Guidelines for Meteorological Station Reconnaissance And Meteorological Sensor Height Measurements

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1.0 Introduction

Meteorological observations are collected at over 200 water level gauges in support of several operational observing system programs. These observations consist of wind speed, gust, and direction, barometric pressure, air temperature and, at select stations, relative humidity. The meteorological data are used for various purposes such as navigation services, storm surge warning, and marine forecasting.

1.1 Background

The Physical Oceanographic Real-Time System (PORTS®) water level stations were among the first to measure meteorological parameters, primarily to supplement oceanographic observations required for navigational safety. The location and type of meteorological sensors installed are almost exclusively determined by the local users to best meet their needs. PORTS® was also the first program for which CO-OPS installed stand-alone meteorological packages separate from water level stations.

Meteorological sensors were first systematically added to National Water Level Observation Network (NWLON) in support of the NOAA National Weather Service (NWS) Southern Region. In addition to PORTS® users and the NWS, partnerships were subsequently established with other NOAA offices and state and local governments to increase the spatial density of meteorological observations, especially important in efforts to mitigate the impacts of coastal storms.

There is a growing demand for meteorological data at CO-OPS tide gauges. Recently, CO-OPS acquired funding from the NWS to install meteorological sensors on existing NWLON gauges. The increasing amount of meteorological data collection is attracting a wider audience beyond oceanographers. Therefore, it is imperative that CO-OPS adheres to NWS installation and metadata measurement standards to meet user needs.

Previous to this document, meteorological sensor heights were referenced above station datum, consistent with oceanographic metadata collection methods. However, NWS and other meteorological data users require heights above the ground, rather than above station datum for models, research and other purposes. Therefore, meteorological sensor heights will now be measured above a Temporary Bench Mark (TBM) located near the sensor support tower base and reported above the TBM and above the station datum, where possible, to accommodate all user requests. The heights above the TBM will serve the meteorological user requirements, and the heights above the station datum, where possible, will serve the oceanographic communities.

1.2 Reference Documents

The following documents are available at CO-OPS website at:

http://tidesandcurrents.noaa.gov/pub.html

Next Generation Water Level Measurement System (NGWLMS) Site Design, Preparation, and Installation Manual (NGWLMS Manual), January 1991

Barometer Calibration Guidelines for Sutron Xpert DCP Systems, updated November 2008

Wind Sensor Alignment Procedure for the R.M. Young Wind Monitor, October 2005

Sutron Accubar Barometer Field Calibration Procedures, Updated February 2008

CO-OPS Water Level and Meteorological Site Reconnaissance Procedures, Updated May 2009

NWS:
National Weather Service Instruction 10-1302
Operations and Services
Surface Observing Program (Land)
Instrument Requirements and Standards for the NWS Surface Observing Programs (Land)
http://www.weather.gov/directives/010/010.htm

OFCM:
Federal Meteorological Handbook No. 1 (FHM-1)
Surface Weather Observations and Reports, 2005
http://www.ofcm.gov/fmh-1/fmh1.htm

2.0 Meteorological Sensor Reconnaissance and Siting Requirements

Background and details regarding *general* site reconnaissance can be found in the Water Level and Meteorological Site Reconnaissance Procedures. Information specific to meteorological sensor reconnaissance are included in this document. **Complete the attached Meteorological Sensor Reconnaissance site and obstruction forms and submit to Operational Engineering Team of the Engineering Division.**

Even if the site is an existing NWLON station, some advance notice may be required or appreciated by the owner. A statement involving partnerships with the NOAA National Weather Service (NWS) and others should be included. For example, if NWS has special requirements or needs with the meteorological sensors at a particular site, CO-OPS needs to give the nearest Weather Forecasting Office (WFO) advance notice of the reconnaissance so that they can have a representative on site to better articulate their needs and verify proper placement for winds.

