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Environment, Safety, Health Directorate

Environmental Protection – Compliance Programs

Standard Operating Procedure

Calibration, Refurbishment & Maintenance Of Meteorology Program Equipment

Reviewers:

Name:	Organization:	Signature:	Date:
Melanie Lamb	ADESH-OIO, QA Specialist	Signature on File	10-23-13

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Name:	Organization:	Signature:	Date:
Ellena Martinez	ADESH-OIO	Signature on File	5/27/14

Approval Signatures:

Subject Matter Expert:	Organization:	Signature:	Date:
Gregory T. Stanton	ENV-CP	Signature on File	11/05/13
Responsible Line Manager:	Organization:	Signature:	Date
Steve Story	ENV-CP, Team Leader	Signature on File	2/20/14
Responsible Line Manager:	Organization:	Signature:	Date:
Anthony Grieggs	ENV-CP, Group Leader	Signature on File	3/12/14

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History of Revisions

Document Number *[Include revision number, beginning with Revision 0]*	**Effective Date** *[Document Control Coordinator inserts effective date]*	**Description of Changes** *[List specific changes made since the previous revision]*
0	10/96	New Document
1	03/99	Reformatted in accordance with LIR 300-00-01, Safe Work Practices
2	04/01	Added new section 9.0, Training
3	04/02	Change in Directorate
4	04/03	Team name change to Environmental Surveillance
5	05/04	Updated and reformatted document to conform to MAQ procedures.
6	05/05	Quick change revision to convert HCP to HR, removes chain-of-custody form, and refers to new chain-of-custody procedure.
0	03/08	Replaced: ENV- MAQ-402, R6. Removed sections relating to instruments no longer used. Changed methods of calibration using modern test equipment. Modified calibration methods to use calibrated datalogger as a measuring device
1	04/13	Reformatted to new Division template. Added Attachment 24, CMF7. Updated scope, definitions, and periodic monitoring. Added details to calibration process steps.
2	10/13	Updated Approval Signature Information Removed Bearing Spin-Down Testing Added Attachments 24 to 29 Updated All CMF forms for compliance to UPC Deleted References to Propvane Azimuth Scope Removed Azimuth Transit Process for Compass Updated SODAR & Fuel Moisture System Information and removed calibration requirements. Incorporated information on 6 Month Wind Instrument Checks. Incorporated recommendations from 2013 Calibration Review. Added Attachment 28. Added new forms. Total revision to meet UPC program implementation. Added additional CMF forms, new organization.

Table of Contents

1.0 PURPOSE

This procedure describes the maintenance, refurbishment and calibration processes for the equipment and instruments used in the Meteorology Monitoring Project. This SOP encompasses the system data acquisition components along with the sensors and instruments which measure the atmospheric variables in support of all the operations at the Los Alamos National Laboratory (LANL). The Meteorology Project operations presently fall under the umbrella of the Environmental Protection Division within the Environmental Safety & Health (ESH) Directorate. Not all instruments or sensors in the procedure require verification or calibration.

2.0 SCOPE

The Meteorology Instrumentation Technician is responsible to maintain the equipment, instruments and sensors following this procedure. The technician insures that changes to this document are implemented in a timely manner. Item As-Found calibrations should be completed as soon as possible following instrument removal from monitoring sites.

2.1 HAZARD REVIEW

The work described in this procedure has a **LOW Hazard** rating as documented by submittal of a completed *ENV Low Hazard Verification form* to the Quality Assurance Specialist.

3.0 RESPONSIBILITIES

The training method for this procedure is "self-study" (required reading). Training is documented in accordance with ENV-DO-QP-115, *Personnel Training*.

The Meteorology Instrumentation Technician should meet the training, technical competency, and experience requirements set forth by the Meteorology Monitoring Project Leadership, the Human Resources Department, and as noted in the position description.

Actions specified within this procedure, unless proceeded with "should" or "may," are to be considered mandatory (i.e., "shall", "will", "must").

4.0 DOCUMENT CONTROL & RECORDS MANAGEMENT

The following records are generated as a result of this procedure and are maintained in accordance with ENV–DO-QP-110, *ENV Records Management Program*:

- Form CMF1-Horizontal Wind Measurement Instruments Tracking & Verification
- Form CMF2-Vertical Wind Measurement Instruments Tracking & Verification
- Form CMF3-Temperature Measurement Sensor Tracking & Verification
- Form CMF4-Humidity & Pressure Measurement Instruments Tracking & Verification
- Form CMF5-Precipitation Measurement Instruments Tracking
- Form CMF6-Solar Radiation Measurement Instruments Tracking & Verification
- Form CMF7-Data Logger Instrument Tracking & Verification
- Form CMF8-Meteorology Standards Calibration Tracking Worksheet
- Form CMF9-05305AQ Wind Instrument Calibration Worksheet
- Form CMF10- 27106T Wind Instrument Calibration Worksheet

5.0 WORK PROCESSES

The Meteorology Instrumentation Technician performs the steps outlined in the subsequent pages.

5.1 HORIZONTAL WIND VANE PROPELLER ANEMOMETER

5.1.1 PREPARATION FOR CALIBRATION

Step	Action
1	Familiarize yourself with the Horizontal Wind Vane Anemometer; Read Attachment 1 "Horizontal Wind Vane Anemometer Description, Specifications, and Common Problems"
2	Compile the following equipment and supplies: • RM Young Model 18112 Vane Angle Bench Stand Fixture • Level Development Model CG20 Surface Mount Bulls-Eye level, (or equivalent) • RM Young Model 18310 Anemometer Torque Disk with weights • RM Young Model 18331 Horizontal Vane Torque Gauge • RM Young Model 18801 or 18802 Anemometer Drive unit. • RM Young 1800 RPM fixed rate Anemometer Drive unit • Campbell Scientific calibrated Model 21X datalogger. • 21X Pigtail Instrument Cable Adapter • Campbell Scientific Program written for testing Anemometers (must be written by technician) • Computer/Laptop with PC208W or LoggerNet software & SC32B serial interface module w/cable • Stanley, 9" Torpedo Level, (or equivalent). • Calibrated Digital or Analog Oscilloscope (with appropriate range)
3	Review the instrument, equipment, sensor, and manufacturer's literature before proceeding with activities.
4	Complete all the appropriate Header information of form CMF1, (Attachment 18) Horizontal Wind Instruments Tracking & Verification Form.

5.1.2 HORIZONTAL WIND VANE ANEMOMETER CALIBRATION

1	Perform the Vane Torque Test: Place the Model 18112 Vane Angle Bench Stand Fixture on a smooth level surface and confirm level with a 9" torpedo level. Adjust the three platform thumb screws to obtain level.
2	With the Propeller installed mount UUT on the Model 18112 Vane Angle Bench Stand Fixture following the manufacturer's instructions, making sure to tighten the locating ring.
3	Install the Model 18331 horizontal torque gauge on the UUT following the manufacturer's instructions making sure to align the gauge with the vertical reference marks on the side of the UUT.
4	Place the bulls-eye level on the Model 18331 vane torque gauge and confirm the unit is level as placed on top of the UUT.
5	Perform the Wind Direction Vane Torque Test: • Using the Model 18331 Vane Torque Gauge, measure the wind vane system torque in four quadrants following the steps below (Note: room air movement must be calm) • Lower the Alignment Arm of the Bench Stand so the UUT rotates freely on the fixture. • Position the nose of the UUT at the 90 degree position of the bench stand and pause a moment until the UUT stops moving; measure the torque in both directions insuring you hold the thread of the vane torque gauge relatively level and perpendicular to the UUT. • Position the nose of the UUT at the 180, 270, & 360 degree positions respectively and make torque measurements at each setting. • Record the instrument serial number and the torque measurement values in the appropriate spaces on form CMF1 Part-2, (see Attachment 18) • If any of the 4-quadrant vane torque value readings are > 20 g-cm, replace the vertical shaft bearings during refurbishment in accordance with the instrument manual.
6	Perform the Wind Speed Torque Test: • With the UUT still installed on the Bench Stand Angle Fixture remove the propeller. • Identify the heavy point on the shaft: Spin the shaft by hand 3 times in the CW and CCW directions, each time marking with a sharpie the top side of the shaft when the shaft has stopped spinning. • With masking tape, mount the Model 18310 torque disk (with the 0.5 g-cm weights attached) on the UUT locating the weight in the center of the sharpie marks on the shaft. • Rotate the torque disk in the CCW and CW directions through the quadrants pausing at 45, 90,135,225,270, & 315 degree positions to confirm the torque value at each position. • Verify the torque at each stop is below the required specification. • If the torque disk does not rotate at the specified weight, add additional weights to increase the load until the torque disk rotates through the range. • If the torque test result is a PASS, record a check mark (√) in the torque test column of the CMF1. • If the torque test result is a FAIL, record the torque value in the torque test column of form CMF, Part-1 (see Attachment 18). • The PASS/FAIL parameters are indicated on the appropriate CMF Forms. **Notes:** To pass the As-Found torque test the torque must measure $\leq$ 1.0gm-cm or less. To pass the As-Left (Pre-Installation) torque test the torque must measure $\leq$ 0.5 gm-cm. If the instrument fails a particular torque test the instrument must be refurbished and pass the As-Left tests prior to installation in the field.

