METEOROLOGICAL STATION STANDARD OPERATING PROCEDURES
UTE MOUNTAIN UTE TRIBE AIR QUALITY PROGRAM

This document outlines the standard operating procedures (SOP) for the site selection, hardware connections, programming, maintenance, calibration and data collection of a Campbell Scientific based meteorological weather station for the Ute Mountain Ute Tribe's Air Quality Program (UMUAQ). This SOP does not replace the Campbell Scientific manual, but the user must become familiar with the procedures in this manual. The purpose of the SOP is to standardize setup, maintenance, calibration, and data download procedures for the Ute Mountain Ute Air Quality Program.

This document is separated into seven parts:

North Pump House Meteorological Station, White Mesa, Utah

The SOP is designed to help research coordinators and technicians carry out meteorological data collection at their site, minimize the collection of inaccurate data, and ensure consistent operating procedures. As you use this document and the associated tracking sheet, keep notes on what changes you would like to see that could streamline the procedure without jeopardizing the quality of the data we are collecting.

1. **General Information, site selection and sensor placement**

The primary concern in site selection is to choose a site that is typical of the main areas of concern and research for the UMUT-AQ. The site should not be located near parking lots, buildings or other areas of unnatural influence on weather patterns. The second concern of site selection is accessibility for maintenance and data download. The units have to be maintained and data downloaded at least once a month.

The site is located in White Mesa, Utah on the North pump house off of Cowboy Street. The area is protected by a barbed wire fence enclosure and has an already existing power source.

Tripod

The CM106 is used here as a general purpose tripod that can be used for mounting sensors, solar panels, antennas, and instrument enclosures. The CM106 is constructed from galvanized steel, with individually adjustable legs that allow installation over uneven terrain. Height of mast is 7ft or 10ft with mast extension. Tripod installation near power lines is dangerous. The minimum safe recommended distance from overhead power lines is 2 times the height of the tripod and mast combined.

Temperature and Relative Humidity

The HMP60 Temperature and Relative Humidity Probe contains a Platinum Resistance Temperature detector (PRT) and a Vaisala INTERCAP capacitive relative humidity sensor. The sensor must be mounted in a gill radiation shield designed for the sensor. The sensor should be located over an open level area at least 9 m in diameter. Sensors should be located at a distance of at least four times the height of any nearby obstruction and at least 30 m from large paved areas.

Barometric Pressure

The CS106 is a barometric pressure sensor. It functions over a standard barometric pressure range of 500 to 1100 millibar (mb), which is below sea level (as in a mine) to over 15,000 feet above sea level. Designed for use in environmental applications, the CS106 is housed in the datalogger enclosure.

Wind Speed and Direction

The 05103 Wind Monitor sensors are used to measure horizontal wind speed and direction. Wind speed is measure with a helicoid-shaped, four-blade propeller. Rotation of the propeller produces an AC sine wave signal with frequency proportional to wind

speed. Vane position is transmitted by a 10K ohm potentiometer. With a precision excitation voltage applied, the output voltage is proportional to wind direction. Locate wind sensors away from obstructions. Generally, there should be a horizontal distance of at least ten times the height of the obstruction between the windset and the obstruction. If the sensors need to be mounted on a roof, the height of the sensors above the roof should be at least 1.5 times the height of the building. The wind sensor should also be placed true North, where the angle of declination is taken to account from magnetic North.

Rain gage

The TE525 is a tipping-bucket rain gage widely used in environmental monitoring applications. The TE525 funnels precipitation into a bucket mechanism that tips and actuates a switch. The momentary switch closure is counted by the pulse-counting circuitry of any of the Campbell Scientific dataloggers.

2. Hardware/Tools

Tripod

a. *1/2" and 7/16" open end wrenches*
b. *Adjustable wrench*
c. *Phillips head screwdriver*
d. *Straight bit screwdriver (medium and small)*
e. *12" torpedo level*
f. *Side-cut pliers*
g. *Tape measure*
h. *Compass and site declination angle*
i. *Step ladder*

Temperature and Relative Humidity

NA

Barometric Pressure

NA

Wind speed and Direction

General installation requires the wind monitor to be setup aligned to true North

a. *5/64" Allen wrench*
b. *½" open end wrench*
c. *Compass and declination angle for the site*

d. *Small screw driver provided with datalogger*
e. *UV resistant cable ties*
f. *Small pair of diagonal-cutting pliers*
g. *6-40" torpedo level*

See specific installation instructions from the Campbell Scientific manual.