When conducting a site reconnaissance for meteorological sensors, the following equipment, forms, and information are needed:

- Digital Camera/Videotape Recorder
- Published Bench Mark Sheet, if available, or historical bench mark descriptions
- Historical station information, if available
- NGS Datasheets for area - required in the lakes to reference NAVD88/Dynamic Heights for the International Great Lakes Datum

- Shovel and other digging equipment
- Bench Mark recovery items (survey ribbon, marking paint)
- Metal detector
- Sample License or Lease Agreement/Letter of Permission
- Weighted tape
- 50 or 100 m survey tape for Bench Mark recovery
- Engineering sketch pad
- Inclinometer
- Carpenters level or plumb bob
- Hand-held GPS
- Compass
- IP Modem Kit which consists of a Verizon IP Modem, AT&T IP Modem, Small Battery, and an Antenna
- Chart section
- Meteorological Sensor Reconnaissance forms
- All contact information

Make the following observations:

- Direction of prevailing winds.
- For wind sensor installations, choose an area free of obstructions that affect the path of the wind (see section 2.1). Verify positioning with any associated partnership representatives.
- IP Modem signal strength. Connect the IP Modem Kit to your laptop or a loopback, then contact the instrument lab and let them communicate to the modem and determine signal strength. Perform this for each service provider IP Modem in the kit. Record the service provider and the respective signal strength.
- GPS latitude/longitude of station & bench mark locations. Record position to the tenth of a second.
- *Take digital photographs of the proposed DCP/sensor location and benchmarks.*

To obtain data representative of a station's surroundings, local conditions must not be artificially influenced by surrounding materials and/or obstructions (e.g., concrete, buildings, snow, etc). The sensor exposure will strive to minimize or eliminate the effects of manmade or geographical obstructions. Sensors should be located as far as practicable from cultivated land to reduce contamination by dust and dirt.

These sensor siting requirements are adopted from the Office of the Federal Coordinator for Meteorology (OFCM) standards, with which all federal agencies, including the NWS, comply. Proper siting of meteorological sensors may be difficult depending on station location, but every effort should be made to meet these requirements, thus ensuring that the sensor is representative of local conditions. If any questions arise regarding the requirements, contact OET for guidance.

2.1 Wind

- The standard mounting elevation is 9 - 10 m (30 - 33 ft) above the ground in open, level terrain. Small gradual slopes are acceptable. If local restrictions prevent installing the sensors at the 10 m (33-ft) standard, install them no less than 6 m (20 ft) above the ground.
- A horizontal distance of ten times the height of an obstruction should be maintained, between the wind sensor and the obstruction, for the surrounding area to be considered open terrain. An obstruction can be manmade (building) or natural (tree).
- If the sensor is to be mounted on the roof of a building, it should be mounted at a height of 6 m (20 ft) above the highest structure. This is to remove the sensor from the area in which the air flow is affected by the building. For tall buildings where this guideline cannot be met, a 3 to 5 m (10 to 15 ft) mast should be mounted on the side of the building with the prevailing wind.
- If the sensor is to be mounted on a tower, the sensor should be above the tower or on a boom. The boom should be twice as long as the maximum diameter or diagonal of the tower, and should be directed into the prevailing wind.

2.2 Air temperature/Relative humidity

- Standard mounting elevation is 1.2 to 2.0 m (4.0 to 6.5 ft) above grade.
- The sensor should be mounted over a plot of open level ground at least 9 m (30 ft) in diameter. The ground beneath the sensor should be short grass or natural earth, not asphalt, concrete, areas of standing water, etc.
- The distance between the sensor and any obstruction should be at least 4 times the height of the obstruction (40 m for a 10-m obstruction). It should be at least 30 m (100 ft) from large paved areas and not close to steep slopes.
- If mounted on a tower, the sensor should be on a tower boom at least as long as the tower diameter.
- Temperature sensors should have downward facing aspirated shields.

2.3 Barometer

Site selection is not required for the sensor as it is mounted inside the unit and vented to the outside.