7	Confirm Wind Speed Transducer Output: • Remove the Torque Disk and couple the Model 18801, 18802, or other Anemometer Drive Unit to the UUT. • With the calibrated 21x Datalogger still connected to the UUT confirm the datalogger program is programmed to measure wind speed in hertz, and wind direction in degrees. • Run the Anemometer Drive Unit in the counterclockwise (CCW) direction at the five designated speeds noted on form CMF1, Part-1, and (Attachment 18). • Record the tachometer response speeds as measured by the datalogger on form CMF1, Part-1, (Attachment 18). **Note:** To pass the speed transducer output test the measurement must fall within +/-0.2 m/s of the target reading. A calibrated digital or analog oscilloscope may be used in place of a calibrated 21X datalogger for making the Wind Speed Measurements.
8	Confirm Azimuth/Direction Transducer Output: • The datalogger is still connected to the UUT; confirm the datalogger program sampling time is 0.5 seconds. You will be using the datalogger to monitor the UUT degree readings during the test. • With the UUT still mounted on the 18112 Vane Angle Bench Stand Fixture, rotate the UUT clockwise (CW) to the azimuth test points as indicated on CMF1 Part-2, (Attachment 18). • For each test position use the datalogger to observe the azimuth angle value displayed on the computer screen program window. Record the values on CMF1Part-2, (Attachment 18). • For the Azimuth Sweep Test, sweep the Horizontal Anemometer slowly through 360 degrees and monitor the sweep to insure the sweep is smooth and not jumpy. If the azimuth potentiometer test is a PASS record a check mark (√) in the appropriate blank on the CMF1 form. • If the azimuth potentiometer test fails note the findings on the CMF1 form accordingly. **Notes:** With the azimuth sweep test the angle should increase slowly as the vane is moved. If you see inconsistencies/jumping-around during the sweep test then the azimuth potentiometer has bad or worn spots. Reminder: The azimuth potentiometer has a dead band from 355 to 360 degrees. To pass the azimuth transducer output test the measurement must fall within +/-3 degrees of the target reading.
9	Record the instrument Serial Numbers on Attachment 25 for Calibration Tracking Requirements.
10	File the completed Attachment 25 in the appropriate log notebooks.

5.1.3 HORIZONTAL WIND ANEMOMETER REFURBISHMENT & MAINTENANCE

1	Completely disassemble the unit referencing the manufacturers manual
2	Install a new azimuth potentiometer.
3	Install new vertical shaft bearings.
4	Install new horizontal shaft bearings.
5	Mount refurbished unit on the 18112 Vane Angle Bench Stand Fixture for testing, & adjustments
6	Connect assembled unit to the datalogger and computer, and insure proper monitoring program is operating.
7	Azimuth Transducer & Vane Alignment Set-Up: • With the datalogger connected to the unit; confirm the datalogger program sample time is 0.5 seconds. The computer should be connected to the datalogger to monitor the readings during the test • Rotate the UUT clockwise (CW) to the 180° position • Observe the measurement as indicated on the computer screen • Remove the instrument nose cone assembly and loosen the Allen screw holding the azimuth thumb wheel in position. • Reach in through the front of the main instrument housing and adjust the azimuth potentiometer thumb wheel until the UUT measurement indicates (as close as possible)180° • Check the readings at 30°, 90°, 180°, 270°, and 330° as measured by the Model 18112 protractor • Balance the measurement error between the 5 azimuth test points to obtain optimal readings • Tighten the azimuth potentiometer in place with the set screw • Note all test results on the new As-Left CMF1 form.
8	Confirm the Balance of the Vane Assembly : • Remove the Horizontal Anemometer from the Model 18112 Vane Angle Bench Stand Fixture • Hold the Horizontal Anemometer horizontally (with a propeller installed) in a room with no air movement/calm • If balance adjustment is necessary, remove the propeller and insert (or remove) washers to achieve balance. **NOTE:** When the Horizontal Anemometer is balanced and the air calm the Anemometer vane will NOT rotate.
9	Repeat Section 5.1.2 with a new CMF1 for all refurbished Horizontal Anemometers...
10	Coat the instrument body and propeller in preparation for installation: Apply a good-quality automotive wax or Rain-X to the Anemometer instrument body, and a T.F.E. Dry Lubricant type spray to the propeller. Note: The lubricants will minimize snow and ice accumulation and protect the instrument surfaces.
11	Group the calibrated instruments according to the next planned tower installation.
12	Complete the CMF1 form with the exception of the tower & level assignment and place the CMF1 with the instruments ready for installation.
13	Once the instruments are installed on a tower complete the remainder of the CMF1 form, sign & date the form as appropriate and file the form in the tower activity log notebook.

5.2 VERTICAL WIND PROPELLER ANEMOMETER

5.2.1 PREPARATION FOR CALIBRATION

1	Familiarize yourself with the Vertical Wind Vane Anemometer: • Read Attachment 2, Vertical Wind Anemometer Description, Specifications, and Common Problems • Review the equipment, instrument, sensor and manufacturer's literature before proceeding with the calibration & maintenance.
2	Compile the following equipment and supplies: • RM Young Model 18310 Anemometer Torque Disk with weights • RM Young Model 18331 Horizontal Vane Torque Gauge • RM Young Model 18801or 18802Anemometer Drive unit. • RM Young 1800 RPM fixed rate Anemometer Drive unit • Fluke Model 8846A 6-1/2 Digit Precision Multimeter, w/test leads (or equivalent rated instrument) • Stanley, 9" Torpedo Level, (or equivalent) • Vertical Anemometer Calibration Aid (internally fabricated unit)
3	Complete all the appropriate Header information of the CMF2 Form, (Attachment 19) indicating if it is a 6-Month check, an As-Found/Post or As-Left/Pre-Installation Calibration.

5.2.2 VERTICAL WIND PROPELLER ANEMOMETER CALIBRATION

1	Perform the wind speed system torque test: • Remove the propeller from the UUT and carefully place the instrument horizontally in the bench vise • Level the UUT in the vise with the 9" torpedo level • Identify the heavy point on the shaft: Spin the shaft by hand 3 times CW and when the shaft stops spinning mark the top of the shaft with a sharpie marker. Repeat this for the CCW direction. • Take note of the opposite side of the heavy point, the marked locations of the shaft. • With masking tape, mount the Model 18310 torque disk with the proper weights attached to the UUT and with the weights opposite to the heavy point of the shaft, (Line the weight up with the center point of the sharpie marked area on the shaft). • In the CCW and CW directions rotate the torque disk through the quadrants stopping momentarily at the 45, 90,135, 225, 220, & 315 degree positions, confirming the torque value at each position. • Verify the torque test at each stop meets the specification for the specific test • If the torque disk does not rotate at the specified weight, add additional weight to increase the load until the torque disk rotates through the range. • If the torque test result meets the specification below it is a PASS, record a check mark (√) in the torque test column of the CMF2. • If the torque test does not meet the specification below it is a FAIL, record the torque value in the torque test column of the CMF2 (see Attachment 19) **Notes:** To pass the As-Found torque test the torque must measure $\leq$ 1.0gm-cm or less. To pass the As-Left (Pre-Installation) torque test the torque must measure $\leq$ 0.5 gm-cm. If the instrument fails a particular torque test the instrument must be refurbished and pass the As-Left tests prior to installation in the field.
2	Measure the wind speed transducer output: • Couple the model 18801 or 18802 Anemometer Drive unit to the UUT • Connect the Fluke voltmeter to the instrument output pins (A & B) on the Calibration Aid • Run the Anemometer Drive unit (both CCW and CW) at the 3 speeds specified on the CMF2 form • Record the tachometer response values as measured by the voltmeter on the CMF2 form NOTE: For Wiring Confirmation Purposes Pin A is positive (Red wire) for a CCW rotation.
3	**Note:** A completed CMF2 form is necessary to confirm the As-Found and As-Left calibrations.

4	Record the instrument Serial Numbers on Attachment 25 for Calibration Tracking Requirements.

5.2.3 VERTICAL WIND ANEMOMETER REFURBISHMENT & MAINTENANCE

1	Completely disassemble the unit referencing the manufacturer's manual.
2	Install a new tachometer coil and shaft bearings.
3	Repeat Section 5.2.2 Vertical Anemometer Calibration.
4	Coat the instrument body and propeller in preparation for installation apply a good-quality automotive wax or Rain-X to the Anemometer instrument body, and a T.F.E. Dry Lubricant type spray to the propeller. Note: The lubricants will minimize snow and ice accumulation and protect the instrument surfaces.
5	Complete instrument refurbishment information on Attachment 29 Checklist.
6	Group the calibrated instruments according to the next planned tower installation.
7	Complete the CMF2 with all information except the tower & level assignment and stage the CMF2 form with the instruments ready for installation.
8	Once the instruments are installed on a tower complete the remainder of the CMF2 form, sign & date as appropriate and file the form in the appropriate tower activity log notebook.

5.3 TEMPERATURE SENSORS

5.3.1 PREPARATION FOR CALIBRATION

1	Familiarize yourself with the Temperature Sensor: Read Attachment 4, Atmospheric Temperature Sensor w/Radiation Shield Assembly, Description, Specifications & Common Problems
2	Compile the following equipment and supplies: • 1900ml Dewar flask • Dewer Flask Cover (test aide) with penetrations for 10 temperature sensors • Calibrated Fluke 8846A 6-1/2 Digit Precision Multimeter (or equivalent) • Calibrated Fluke 884X- 100 Ohm RTD Temperature Probe (or equivalent) • Calibrated Fluke 87V Multimeter (or equivalent) • Temperature Probe Test Aid Switch Box • Crushed Ice • Variable/Hot Water Supply {Means/Method to alter Test Bath Temperature to 15ºC & 30ºC} • Temperature Transducer Data Interpolation Sheet
3	Compile the necessary CMF3 forms from the attachment section.