3. Wiring

A detailed color coded schematic of wiring is located on site for ease of access and use. A text schematic is shown below.

Temperature and Relative Humidity

Wire label	**Color**	**CR200X Datalogger**
Temp Signal	Black	Single-Ended Input
Relative Humidity	White	Single-Ended Input
Power and Signal Ground	Blue	G
Power 12V	Brown	12V
Shield	Clear	

Always connect the blue lead to the datalogger first, followed by the black, white, and clear leads. Connect the brown (Power) lead last.

Barometric Pressure

Wire	**CS106 Terminal**	**Datalogger Single-Ended Measurement**	**Datalogger Differential Measurement**
Blue	VOUT	S.E. Input	High Side of Differential Input
Yellow	AGND	AG (CR10(X), CR500, CR510) (Other Dataloggers)	Low Side of Differential Input
Black	GND	(21X, CR7, CR9000(X)) G	(21X, CR7,CR9000(X)) G
Green	EXT TRIG	Control port (use to turn power on/off)	Control port (use to turn power on/off)
Red	SUPPLY	12VDC	12VDC
Shield	Shield	G (CR10(X), CR500, CR510 (other dataloggers)	G (CR10(X), CR500, CR510 (other dataloggers)

Wind speed and Direction

Color	**Description**	***CR200X***

Red	Wind Speed Signal	P_LL
Black	Wind Speed Reference	
Green	Wind Direction Signal	SE Analog
Blue	Wind Direction Excitation	Excitation
White	Wind Direction Reference	
Clear	Shield Wire	

Rain gage

Color	**Description**	**CR200X**
Black	Signal	P_SW
White	Signal Return	
Clear	Shield	

4. Programming and data download

Datalogger

The datalogger is programmed via the Campbell Scientific PC 400 software. The usable data points are based on the interval of collection, the amount of variables included (max, min, average, etc.), and the average of the interval of collection. The current data logger program is set for a monthly collection schedule to prevent overriding of memory. Data collection must be carried out physically with a nine pin to USB to a field laptop computer that contains the PC 400 software. The software is accessed on the desktop of the Air Quality Technicians laptop.

a. Collecting Data onsite from Meteorological Station:

-Double Click on PC 400 on the desktop
-Click 'Open Program'
-Click 'UMUT Met2.swc'
-This is the programming section of the software, where details of data collection are available. The screen behind, PC400 4.1 Datalogger support software is for actual data collection.
-Highlight the checkbox **'Table 1'**
-Click '**Monitor Data'** to view real time readings or,
-Click **'Collect Data'** to download data to computer

Once 'collect data' is chosen, all data is appended to the computer which will immediately initialize a new data collection set from that date forward.
-Click **'Change Table Output'** to save the data to the Met Station Data file

-Save as **MetData (date)** under North Pump House Meteorological Station

b. Importing Data (DAT) into Excel format:

-Open a new Excel file
-Click **'Data', 'From Text'**, open '**Air Quality/CampbellSci/PC400/All files'** and chose the newly saved Campbell Scientific DAT file
-An import text wizard screen will show up. Click **'next'** then check the box **'comma'** which will organize the data in the correct delineation and then **'next'** again. Click **'finish'** and you should have your data into a nice new excel file.
-The data that you have now is all appended met data for the dates chosen. Graphs can be made for variable meteorological parameters, including a **WindRose** graph which will be described below.
-Click on **'Sheet 2'** and copy and paste the columns TOA5 TIMESTAMP, WS_mph miles/hour Smp, WindDir_D1_WVT miles/hour WVc with a column space in between all of them.
-Create a Wind Speed and Wind Direction average column that averages six rows of the respective wind speed and wind direction
-Now make a column for each day, month, year, hour and minute by clicking **= 'minute'(date), = 'hour' (date), = 'year' (date),** etc.
-Under the Data Header, chose the filter tool and apply it to the minute column, choosing whichever ten minute interval is at the top of the list. For example, if the first data entry is **9/2/2011 11:20,** then filter for all **'20'** minute intervals.
-Copy and paste the entire sheet that has the filter applied to a new excel file titled **'WRReady(date)'** under '**Air Quality/North Pump House Met Station/Met Data.'**
-In the new **'WRReady(date)'** file, highlight the average wind direction column, right click to **format cells,** chose number and decrease the decimals from **2** to **0**. Wind Rose software will not accept input data for wind direction with decimals!
-Save **'WRReady(date)'** file in Excel Workbook 97/2003!
-This format is now ready for import into **'Lakes Environmental/WRPlot /WindRose.' NOTE:** You should save this file in Excel Workbook 97/2003 to be compatible with **WRPlot** software.

