar model 425 series operations manual

12. LITERATURE REFERENCES

US EPA Siting Requirements for Meteorological Equipment – Volume II, Section 2.0.8

Alberta Environment Air Monitoring Directive – 1989 & 2006

13. REVISION HISTORY

Revision 0 (new document)

Revision 1.0 – Section 1.1 – changed Solar to Apparent to be consistent with AMD
Inserted AMD section reference
Changed Team Lead to Manager

14. APPROVAL

Approved by: **Harry Benders** **Date: January 27, 2011**

Title: **Air Monitoring Manager**