5.3.2 TEMPERATURE SENSOR CALIBRATION

1	Familiarize yourself with all the equipment manuals and pertinent manufacturer's literature regarding the instrument and calibration equipment before proceeding.
2	For As-Found/Post Calibrations group the temp probes according to tower they were removed from and enter the probe and tower information into form CMF3, Part-III. (Attachment 20)
3	For As-Left (Pre-Installation) Calibrations group the probes and assign them as a set to one tower; entering the serial numbers in the tower assignment table of CMF3, Part-I.
5	To start fill the Dewar flask with a crushed ice/water bath.
6	The target temperature for the initial test bath is 0º +/- 0.1ºC; see CMF3 Part-I for the other test bath temperatures.
7	Place the temperature probes in the bath with the reference RTD/Thermometer positioning the temperature sensors at a 4.5" depth (the mid-point region of the test bath) and confirm a 1/2" distance between the temp. probes and the side of the Dewar flask.
8	Insert the RTD probe in the flask to the same depth as the sensor tips.
9	Allow 3-5 minutes for the bath temperature to stabilize at the target temperature. [NOTE: For the 0ºC bath no temperature adjustment should be necessary; For the 15ºC & 30ºC test baths adjust the bath temperature by adding warmer or colder water until the desired temperature is reached.
10	When the bath temperature has stabilized at the desired reading, record the temperature of the bath on Attachment 20, form CMF3, Part III, in the Reference Temperature Section. **Note:** You will need to record the Test Bath Start & End Temperatures 3 times for each temperature level test.
11	With the appropriate multimeter connected to the Temperature Probe Test Aid Switch Box measure and record the resistance of each probe in the appropriate space on form CMF3, Part I.
12	Repeat steps 7 through 11 for the 15ºC & 30ºC test baths.
13	Transcribe your readings and measurements to the appropriate forms of Attachment 20, CMF3, Part-I, Part-II, & Part-III.
14	For each of the Averaged Resistance Readings found on form CMF3 Part-I, refer to the Calibration Aid Temperature Transducer Resistance Interpolation Chart (Attachment 28) to identify the temperature conversion to resistance reading.
15	Enter the appropriate reading in the Resultant Temperature Column of form CMF3, Part-I.
16	For tracking the verification, installation, and removal of temperature sensors from the meteorology sites, complete the appropriate parts of Attachment 20, CMF3, for As-Left & As-Found Calibrations & file the completed forms in the appropriate Tower Activity Log Notebook.
17	Record the instrument Serial Numbers on Attachment 25 for Calibration Tracking Requirements.

5.3.3 TEMPERATURE SENSOR MAINTENANCE

1	Replace all of the tower site aspiration fans at 4-year intervals to ensure reliable operation.
2	Apply automotive wax or Rain-X to the aspiration shield painted surfaces annually (when accessible) for protection and to reduce ice buildup.
3	Calibrate & replace the monitoring site temperature probes following the recommendations of the LA-UR-08-3032 LANL Meteorological Monitoring Plan, and the User Performed Calibration Procedure.
4	During sensor change-outs inspect the wiring and connectors for oxidation and corrosion; replace as necessary.

5.4 PRESSURE TRANSDUCERS

5.4.1 PREPARATION FOR CALIBRATION

The pressure transducer sensors are submitted to the Standards & Calibration group annually for calibration.

5.4.2 PRESSURE TRANSDUCER MAINTENANCE

1	Read Attachment 5, Atmospheric Pressure Instrument Description and Specifications, and manufacturers documentation to Familiarize yourself with the instrument.
2	Replace the pressure transducers following the recommendations of the LA-UR-08-3032 LANL Meteorological Monitoring Plan, and the User Performed Calibration Procedure. Note: Maintain calibrated operational spares as necessary to minimize monitoring downtime.
3	Exchange the deployed unit with a newly calibrated unit and submit the removed unit to the Standards and Calibration group for calibration.
4	Complete form CMF4 (Attachment 21) with the As-Found Information when the unit is received back from S&CL.
5	Insert the completed CMF4 forms into the appropriate section of the tower activity log notebook.

5.5 RELATIVE HUMIDITY SENSOR

5.5.1 HUMIDITY SENSOR CALIBRATION

The humidity sensors are submitted to the Standards & Calibration group for calibration.

5.5.2 HUMIDITY SENSOR MAINTENANCE

1	Familiarize yourself with the instrument read Attachment 6; Relative Humidity Instrument Description and Specifications and the manufacturer's documentation
2	Replace the humidity sensors following the recommendations of the LA-UR-08-3032 LANL Meteorological Monitoring Plan, and the User Performed Calibration Procedure. Note: Maintain calibrated operational spares as necessary to minimize monitoring downtime.
3	Complete form CMF4 (Attachment 21) with the As-Found Information when the unit is received back from S&CL.
4	Complete form CMF4 (Attachment 21) with the As-Left Information when the unit is received back from S&CL, and prior to deployment to the field
5	Insert the completed CMF4 forms into the appropriate section of the tower activity log notebook.

5.6 FUEL MOISTURE INSTRUMENTATION ASSEMBLY MAINTENANCE

1	Calibration &/or Verification are NOT required for this installation unless found to be damaged.
2	Familiarize yourself with the assembly read Attachment 7, 10-Hour Fuel Moisture Monitoring Assembly Description, Specifications & Common Problems.
3	Replace the 2 fuel moisture wooden dowels annually, and inspect the installation for damage. **Note:** The wooden dowels are matched by the vendor "Campbell Scientific" so should be replaced in pairs.
4	Make an entry in the Fuel Moisture Activity Log Book citing the following: • Work Completed & Descriptions of Adjustments or Modifications • Requirements for any Data Editing & corresponding Time Periods for edits • Any other important/pertinent information regarding data quality

5.7 HEATED TIPPING BUCKET PRECIPITATION GAUGE MAINTENANCE

1	Per our meteorology program monitoring requirements Calibration &/or Verification are NOT required unless the unit is found to be damaged.
2	Familiarize yourself with the unit; read Attachment 8 Heated Tipping-Bucket Precipitation Gauge Description, Specifications & Common Problems along with manufacturers documentation
3	Examine the instrument for damage.
4	Open the mechanism to clean and examine.
5	Brush and Wipe-Out the unit as required.
6	Clean the tipping bucket mechanism with alcohol and the brush to remove any dissolved solids.
7	Check the leveling indicator on the bottom of the unit to verify that the gauge is level; adjust if necessary.
8	Fill out CMF5 as required for this procedure.
9	File the completed CMF5 in the appropriate section of the tower activity log notebook.

5.8 ULTRASONIC SNOW DEPTH SENSOR - MAINTENANCE

1	Per our meteorology program monitoring requirements calibration &/or verification are NOT required unless the unit is found to be damaged.
2	Familiarize yourself with the unit read Attachment 9. Ultrasonic Snow Depth Sensor Description, Specifications & Common Problems
3	Confirm the plumb of the ultrasonic senor with a carpenters torpedo level.
4	If necessary adjust the zero value output by changing the offset in the datalogger program.
5	Replace the desiccant packet in the SR50 annually.
6	Complete the CMF5 form as necessary and file in the appropriate section of the tower activity log notebook.
7	If the SR50 ultrasonic sensor fails in operation return the unit to the manufacturer for repair.
8	Late in the fall, cut the grass very closely to the ground in a 36" diameter circle beneath the SR50 ultrasonic sensor. **Note:** Any grass growth that occurs under the measurement cone will affect the instrument readings.

5.9 8-48 PYRANOMETER & PIR PYRGEOMETER- INSTRUMENTS

1	Familiarize yourself with the units read Attachments 10 & 11, Pyranometer & Pyrgeometer Descriptions, Specifications & Common Problems
2	Instrument Recertification Options: • Manufacturer Recertification: Every 4 years return the instrument to the manufacturer for recertification. OR • Collocation: Every 4 years evaluate the instrument's performance by comparing the instrument performance to a recently (manufacturer) recertified unit specifically by collocating the instruments during operation and compare data for 1 24hour period. **Note:** Maintain certified operational spares as necessary to minimize monitoring downtime.
3	Manufacturer Recertification: • Replace the deployed instrument at a tower with a newly recertified unit and ship the unit to the manufacturer for recertification.
4	Collocation Recertification: • The reference/standard instrument will be collocated with the instrument at each specific monitoring site. • Gather Test Program • Programmed Laptop computer w/SC32B interface cable. • Compare the output of the standard with the output of the tower site instrument. • If necessary, adjust the datalogger program multiplier to compensate for the aging of the tower site instrument.
5	Multiplier Change: • With a newly installed pyranometer change the datalogger input program multiplier to match the new units constant.
6	Complete form CMF6 (Attachment 23) and insert the form into the appropriate section of the tower activity log book.

5.10 METEOROLOGY DATA ACQUISITION SYSTEMS

Familiarize yourself with the equipment by reading Attachment 12; Data Logger Data Acquisition Systems Description & Specifications. The data logger units are sent out Bi-Annually (every 2 years) through S&CL for Calibration

5.11 SOUND DETECTION & RANGING SYSTEM (SODAR) DESCRIPTION & SPECIFICATIONS

Familiarize yourself with the equipment by reading Attachment 3; Sound Detection & Ranging (SODAR) System with Random Acoustic Sounding System (RASS) Description & Specifications. The unit is a computer program based system which does not require calibration; however the unit is equipment with a self-test function which should be run monthly to identify any system component failures. The main antenna array is checked twice per year for debris and cleaned if necessary.

5.12 METEOROLOGY INSTRUMENTATION CALIBRATION & TEST EQUIPMENT – FIELD DIGITAL MULTIMETERS

1	Familiarize yourself with the instrument read Attachment 13, Digital Multimeter Description & Specifications
2	For calibration of the unit return it to the LANL S&CL group. NOTE: The calibration cycle is established and controlled by the S&CL group which maintains the appropriate historical tracking documentation
3	Upon receipt from S&CL for calibration confirm the file number & expiration date on the sticker is for the item received.
4	Calibration tracking documentation is kept in an online database with the S&CL group.