c. Importing Excel File to Lakes Environmental WRPlot:

-When in **WRPlot,** click **'Tools'/'Import from Excel'/'Specify file'** and select your file.
-Specify your '**Excel Column Name'** by letter and modify your units in **'Unit in Excel File'** to the proper units

-Specify your proper 'Rows to Import' for the respective first and last
-Make sure to specify station information
-Click **'Import'**
-Close that window, and behind will be another window that you can add the Samson file you've created in the previous step.
-Once created, under the **Met Data Information** tab you should specify the days of the data collection range.
-View the WindRose and save it by clicking **Edit/Copy to File/Bitmap.** Save as **WindRose(date)** under **MetData** file.

5. Data Download and Backup Procedure

In the Field	One month of data is downloaded using PC400 loaded on UMENVLPTP06	"Save as" CR200 mm-dd-yy in C:/Air Quality/Campbell Scientific/PC400/	
In the Office	Copy the CR200 mm-dd-yy from laptop to V:/CAA103/Data/ and External HD (Phantom) D:/Data/	Within a week of download, convert and process CR200 mm-dd-yy to Excel Format and "save as" mm-dd-yy	Follow Met SOP for Wind Rose

6. Meteorological Calibrations: Standard Operating Procedures

a. <u>Rainfall</u>

- Fill calibrated bottle from Rain Gauge Calibrator to the 900ml level.

- Attach base with plastic orifice tip to bottle.

- Remove screen from rain gauge and invert bottle and base so that water drips into hole in rain gauge funnel.

Note: The bottle must be turned over quickly and smoothly to avoid splashing water out of the bottle. It is recommended to hold bottle over the rain gauge to catch any spilled water, so it will be counted in the total amount of water.

-Record rainfall amount from data logger in the site logbook. The process will take 45 min to 1 hour.

b. Temperature

- Place temperature probe and thermometer in a water bath that is close to ambient temperature (approximately 20ºC). Record readings from thermometer and data logger in site logbook.

- Place temperature probe and thermometer in an ice bath. Stir constantly until temperature stabilizes. Record readings from thermometer and data logger in site logbook.

- Place temperature probe and thermometer in water and heat to 100ºC reading on thermometer. Record readings from thermometer and data logger in site logbook.

c. Wind Speed

1c. Wind Speed Threshold:

- Remove propeller from the propeller shaft.

- Set torque disc for proper torque according to a table found in manufacturer's instruction manual.

- Install torque disc on propeller shaft; ensure torque disk is facing out.

- Check rotation of disc using the following weights for this portion of the calibration:

Black Nylon Screw	(0.1 gram)
Stainless Steel Screw	(1.0 gram)

The total torque (grams per centimeter) depends of the position of the weight(s) inserted in to the propeller torque disc. Use the Manufacturer Instruction Manual's Anemometer Torque Disc schematic as an additional guide.

Example #1: If a Black Nylon Screw (0.1gram) is inserted into the third position from the center of the propeller torque disc, the total torque will equal 0.3grams per centimeter.

Example #2: If a Stainless Steel Screw (1.0gram) inserted into the second position from the center of the propeller disc, and at the same time there is a Black Nylon Screw (0.1gram) inserted into the 4^{th} position from the center of the propeller torque disc, the total torque will equal 2.4 grams per centimeter.

- Insert weight(s) in to the propeller torque disc (with weights in a horizontal position) until the rotation threshold is achieved. The minimum rotation threshold should be recorded. Both clockwise and counterclockwise rotation should be checked and recorded in the site logbook.

- Ensure the propeller torque disc rotation threshold is within specification.

Note: If the torque disc rotation threshold is out of specification, replace the propeller shaft "Flange Bearing", then repeat test.