3.0 Meteorological Sensor Height Measurement Requirements

The following requirements specify that **sensor heights be measured to the nearest 30 cm (1 ft)** and the measurements for meteorological sensors (wind, air temperature and barometer) are to be made to the middle of the sensor. All meteorological sensors shall be measured, recorded on paper, and reported on site reports in metric units only. All meteorological sensor measurements shall be conducted every 5 years.

Methods to obtain these sensor heights depend upon the type of station that the sensors are located at (a tide/water level station or a stand-alone met station).

3.1 Water Level stations

These stations include a meteorological tower (Rohn tower or a Shakespeare pole) generally installed in the immediate vicinity of the water level station and its associated benchmark network.

The requirements for measuring the meteorological sensor heights are:

- A temporary bench mark (TBM) shall be established at the base of the meteorological tower or pole if there is not already an acceptable benchmark directly below the tower. A bolt used to anchor the structure can be used as the reference TBM. The TBM should be at a height that is representative of the surrounding terrain.
- All measurements of meteorological sensor heights on the tower/pole will be measured down to the TBM in order to establish the height of the sensor above ground.
- The TBM shall be connected via line leveling to at least one bench mark at a water level station so that TBM elevation and the meteorological sensor elevation above station datum can be determined.
- The following sensors shall be measured down to the TBM:
  Wind (primary and backup)
  Air Temperature
  Relative Humidity
  Dew Point
  Rain Fall
  Solar Radiation
- Enter the value in the E-Site report under "Height above TBM" to the nearest 30 cm for the appropriate meteorological sensors, or on the tide station report, as applicable.
- The barometer shall be calibrated according to the CO-OPS Barometer Calibration Guidelines, updated February 2002.
- The TBM shall be included in the leveling run and connected to the Primary Bench Mark (PBM). OET will use the leveling run to help establish the heights of the meteorological sensors above the station datum.

3.2 "Stand-alone met" stations

A stand-alone met station consists solely of meteorological sensors and therefore is not accompanied by a suite of tidal bench marks. All of the measurement requirements for meteorological sensors are referenced to a TBM using the same methods explained above for water level/tide stations. Because of the absence of bench marks in the area of the station separate guidelines shall be followed to obtain a tie to datum.

For stand-alone met stations that **DO NOT** have a barometer present the field crew must reference the meteorological sensors above the TBM only. Otherwise when a barometer **IS** present the field crew must obtain a tie to MSL.

There is no single best fit method to obtain a tie to datum (MSL) without the presence of benchmarks since every stand-alone met station will present unique situations. The following guidelines will provide the field crew with various methods to obtain a TBM height relative to MSL at a stand-alone met station. It will be up to the discretion of the crew chief to choose the method that best fits the situation facing him/her at a particular station.

- In certain situations there may be a published bench mark sheet or a data sheet available (NGS or USGS bench marks that would give a site elevation) in the area of a stand-alone met station. If the bench mark has a published elevation, then the field crew can level to the mark from the TBM to obtain a tie from the barometer to datum.
- In the absence of a published bench mark elevation, level from the TBM to the vicinity of the water surface. Provide the time of measurement in GMT from the TBM to the water surface.

  From this point there are several methods that may be used to obtain a height of the average water level.
  - If there is a bulkhead present use a steel tape to measure down to the water surface.
  - A level rod may be held as close to the water surface as possible. This method may be difficult to obtain a steady elevation but still remains viable.
  - A spike may be set and leveled to the shoreline at a height that best represents the average water level based on the judgment of the crew chief.
  - A "staff" may be driven into the sea/lake floor and leveled to the top of the staff. The instantaneous water level may then be read off the staff.

- If the meteorological tower is located on a pier then the field crew will need to provide the following information:
  - TBM height above the water.
  - Time of measurement in GMT from the TBM to the water.

The time that the instantaneous water level reading is taken shall be noted in the comments section for the meteorological sensors in the E-SITE report or on the tide station report, as applicable. Then the height above MSL for the barometer could be determined from the time recorded.

APPENDIX A

Meteorological Reconnaissance Form