5.13 METEOROLOGY INSTRUMENTATION CALIBRATION & TEST EQUIPMENT – PRECISION DIGITAL RESISTANCE TEMPERATURE DEVICE (RTD) PROBE.

1	Familiarize yourself with the instrument read Attachment 15 Precision Resistance Thermistor (RTD) Description and Specifications
2	For calibration of the unit return it to the LANL S&CL group. NOTE: The calibration cycle is established and controlled by the S&CL group which maintains the appropriate historical tracking documentation
3	Upon receipt from S&CL for calibration confirm the file number & expiration date on the sticker is for the item received.
4	Calibration tracking documentation is kept in an online database with the S&CL group.

5.14 METEOROLOGY INSTRUMENTATION CALIBRATION & TEST EQUIPMENT – PROPELLER ANEMOMETER WIND SPEED SENSOR CALIBRATORS

1	Familiarize yourself with the instruments read Attachment 16, Anemometer Drive Wind Speed Sensor Calibration Units Descriptions & Specifications
2	For calibration of the unit return it to the LANL S&CL group. NOTE: The calibration cycle is established and controlled by the S&CL group which maintains the appropriate historical tracking documentation
3	Upon receipt from S&CL for calibration confirm the file number & expiration date on the sticker is for the item received.
4	Calibration tracking documentation is kept in an online database with the S&CL group.

5.15 METEOROLOGY INSTRUMENTATION CALIBRATION & TEST EQUIPMENT – PROPELLER ANEMOMETER WIND SENSOR VANE/AZIMUTH ANGLE BENCH STAND

Familiarize yourself with the instrument read Attachment 17; Propeller Anemometer Bench Stand Vane/Azimuth Angle Fixture Description. Unit does not require calibration and is replaced if damaged.

5.16 METEOROLOGY INSTRUMENTATION CALIBRATION & TEST EQUIPMENT – HORIZONTAL ANEMOMETER AZIMUTH SITING

Azimuth siting is performed every 5 years to make adjustments for changes in magnetic north declination. Fixed towers are confirmed on a level by level basis using a compass or GPS unit with a resolution of ¼ degrees or greater. The compass or GPS is positioned on each booms instrument mounting post and rotated until the desired measurement w/declination adjustment is observed; the locating ring for the instrument is adjusted to match the compass/GPS reading. Findings and adjustments are noted in the specific tower log book.

6.0 REFERENCES

- LA-UR-08-3032 LANL Meteorological Monitoring Plan
- User Performed Calibration Procedure

7.0 DEFINITIONS

As-Found – The state at which a sensor, instrument, or piece of equipment is found to be during the verification or calibration process activities; the physical state prior to any repairs, or adjustments are performed.

As-Left – The state at which a sensor, instrument, or piece of equipment is determined following the completion of the verification or calibration process activities; the physical state following the completion of any repairs or adjustments.

Calibration – is the process of comparison a unit under test (UUT) to a known magnitude standard with the intent to determine the deviation of the UUT from the standard; and to make corrections or adjustments to the (UUT) with the intent of bringing the units function to within the magnitude or tolerance range of the accepted standard.

Calm – wind speed below the threshold for movement of the anemometer

Distance Constant - The distance constant of a sensor is the length of fluid flow past the sensor required to cause it to respond to 63.2%, i.e., l - l/e, of the increasing step-function change in speed. (WebMet.com)

Maintenance – the activity of keeping equipment, sensors, systems & processes in a serviceable or properly functioning condition so the equipment, sensors, systems or processes do exceed the Mean Time Before Failure (MTBF).

Calibration and Maintenance Form (CMF) - Calibration and maintenance are closely related in this program and are documented on combined forms for each instrument category. Maintenance work is recorded in the comments section of these forms.

Instrument - An instrument is a measuring device consisting of subcomponents such as a sensor and a transducer.

Sensor - A sensor is a transducer that converts a physical, biological or chemical parameter into an electrical signal, for example: temperature, pressure, flow, vibration, or distance. (as taken from www. NIST)

S&CL – Acronym for the LANL Standards and Calibration Laboratory

Transducer - A transducer is a separate component or part of an instrument that converts energy generated, through sensing, from one form to another.

Unit Under Test (UUT) – an Instrument, Sensor, or piece of equipment undergoing testing, verification, or calibration.

Verification – is a process similar to Calibration however the UUTs do not have the ability to be adjusted and typically are refurbished or replaced to bring the UUTs in the acceptable tolerance range.

SODAR- Sonic Detection And Ranging

RASS - Radio Acoustic Sounding System

8.0 ATTACHMENTS

Attachment 1: Horizontal Wind Vane Anemometer Description, Specifications, & Common Problems
Attachment 2: Vertical Wind Anemometer Description, Specifications & Common Problems
Attachment 3: SODAR Sonic Detection & Ranging Description, Specifications & Problems
Attachment 4: Atmospheric Temperature Sensor w/Radiation Shield Assembly Description, Specifications & Common Problems
Attachment 5: Barometric Pressure Sensor Description, Specifications & Common Problems
Attachment 6: Relative Humidity Instrument Description, Specifications & Common Problems
Attachment 7: 10-Hour Fuel Moisture Monitoring Assembly Description, Specifications, & Common Problems
Attachment 8: Heated Tipping-Bucket Precipitation Gauge Description, Specifications, & Common Problems
Attachment 9: Ultrasonic Snow Depth Sensor Description, Specifications, & Common Problems
Attachment 10: Pyranometer Solar Radiation Measurement Instrument Description, Specifications, & Common Problems
Attachment 11: Pyrgeometer Infrared Solar Radiation Measurement Instrument Description, Specifications, & Common Problems
Attachment 12: Data Logger, Data Acquisition Systems Description & Specifications
Attachment 13: Digital Multimeter Fluke 87V Description & Specifications
Attachment 14: Precision 6.5 Digit Digital Multimeter Fluke 8846A Description & Specifications
Attachment 15: Platinum Resistance Thermometer Description & Specifications
Attachment 16: Anemometer Drive Wind Speed Sensor Calibration Units Description & Specifications
Attachment 17: Wind Sensor Calibration Vane/Azimuth Angle Bench Stand Descriptions & Specifications
Attachment 18: Form CMF1-Horizontal Wind Measurement Instruments Tracking & Verification
Attachment 19: Form CMF2-Vertical Wind Measurement Instruments Tracking & Verification
Attachment 20: Form CMF3-Temperature Measurement Sensor Tracking & Verification
Attachment 21: Form CMF4-Humidity & Pressure Measurement Instruments Tracking & Verification
Attachment 22: Form CMF5-Precipitation Measurement Instruments Tracking & Verification
Attachment 23: Form CMF6-Solar Radiation Measurement Instruments Tracking & Verification
Attachment 24: Form CMF7, Data Logger Instrument Tracking and Verification
Attachment 25: Meteorology Standards Calibration Tracking Worksheet

Attachment 26: Form CMF9 05305AQ Wind Instrument Calibration WorkSheets
Attachment 27: Form CMF10 2106T Wind Instrument Calibration Worksheets
Attachment 28: Temperature Probe Resistance to Temperature Conversion Chart
Attachment 29: Wind Instrument Refurbishment Checklist

Click here for "Required Read" credit.

ATTACHMENT 1: MODEL 05305-AQ HORIZONTAL WIND VANE ANEMOMETER DESCRIPTION, SPECIFICATIONS, AND COMMON PROBLEMS

Horizontal Wind Vane Anemometer **Description, Specifications & Common Problems**	Records Use only 

Description

- The propeller vane anemometer (propvane) model 05305-AQ is a UV stabilized plastic instrument with steel and anodized aluminum fittings, & stainless steel bearings manufactured by the RM Young Co.
- Wind Speed is sensed by a carbon fiber #08254 thermoplastic (CFT), 4-blade helicoid propeller with a 30-cm pitch that outputs a sine-wave voltage signal with a frequency directly proportional to wind speed.
- The wind speed transducer is an AC tachometer generator coupled to the propeller and provides an output signal induced with a magnetic pickup coil on the propeller shaft, and outputs a frequency of 3 cycles per propeller revolution which is directly proportional to the wind speed.
- Wind Direction is sensed by a lightweight vane assembly with a 0.45 damping ratio and dampened natural wavelength of 4.9 m. The vane threshold sensitivity is 0.5 m/s for a 10º displacement.
- The wind direction transducer is a precision potentiometer with a variable output resistance value that is directly proportional to wind direction.
- The instrument output signals are captured by the connected datalogger to report wind direction & speed.

Specifications

05305-AQ Wind Speed

Range: 0 to 50 m/s (112 mph)
Threshold Sensitivity: 0.4 m/s (.09 mph)
Standard Accuracy: +/- 0.2 m/s (+/- 3 Hz) or 1% of reading
RPM: 1800rpm = 90Hz=9.2m/s (20.6mph)
Distance Constant: 2.1m for 63% recovery
Transducer: 2K ohm nominal DC resistance
Transducer Output: 80 mVpp @ 100rpm 8.0Vpp @ 10000rpm
Life Expectancy: 50 million revolutions
Temperature Range: -50^{0}C to +50^{0}C
Output Frequency: 3cycles per prop. Revolution (0.102m/s per Hz)

05305-AQ Wind Direction

Electrical Range: 1º to 355º
Electrical Deadband: 355º to 360º
Mechanical Range: 0 º to 360 º
Sensitivity: 28 ohms/degree
Accuracy: +/- 3.0º (angle) from 10º to 350º
Vane Distance-Constant: 2.1 m
Transducer Excitation Voltage 15Vdc max.
Delay Distance: 1.2m for 50% recovery
Threshold Sensitivity: 0.5m/s @ 10º; 0.7m/s @ 5º displacement
Resolution: Infinite (hdwe. limited)

Common Problems

- Wind Speed (Horizontal Shaft) Bearing Failure - causes an increase in the wind speed threshold
- Wind Direction (Vertical Shaft) Bearing Failure - causes sluggish azimuth response.
- Physical Damage - Anemometer propellers are susceptible to damage from larger size hail and clumps of frozen snow falling from overhead elevated instruments and tower structure.