2c. Wind Speed Signal:

- Install coupling disc on the propeller shaft. Install the clamp and bar assembly on to the front of the wind sensor. Then insert the motor assembly into the coupling disc and tighten into place.

- Plug the motor into the "Anemometer Drive Control Unit".

- The first reading for RPM will be a zero reading, Record readings from the Anemometer Drive Control Unit and data logger in the site logbook.

- Set Anemometer Drive Control Unit to produce 200PRM. Record the readings from the Unit and data logger.

- Set Anemometer Drive Control Unit to produce 400PRM. Record the readings from the Unit and data logger.

- Repeat for RPM values of 600, 1000, 4000, and 7000.

- Ensure the "Anemometer Drive" test is within specification.

Note: If the "Anemometer Drive" test is out of specification, replace the propeller shaft "Flange Bearings", then repeat the test.

3c. Replacing the Propeller Shaft Flange Bearings

Use the Manufacturer Instruction Manual's Bearing Replacement/Potentiometer Adjustment schematic as an additional guide.

- Remove the "Nose Cone" assembly from the front of the wind sensor.

- Remove the magnet from the Nose Cone assembly by loosening the magnet set screw. Pull the propeller shaft out after removing the magnet.

- From the Nose Cone remove the two bearings, located in the front and located in the back. Replace with new bearings.

- Reattach the propeller back to the Nose Cone.

- Replace the magnet onto the propeller shaft. Use the “Gap Gauge” to properly gap the magnet on the propeller shaft, while tightening the set screw.

- Re-Install the Nose Cone back onto the front of the wind sensor.

4c. Wind Vane Bearing Condition:

- Install the vane torque gauge on top of the wind vane. Ensure centerline of the torque gauge is aligned with the centerline of the bearing shaft.

- Using a piece of thread attached to the leaf spring of the vane torque gauge, turn the wind vane 360 degrees. Perform this action for both clockwise and counterclockwise.

- Record the torque values in the site logbook. Ensure the values are within specification.

d. Wind Direction:

1d. Degree Verification

- Install the Alignment Arm Assembly on to the Vane Angle Bench Stand. Secure the Wind Vane in the “V” portion of the Alignment Arm Assembly.

- Align the compass on the Vane Angle Bench Stand to read 30 degrees. Take the reading off the data logger and record in the site logbook.

- Repeat for the remaining compass point values: 110, 190, 260, and 340 degrees. (Note: Theses number have been chosen to ensure uniformity across the range of motion).

- Ensure all of the compass point readings are within specification.

2d. True North Alignment/Verification

- Re-install the propeller on the shaft. Mount the wind sensor back on the tower.

- Standing at least 10 meters away from the tower, use a compass to verify the “directional reference pointer” is pointing towards true north (±5 degrees).

- Record compass reading in the site logbook. Ensure correct alignment.

7. Meteorological Instruments Routine Maintenance: Standard Operating Procedure

Do Monthly:

- Check that all meteorological instruments are operational and producing correct readings typical for the surrounding environment.

- Check voltages from instrument wirings with the Fluke Mulitmeter. Record observed voltage readings from Data logger and DVM in site logbook.

- Ensure instruments are recording within range. If readings are outside range, refer to **Meteorological Calibrations** SOP for calibrations. Also, refer to instrument manuals for trouble shooting procedures.

a. Wind Speed / Wind Direction

- Check that wind monitor is operational and producing correct readings typical for the surrounding environment
- Take wind speed and wind direction parameters offline on Data logger.
- Wind Speed Threshold: In calm weather, blow gently on propeller. Watch for obvious high torque or irregular rotation.
- Wind Direction Threshold: In calm weather blow gently on vane. Watch for obvious high torque or irregular motion. Check vane balance and adjust if necessary.
- Wind Direction Signal: Visually align vane with known reference. Compare output signal. Align vane with additional reference points or cardinal points marked on housing.
- Ensure wind monitor is reading within range. If readings are outside of range, refer to **Meteorological Calibrations** SOP for calibrations. Also, refer to instrument manuals for troubleshooting procedures.

b. Tipping Bucket Rain Gauge

- The rain gauge should be inspected periodically. Accumulated dirt and debris should be cleaned from funnel, screen and tipping bucket.
- Electrical connections should be inspected and cleaned. Leveling screws may be readjusted at this time, if needed.
- Refer to **Meteorological Calibrations** SOP to ensure measurement accuracy.