ATTACHMENT 2: MODEL 27106T VERTICAL WIND VANE ANEMOMETER DESCRIPTION, SPECIFICATIONS, AND PROBLEMS

Vertical Wind Anemometer **Description, Specifications & Common Problems**	Records Use only Los Alamos NATIONAL LABORATORY EST.1943

Description

- The RM Young model 27106T Gill Propeller Anemometer is mounted vertically and uses a 20cm diameter carbon fiber thermoplastic (CFT) 4-blade helicoid propeller with a 30.0cm pitch.
- The propeller responds only to that component of the wind that is parallel to its axis, and the response is a function of its orientation to the wind closely approximating the cosine law.
- When the wind is exactly perpendicular to the axis of the propeller (a horizontal wind) the propeller rotation stops.
- The output signal is positive (cw-updraft) or negative (ccw-downdraft) depending on the direction of the vertical wind component. Multiplying the signal by 1.25 corrects for the potential non-cosine response of the propeller. The non-cosine correction calculation is executed in the data logger. The best air flow estimates are obtained for movement occurring within ± 30 degrees of the horizontal.
- Signal output from the tach-generator transducer is an analog dc voltage directly proportional to the wind component across the propeller.

Specifications

Axial Flow Range: 0 to 40m/s (90mph)
All Angle Range: 0 to 35m/s (80mph)
Signal Output: 1800 rpm (500 mV)= 9.0 m/s (20.1 mph)
Threshold Sensitivity: ± 0.4 m/s (± 2.5 mV) (0.8 mph)
Operating Temp: -50°C to +50°C
Accuracy: +/- 1.0% of reading (from +/-.01m/s to +/-0.35m/s)
Range: 0 to 35m/s (90mph) range for Axial Flow
Distance Constant: 2.1m(6.9ft)
Transducer: Analog DC voltage proportional to axial wind component

08254 CFT Propeller Speed Parameters

Diameter: 20cm
Pitch: 30.0cm
Range: 0-35m/s (80mph)
Threshold: 0.4m/s (0.8mph)
Distance Constant: 2.1m (6.9ft)

Common Problems

- Partial or complete bearing failure resulting in increased friction and the wind threshold parameter causing reduced signal output for vertical wind speed.
- Winter Operation- The anemometer propellers on instruments with level-1 tower locations are more susceptible to damage from falling clumps of ice & snow.
- Summer Operation - Anemometer propellers are susceptible to damage from larger size hail.

ATTACHMENT 3: MODEL XFAS-52 SOUND DETECTION & RANGING SYSTEM (SODAR) DESCRIPTION AND SPECIFICATIONS

Sound Detection & Ranging System (SODAR) **Description and Specifications**	Records Use only Los Alamos NATIONAL LABORATORY EST.1943

Description

The model XFAS52 Sound Detection & Ranging Instrument (SODAR) is manufactured by Scintec AG. Our installation provides measurements of horizontal wind speed and direction, vertical speed, and standard deviation of a maximum of 256 vertical layers. The layers may be from 20-500 m thick. Our installation includes the RASS (Radio-Acoustic-Sounding-System) Extension which provides temperature profiles in the atmospheric boundary layer. The temperature values are retrieved using the RASS technique measuring the speed of sound and deriving the temperature from the sound feedback. The speed of sound is measured by Doppler analysis of the frequency of radio-waves which have been reflected at the acoustic waves emitted by the sodar.

The SODAR system is permanently installed at the TA-6 meteorology tower site. The system consists of the signal processing unit (SPU), a large transmit/receive phased array antenna, antenna heater system with a power supply, acoustic barrier for the antenna, and a transmit & receive antenna for the RASS Extension. There is a desktop computer at the TA-6 site that is used for diagnostics, control of the SODAR, data collection, and transmission of data to customers.

The SODAR has a myriad of operating parameters that the user can adjust to provide optimal SODAR operation at a particular site – please refer to the operator's manual for a complete description of the various parameters.

Following Initial Setup No Calibration is required for this system; however monthly self-tests are run to verify system operation.

The SODAR-RASS system does not require any physical calibration/verification; the system functions a self-test once per month to identify any failing components.

Specifications

RASS Extension

Temp. Accuracy: 0.2°C

Radio Frequency: 1290MHZ

Minimum Range: 40m

Vertical Resolution: 20m w/XFAS Unit

Temperature Measurement Range: -50°C to +60°C

Transmit/Receive Antenna Configuration: Parabolic

XFAS52

Range (height): 20 to 2000 (5000) m

Range (horizontal speed): 0 to 50 m/s

Range (vertical speed): ± 10 m/s

Range (wind direction): 0 to 359 degrees

Accuracy (horizontal): ± 0.3 m/s

Accuracy (vertical): ± 0.1 m/s

Accuracy (wind direction): ± 3 degrees

ATTACHMENT 4: MODEL 060A-2 TEMPERATURE SENSOR W/RADIATION SHIELD DESCRIPTION, SPECIFICATIONS, & COMMON PROBLEMS

Atmospheric Temperature Sensor w/Radiation Shield Assembly Description, Specifications & Common Problems	Records Use only 

Description

Temperature Measurement Assembly

Model 076B Fan Aspirated Solar Radiation Shield (Met One Inc.)
Model 060A-2 thermistor temperature sensor/probe (Met One Inc.)

- The Model 076B aspirated solar radiation shield is mounted vertically, drawing air in from the bottom and exhausting the air out the top. The shield is shaped like an umbrella and houses the temperature thermistor and aspiration fan.
- Beneath the umbrella top is the thermistor probe housing formed as two perforated concentric metal tubes through which the aspirator fan draws the "wash" air. The space between the two tubes is the path for the high-volume "wash" air which dissipates the heat caused by the suns' solar energy collected on the surface area of the outer metal tube. The thermistor is mounted in the center of the inner tube, which has a restricted air flow (to ensure the high-volume wash air).
- The vertical alignment of this assembly and the aspiration feature reduces temperature measurement error to less than 0.05 ºF) or -17.75ºC.
- The data logger provides the excitation for the thermistor probes and records the measurements through a precision resistor network for each probe. The probes are electrically excited momentarily for obtaining the temperature measurements.

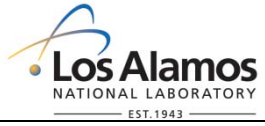
Specifications

Range: - 50º C to + 50º C (-58 º F to +122 º F)
Sensitivity: 5.6 mV/º C, +/- 0.1 º C
Accuracy: +/- 0.1º C (0.18ºF) throughout range, PSD Compliant
Resolution: ± 0.1º C
Time Constant: <10 seconds (in still air)

Common Problems

- During winter operation Ice buildup on the surface area of the solar radiation shield can artificially decrease the surrounding air temperature, (wax shield & monitor/remove snow buildup).
- During summer operation intermittent operation or failure of the aspiration fan will result in inconsistencies in temperature readings when compared to other temperature sensors positioned on the same tower.

ATTACHMENT 5: MODEL 270 BAROMETRIC PRESSURE SENSOR DESCRIPTION, SPECIFICATIONS, AND COMMON PROBLEMS

Barometric Pressure Sensor Description, Specifications & Common Problems	Records Use only 

Description

Model 270 (Setra Inc.) Pressure Transducer uses a variable capacitance ceramic sensor with proprietary analog circuitry. The unit design is a thermally stable glass fused ceramic sensing capsule coupled with a sophisticated capacitance charge-balance IC circuit which includes signal conditioning and environmental compensation.

Specifications

Barometric Range: 600 to 1,100 hPa/mbar

Max Pressure: 20 psia

Accuracy: <+/- 0.05% Full Scale

Resolution/Repeatability: 0.005% full-scale range (limited by noise)

Long Term Stability: <+/- 0.1% Full Scale over 6 months @ 70º F.

Output: 0-5Vdc (10mV/mbar)

Common Problems

- This sensor has no reoccurring or common problems and is historically very stable
- Insure the sensor opening is protected with a fine mess screen type material to prevent contamination by dirt and small insects.

ATTACHMENT 6: MODEL MP101A RELATIVE HUMIDITY INSTRUMENT DESCRIPTION, SPECIFICATIONS, AND COMMON PROBLEMS

Relative Humidity Instrument Description, Specifications & Common Problems	Records Use only 

Description

Model MP101-A (Rotronic Instrument Corp.) Relative humidity (RH) probe is a combined humidity and temperature probe designed primarily for outdoor applications. The unit contains a hygroscopic variable capacitance sensor and a Pt100 RTD with an electronic interface providing linear high-level outputs.

Specifications

Humidity Measurement Range: 0 to 100 % RH

Temperature Measurement Range: -40ºC to +60ºC.

Sensitivity: 10 mV/% RH

Accuracy: < ± 1.5% RH @ 0-100 %RH

Resolution: < ± 0.5 % RH

Humidity Sensor Stability: Better than 1% RH over one year.

Repeatability: +/-0.3%RH & +/-0.1ºC.

Linear Humidity Output Signal: 0→1.0VDC = 0→100%RH

Linear Temperature Output Signal: -0.4→0.6VDC = -40→+60 ºC.

Common Problems

This sensor has no reoccurring or common problems and is historically very stable

ATTACHMENT 7: MODEL CS505/CS205 FUEL MOISTURE MONITORING ASSEMBLY DESCRIPTION, SPECIFICATIONS, AND COMMON PROBLEMS

Fuel Moisture Monitoring Assembly Description, Specifications & Common Problems	Records Use only 

Description

- The configured fuel moisture monitoring assembly makes up a 10-hour fuel moisture & temperature sensor unit. The assembly consists of a CS205 Fuel Temperature Stick (#10824 Ponderosa Pine Dowel), a CS505 Fuel Moisture Sensor, and a Model 107 Temperature Probe, all from Campbell Scientific Inc. (CSI). This configuration of sensors offers the ability to emulate and measure the moisture content and temperature of similarly sized twigs as found on a forest floor.
- The Campbell Scientific Model CS205 fuel moisture stick is replaced annually.
- Associated with the fuel moisture stick is a fuel temperature stick which consists of a Campbell Scientific Model 107 temperature probe installed within another wooden dowel. The fuel temperature stick is replaced annually.
- The fuel monitoring assembly is installed at TA-6 site on an independent datalogger.
- Calibration/Verification of the fuel moisture assembly is not required unless damaged.

Specifications

107 Temperature Probe

BetaTherm 100K6A1 Thermistor

Measurement Range -35º to +50ºC

Accuracy: <+/-0.5ºC over measurement range. (Edlog dataloggers only)

CS205 10-Hour Fuel Temperature Stick: See manufacturer specification sheet.

10824 10-Hour Fuel Moisture Stick: See manufacturer specification sheet.

CS505 10-Hour Fuel Moisture Sensor: Percent Moisture by weight; 1%=1g.

Operating Range: 0 to 70% moisture content

Fuel Moisture Accuracy: See manufacturer specification sheet.

Common Problems

This sensor assembly has no reoccurring/common problems and is historically very stable

ATTACHMENT 8: MODEL 6021A HEATED TRIPPING-BUCKET PRECIPITATION GAUGE DESCRIPTION, SPECIFICATIONS, AND COMMON PROBLEMS

Heated Tipping-Bucket Precipitation Gauge Description, Specifications & Common Problems	Records Use only

Description

- Precipitation measurements are made with the Model 6021-A (AllWeather Inc.) electrically-heated tipping-bucket precipitation gauge. This gauge has a thermostatically controlled electric heater surrounding the collection funnel that melts frozen precipitation to actualize water-content measurements.
- The measurement device is a teeter totter bucket mechanism that tips with each one-hundredth of an inch of precipitation collected. A bucket tip initiates a momentary switch closure that is counted by the data logger. The data logger totalizes the precipitation for the 15 minutes data-output period.
- The gauge installations include wind screens which still the air flow over the top of the gauge. A rain gauge installation without a wind screen is considered to under report precipitation events by 25%.
- This instrument does NOT require calibration unless damaged.

Note: The selection of the tipping-bucket gauge was made after comparisons with weighing buckets in several locations. The frequent-slight amounts of precipitation typical of this semiarid climate promoted the selection of the tipping-bucket because of its higher measurement resolution capability.

Specifications

Operating Temperature: -25°C to +40°C

Sensitivity: 1 tip = 0.01 inch

Calibrated Accuracy: +/-0.5% at 0.5 inch per hour

Repeatability: +/-3% at 0.5 inch per hour

Collection Orifice: 8.214" diameter (208mm)

Output: 0.1-second switch closure (Form A reed, mercury wetted)

Common Problems

- Dissolved/dried precipitates can cause an imbalance in the measurement mechanism when they dry on the tipping bucket mechanism.

ATTACHMENT 9: MODEL SR50 ULTRASONIC SNOW DEPTH SENSOR DESCRIPTION, SPECIFICATIONS, AND COMMON PROBLEMS

Ultrasonic Snow Depth Sensor **Description, Specifications & Common Problems**	Records Use only Los Alamos NATIONAL LABORATORY EST. 1943

Description

- The SR50 Ultrasonic snow depth gauge is manufactured by Campbell Scientific, Inc. The gauge is used in conjunction with a Campbell Scientific 21X data logger to provide continuous measurement of snow on the ground. The data logger controls the operation of the SR50 gauge and loges the data as specified by the user.
- The gauge installed at TA-6 is suspended from a boom attached to an 8-foot high tower section embedded in the ground. The gauge is 83.4 inches above the ground. The data logger is programmed to record this distance as zero. Any decrease in this distance is shown as snow on the ground and recorded in inches.

Specifications

Measurement Range: 0.5 to 10 meters

Accuracy: +/-1cm or 0.4% of distance to target (whichever is greater). To obtain this accuracy requires compensation input from external air temperature

Accuracy As Installed: +/-0.4 inches

Resolution: 0.1mm (0.0393701inches)

Resolution As Installed: +/- 0.2 inches

Beam Acceptance Angle: 22° (approximate)

Signal Output: 0-5V Pulse Train (employed for our installations)

Operating Temp.: -45^{0}C to $+50^{0}$C

Common Problems

- Vegetation growth underneath the sensor measurement area (inside of the 22 degree cone angle area) is measured by the unit.
- Animals sleeping under the sensor during night-time hours

ATTACHMENT 10: MODEL 8-48 PYRANOMETER SOLAR RADIATION MEASUREMENT INSTRUMENT DESCRIPTION, SPECIFICATIONS, AND COMMON PROBLEMS

Pyranometer Solar Radiation Measurement Instrument Description, Specifications & Common Problems	Records Use only 

Description

- As solar radiation passes through the earth's atmosphere, some of it is absorbed or scattered by air molecules, water vapor, aerosols, and clouds. The solar radiation that passes through directly to the earth's surface is called Direct Solar Radiation. The radiation that has been scattered out of the direct beam is called Diffuse Solar Radiation. The direct component of sunlight and the diffuse component of skylight falling together on a horizontal surface make up Global Solar Radiation. (EPLAB, www.eppleylab.com)
- The unit we use is a Model 8-48 (Eppley Laboratory, Inc.) pyranometer capable of measuring shortwave visible radiation.
- These pyranometers are installed upward-facing to measure incoming shortwave visible radiation, and downward-facing to measure shortwave visible radiation reflected from the ground.
- The pyranometers measure total solar radiation (direct and diffuse) as it radiates onto a flat horizontal plane. The optical glass window passes energy in the 0.285 to 2.8 microns range onto the sensor surface area for measurement.

Specifications

Sensitivity: 10 µV/W/ m^2 (*approximately)

Accuracy: Based on the Lambert Cosine Response, ± 3.5% from normalization (0º-70º zenith angle) and ± 6.5% (70º-80º zenith angle). This accuracy accounts for temperature dependence.

Accuracy: +/-2% from normalization 0-70^0 Zenith Angle

Range: 0 to1400 Wm^{-2} at +/- 1% Linearity

Response Time 95%, 60 seconds; Directional Response: < 20 Wm^{-2}

Resolution: < 1 $Wm^{-2;}$ Temp. Response: ±2%

Non-Stability: <0.5% / yr (typ.); Non-Linearity: ±1.0%

Spectral Selectivity: 5%; Tilt Response: < 5% Achievable Uncertainty (Hourly): 3-5 %

Achievable Uncertainty (Daily): 3 %

* The value shown for sensitivity is typical; but each pyranometer has its own sensitivity value which is determined at the time of manufacturer's calibration. The sensitivity value is programmed into the data logger as a calibration value.

Common Problems

- Shading Interference
- Placement of instruments should be in a location which is not obstructed by overhead vegetation or vegetation which interferes with the angle of exposure of the instrument to the sun, (Unless for the intended purpose of measuring said interference).

ATTACHMENT 11: MODEL PIR PYRGEOMETER INFRARED SOLAR RADIATION MEASUREMENT INSTRUMENT DESCRIPTION, SPECIFICATIONS, AND COMMON PROBLEMS

Pyrgeometer Infrared Solar Radiation Measurement Instrument Description, Specifications & Common Problems	Records Use only 

Description

- The Model PIR Eppley Laboratory Inc. Precision Infrared Radiometer (pyrgeometer) is designed for the measurement of unidirectional global incoming or outgoing long-wave terrestrial radiation. The pyrgeometer is installed upward-facing to measure incoming infrared radiation and downward-facing to measure outgoing/returning infrared radiation.
- The pyrgeometer silicon transmission window passes energy to the sensing surface in the range from 4 to 50 microns.
- The PIR has a temperature compensation circuit to adjust for the thermopiles response variation with temperature. Also there is a thermistor-battery-resistance circuit incorporated to precisely compensate for emitted radiation; this is to allow for the separation of the signal due to incoming radiation.

Specifications

Range: 0 to 700W/m^2 (3.5 to 50 µm)

Sensitivity: 4 µV/W/ m^2 (*approximately)

Linearity: +/-1%, 0 to 700W/m^2

Temperature Dependence: +/-2%, -20°C to 40° C (nominal)

Accuracy: ±1% from 0 to 700 Wm^{-2}

Sensitivity: approx. 4 µV/Wm^{-2}

Temperature Dependence: ±1% over temp. Range -20 to +40°C.

Linearity: ±1% from 0 to 700 Wm^{-2}.

Response time: 2 seconds (1/e signal).

Cosine: better than 5%.

Accuracy: Based on the Lambert Cosine Response, better than 5% from normalization. This accuracy accounts for temperature dependence.

* The value shown for sensitivity is typical; but each pyrgeometer has its own sensitivity value which is determined at the time of manufacturer's calibration. The sensitivity value is programmed into the data logger as a calibration value.

Common Problems

- Shading Interference
- Placement of instruments should be in a location which is not obstructed by overhead vegetation or vegetation which interferes with the angle of exposure of the instrument to the sun, (Unless for the intended purpose of measuring said interference).

ATTACHMENT 12: MODELS CR7, CR10X, 21X DATA LOGGER DATA ACQUISITION SYSTEMS DESCRIPTIONS AND SPECIFICATIONS

Data Logger Data Acquisition Systems Descriptions and Specifications	Records Use only

Description

- The Campbell Scientific, Inc. data loggers (Model CR7X, CR10X, and 21X used here) are designed is such a manner that one of the initial operations performed upon power-up is the analog-to-digital (A/D) conversion. With the sequence designed in as one of the first operations all signal processing is digital and does not require adjustment.
- Since the inception of our meteorology network the data logger operations have been so stable that it has never been necessary to adjust the A/D calibration for any data loggers used in our network.
- The data loggers are sent back to the manufacturer on a two-year cycle for calibration.
- A desktop computer is used at the TA-6 site for SODAR maintenance work and diagnostics and to FTP SODAR data back to an identified network server for further processing. The SODAR must be in continuous communication with this PC, which is running the SODAR's operating system. This PC collects the data and creates the data files.
- The tower dial-up computer located at the meteorology lab is a desktop computer that runs the LoggerNet Campbell Scientific Inc. software for data collection. The software initiates the desktop computer to call the tower data loggers every 15 minutes, then collects the data, and writes the collected data to the appropriate tower data file. When data collection is complete, the dial-up PC then FTPs the data as required for the meteorology program.

Specifications

Range (volts)	CR7X Resolution (microvolts)	21X Resolution (microvolts)	CR10X Resolution (microvolts)
± 5.000	166.0	333.0	x
± 1.500	50.0	N/A	x
± 0.500	16.6	33.3	x
± 0.150	5.0	N/A	x
± 0.050	1.66	3.33	x
± 0.015	0.5	N/A	x
± 2.500	x	x	666
±.250	x	x	66.6
±.025	x	x	6.66
±.0075	x	x	2.00
±.00025	x	x	0.66

Voltage measurement accuracy: CR7X & 21X ± 0.01% of FSR from 0º C to +40º C. CR10X ± 0.05% of FSR.

ATTACHMENT 13: MODEL 87V FLUKE DIGITAL MULTIMETER DESCRIPTION AND SPECIFICATIONS

Digital Multimeter **Fluke 87V** **Description & Specifications**	Records Use only 

Description

Digital Multimeter Model 87V by Fluke Inc. used in the calibration processes for the Horizontal and Vertical Wind Anemometer instruments. Also used in daily shop equipment maintenance and situational troubleshooting operations. Additional instrument description information can be located in the manufacturers' literature.

Specifications

DC voltmeter accuracy: ± (0.05% + 1)
Maximum DC Voltage Resolution: 10µV
Ohmmeter accuracy: ± (0.2% + 1)
Maximum Resistance Resolution: 0.1Ω
Note: Additional instrument specification information can be located in the manufacturers' literature.

ATTACHMENT 14: MODEL 8846A FLUKE PRECISION 6.5 DIGITAL MULTIMETER DESCRIPTION AND SPECIFICATIONS

Precision 6.5 Digital Multimeter Fluke 8846A Description & Specifications	Records Use only 

Description

Precision 6.5 Digit Digital Multimeter by Fluke, capable of measuring many types of signals which includes temperature. The unit, in conjunction with the 884 X-RTD probes, is used in the calibration processes for the Temperature Sensors and can be used in the calibration processes for the Horizontal and Vertical Wind Anemometer instruments for voltage and resistance measurements.

This instrument can also be used in daily shop equipment maintenance and situational troubleshooting operations.

Additional instrument description information can be located in the manufacturers' literature.

Specifications

DC voltmeter accuracy: +/-0.00386V for 100V Range

Maximum DC Voltage Resolution: Varies by Range Setting

Ohmmeter accuracy: 10.00000 for 10KΩ Ohm Range

Maximum Resistance Resolution: Varies by Range Setting

4-Wire Temperature Measurement Accuracy: +/-0.06°C (after 1 year)

4-Wire Temperature Measurement Range: -200°C to +600°C

4-Wire Temperature Measurement Resolution: +/-0.001°C.

Note: Additional instrument specification information can be located in the manufacturers' literature.

ATTACHMENT 15: MODEL 2100B PLATINUM RESISTANCE THERMOMETER DESCRIPTION AND SPECIFICATIONS

Platinum Resistance Thermometer Description & Specifications	Records Use only

Description

The platinum resistance thermometer (Model: 2100B-090-6-B-2) is used in combination with the Fluke 8846A Precision Digital Multimeter in the calibration processes for the 060A-2 temperature probes. The probe in combination with the Fluke 8846A Precision Digital Multimeter is the secondary standard to confirm the temperature probe calibration.

Specifications

Resistance: 100Ω Nominal

Temperature Coefficient: 0.00385Ω/Ω °C nominal

Temperature Range: -200C to 300°C

Accuracy
+/- 0.50°C @ -196°C
+/- 0.050°C @ 0°C
+/- 0.052°C @ 200°C
+/- 0.055°C @ 300°C

Note: Additional instrument specification information can be located in the manufacturers' literature.

ATTACHMENT 16: MODEL 18801 & 18802 ANEMOMETER DRIVE WIND SPEED SENSOR CALIBRATION UNITS DESCRIPTION AND SPECIFICATIONS

Anemometer Drive Unit **Wind Speed Sensor Calibration Units** **Description & Specifications**	Records Use only Los Alamos NATIONAL LABORATORY EST.1943

Descriptions

The below listed items are rotational calibration units to verify the signal output of the RM Young anemometer wind-speed instruments. The output speeds of these devices are directly proportional to the applied power & frequency, and are considered a critically controlled standard. These units are calibrated by the LANL S&CL group.

The Model 18801 is a variable speed calibration unit with an output range of 100 to 10,000rpm, and is capable of rotating the propeller shaft clockwise or counter-clockwise at any rpm in the specified speed range.

The Model 18802 is a variable speed calibration unit with a speed range of 200 to 15,000 rpm, and is capable of rotating the propeller shaft clockwise or counter-clockwise at any rpm in the specified speed range.

There are three fixed speed anemometer drive units, model 27230/300rpm, model 27231/1800rpm, and model 27232/3600rpm.

Specifications

Fixed Speed Drive Units: Being synchronous motors with gear reduction, the rpm value is dependent upon the line frequency of 120 Vac / 60 Hz power used for the AC plug power. Any fluctuation in rpm value would be related to any fluctuation in the 60 Hz power supply.

Model 18801 Unit: Operating Range 100-10000rpm @ 1RPM increments

Model 18802 Unit: Operating Range 200-15000rpm @ 1RPM increments

Model HSE-XXXX: Fixed RPM Anemometer Drive Units

ATTACHMENT 17: MODEL 18112 WIND SENSOR CALIBRATION VANE/AZIMUTH ANGLE BENCH STAND DESCRIPTION AND SPECIFICATIONS

Horizontal Wind Sensor Vane Angle Bench Stand Description & Specifications	Records Use only

Description

- The Model 18112, RM Young Vane Angle Bench Stand is used for the bench-top wind direction calibration process of wind monitor sensors; specifically propeller anemometer devices. It is used to verify the azimuth (direction) measuring portion of the RM Young propeller anemometers.
- The vane angle bench stand/test fixture holds the propeller vane and allows the vane to be rotated through 360 degrees as the azimuth angle is viewed & mechanically measured on a protractor surface. The measured angle is then compared with the electrical output of the anemometer azimuth potentiometer to confirm accuracy.
- This is a mechanical device which does not have or require any calibration or adjustment and is replaced if damaged.
- Model 18112 Vane Angle Bench Stand is used for bench-top wind direction calibration of Wind Monitor sensors. An easy to read pointer indicates 0 to 360 degrees with 1/ 2 degree resolution.

Specifications

Range: 0-360°

Resolution: +/- 0.5°

Accuracy: Fixed at the 0.5° protractor surface markings, only effect would be parallax from reading interpretation.

ATTACHMENT 18: CMF1, 05305AQ HORIZONTAL WIND MEASUREMENT INSTRUMENTS TRACKING AND VERIFICATION

CMF1, Part-I 05305AQ Horizontal Anemometer Wind Speed Instrument Calibration Tracking

Records Use Only

Los Alamos NATIONAL LABORATORY EST. 1943

RM Young Model 05305AQ Anemometer (Reference Section 5.1)

Met. Site: | **Check (√):** □ As-Left □ As-Found □ Close-Out | **Log Page #_____**

Tech. Name: | □ 6-Month Check □ Annual Check | **Calibration Date:_____**

Z#: | **Tech. Signature:** | **Calibration Expiration Date: _____**

Unit Serial Number	Tower & Level	Instrument From Site or To Site: Date	Instrument From Site or To Site: Time	Tech. Initials	RPM vs. Sensor Output (Hz): 200rpm (10Hz) / 1800rpm (90Hz)	RPM vs. Sensor Output (Hz): 900rpm (45Hz) / 3600rpm (1800Hz)	RPM vs. Sensor Output (Hz): 7200rpm (360Hz)	Propeller Torque Test Value (P/F)	(√) On-Site Boom Level Verification	Instrument: Avg. RPM % Error	Instrument: Pass or Fail

Notes & Comments:
% Error = [Part/Whole]x100 RPM % Error is calculated on a separate sheet
Testing is done indoors in a calm wind environment.
Humidity & Air Temperature do not need to be considered when testing these instruments. There are no other test condition considerations
Instrument Pass/Fail Specifications can also be found on the Calibration Worksheets (Attachment #26)

☐ Confirm Environmental Conditions

Form Revision: A

CMF-1, Part-II

05305AQ Horizontal Anemometer Wind Direction (Azimuth) Calibration Tracking

Records Use Only

RM Young Model 05305AQ Anemometer (Reference Section 5.1)

Met. Site : **Check (√):** □ **As-Left** □ **As-Found** □ **Close-Out** **Log Page #**_____

Tech. Name: □ **6-Month Check** □ **Annual Check** **Calibration Date:**_____

Z# **Tech. Signature:** **Calibration Exp. Date:** _____

Vane Torque/Threshold Specs.
As Found : ≤ 20.0gm-cm
As-Left: ≤ 10.0gm-cm

Unit Serial Number	From Site or To Site	Azimuth/Direction Calibration Check Points (insert measured value) Pass = < +/- 3 º						(√) 0-360º Sweep	Direction Pass/Fail	
		30º/60º	90º/120º	150º/180º	210º/240º	270º/300º	330º/360º			
										Vane Torque Test = _____**g-cm** (Pass or Fail) **Cmpltd Azimuth Balance** _____(√)
										Vane Torque Test = _____**g-cm** (Pass or Fail) **Cmpltd Azimuth Balance** _____(√)
										Vane Torque Test = _____**g-cm** (Pass or Fail) **Cmpltd Azimuth Balance** _____(√)
										Vane Torque Test = _____**g-cm** (Pass or Fail) **Cmpltd Azimuth Balance** _____(√)

Notes & Comments: ☐ Confirm Environmental Conditions
% Error = [Part/Whole]x100
Testing is done indoors in a calm wind environment.
Humidity & Air Temperature do not need to be considered when testing these instruments. There are No Other test condition considerations
Instrument Pass/Fail Specifications can also be found on the Calibration Worksheets

Form Revision: A

ATTACHMENT 19: CMF2, 27106T VERTICAL WIND MEASUREMENT INSTRUMENTS TRACKING AND VERIFICATION

CMF-2 27106T Vertical Wind Speed Measurement Anemometer Calibration Tracking

Records Use Only

Los Alamos NATIONAL LABORATORY EST. 1943

RM Young Model 27106T Gill Propeller Anemometer (Reference Section 5.2)

Met. Site: | **Check (√):** □ As-Left □ As-Found □ Close-Out | **Log Page #_____**

Z#: | **Calibration Date:_____ Calibration Expiration Date:_____** | □ 6-Month Check

Tech. Name: | **Tech. Signature:** | □ Annual Check

Serial Number	Tower & Level	Instrument From or To Site		Tech. Initials	RPM vs. Speed Sensor Output (mV) Sensor Output mV / % Error (Pass = ≤ +/- 2.5mV)				Propeller Threshold Specs. As-Left: ≤ 0.5gm-cm As-Found: ≤ 1.0gm-cm	
		Date	Time		200rpm (55.5mV)	300rpm (83.3mV)	1800rpm (500mV)	3600rpm (1000mV)	Pass/Fail Speed Sensor	Pass/Fail Prop. Threshold

Notes & Comments:
% Error = [Part/Whole]x100
Testing is done indoors in a calm wind environment.
Humidity & Air Temperature do not need to be considered when testing these instruments. There are No Other test condition considerations
Instrument Pass/Fail Specifications can also be found on the Calibration Worksheets (Attachment #26)

☐ Confirm Environmental Conditions

Form Revision: A

ATTACHMENT 20: CMF3, 060A-2 TEMPERATURE MEASUREMENT SENSOR TRACKING AND VERIFICATION

CMF-3 Part-1, 060A-2 Temperature Sensor Verification Final Test Summary

Records Use Only

Los Alamos NATIONAL LABORATORY EST. 1943

MetOne Model 060A-2 Air Temperature Sensor (Reference Section 5.3) **Calibration Date:_____**

Tech. Name: **Check (√):** □ **As-Left** □ **As-Found** □ **Close-Out** **Log Page #_____**

Z#: **Tech. Signature:** **Calibration Expiration Date:_____**

Test Slot	Location To / From	Probe Serial #	0°C Test Bath Ref. Temp. →_____	% Error	P/F	15°C Test Bath Ref. Temp. →_____	% Error	P/F	30°C Test Bath Ref. Temp. →____	% Error	P/F
1)											
2)											
3)											
4)											
5)											
6)											
7)											
8)											
			↑ Sensor Temperature Response ↑ to Each Test Bath Temperature ↑								

Notes & Comments:

% Error = [Part/Whole]x100

Humidity & Air Temperature do not need to be considered when testing these instruments. There are No Other test condition considerations

Instrument Pass/Fail Specifications can also be found on the Calibration Worksheets (Attachment #26)

The Resistance to Temperature Conversion Table is Attachment #28

☐ Confirm Environmental Conditions

Form Revision: A

CMF-3 Part-2, 060A-2 Temperature Sensor Tower Installation Tracking, Probe & Fan Verifications

Record Use Only

Los Alamos NATIONAL LABORATORY EST.1943

MetOne Model 060A-2 Air Temperature Sensor **(Reference Section 5.3)** **Calibration**

Tech. Name: **Check (√):** □ **As-Left** □ **As-Found** □ **Close-Out** **Log Page #_____**

Z#: **Tech. Signature:** **Calibration Expiration Date:_____**

		Sensor Installation/Removal			0°C Temp. Ice Test Bath	15°C Ambient Temp. Test Bath	30°C Elevated Temp. Bath Test			
Probe Serial #	Location To / From	Date	Time	Tech. Initials	Standard Sensor UUT	Standard Sensor UUT	Standard Sensor UUT	% Error	Probe (P/F)	(P/F) Asp. Fan Op. Check

Notes & Comments:

% Error = [Part/Whole]x100

Humidity & Air Temperature do not need to be considered when testing these instruments. There are No Other test condition considerations

Instrument Pass/Fail Specifications can also be found on the Calibration Worksheets (Attachment #26)

The Resistance to Temperature Conversion Table is Attachment #28

☐ Confirm Environmental Conditions

Form Revision: A

CMF-3 Part-3, 060-A2 Temperature Sensor Calibration Recorded Test Bath Readings

Records Use Only

Los Alamos NATIONAL LABORATORY EST. 1943

MetOne Model 060A-2 Air Temperature Sensor **(Reference Section 5.3)** **Calibration Date:_____**

Tech. Name: **Check (√):** □ **As-Left** □ **As-Found** □ **Close-Out** **Log Page #_____**

Z#: **Tech. Signature:** **Calibration Expiration Date:_____**

Test Bath Temp.	Trial #1	Trial #2	Trial #3	Test Bath Avg. Temp.
Start →				
End →				

□ **Ice Bath Range:** 0^0C +/- 0.1^0C
□ **Ambient Bath Range:** 15^0C +/- 2^0C
□ **Heated Bath Range:** 30^0C +/- 2^0C

Probe Specs: +/- 0.1°C
ANSI 2005 Specs: +/- 0.5°C
WES 300 Plan Specs: +/- 0.3°C

Test Slot	Location To / From	Probe Serial #	1st Resistance Reading (kΩ)	2nd Resistance Reading (kΩ)	3rd Resistance Reading (kΩ)	Average Resistance Reading (kΩ)	°C Conversion Table Equivalent Temp.	% Error	P/F	Tech Initials
1)										
2)										
3)										
4)										
5)										
6)										
7)										
8)										

Notes & Comments:
% Error = [Part/Whole]x100
Humidity & Air Temperature do not need to be considered when testing these instruments. There are No Other test condition considerations
Instrument Pass/Fail Specifications can also be found on the Calibration Worksheets (+/- 0.11°C)
The ratio requirement for calibration can be found on the "Standard Use Tracking Sheet" (Attachment #25)
The Resistance to Temperature Conversion Table is Attachment #28

☐ Confirm Environmental Conditions

Form Revision: A

ATTACHMENT 21: CMF-4, MP101A HUMIDITY AND 270 PRESSURE MEASUREMENT INSTRUMENTS TRACKING AND VERIFICATION

CMF-4 MP101A Humidity & 270 Pressure Instrumentation Tracking & Verification

Records Use Only

Model MP101A Humidity Probe & Model 270 Pressure Transducer **(Reference Sections 5.4 & 5.5)**

Met. Site: **Check (√):** □ **As-Left** □ **As-Found** □ **Close-Out** **Log Page #** _____

Tech. Name/Z#: **Tech. Signature:** **Calibration Date:** _____

Rotronics Model MP101 Humidity Instrument Verification

Unit To/From Location	Date/time	Serial Number	Confirming Tech. Initials	Unit Cal. Date	Cal. Expiration Date	S&CL Calibration Certificate Info.

SETRA Model 270 Pressure Instrument Verification

Unit To/From Location	Date/time	Serial Number	Confirming Tech. Initials	Unit Cal. Date	Cal. Expiration Date	S&CL Calibration Certificate Info.

Notes & Comments:
The calibration interval is annually for these instruments.
The calibration records for these instruments are maintained by the S&CL (Standards and Calibration Laboratory) of LANL.

Form Revision: A

ATTACHMENT 22: CMF-5 6021A PRECIPITATION MEASUREMENT INSTRUMENTS TRACKING

CMF-5 Part-1, 6021A Heated Tipping Bucket Precipitation Instrument Tracking

Records Use Only

Los Alamos NATIONAL LABORATORY EST.1943

AllWeatherInc. Model 6021A Heated Tipping Bucket Rain Gauge (Reference Section 5.7)

This unit does not require calibration unless damaged. **The unit is checked annually for debris, cleaning, &damage.**

Met. Site: **Log Page #_____**

Tech. Name/Z#: **Tech. Signature:**

Date	Time	Loc	Unit SN#	(√) Confirm Gage Level	(√) AC Power	(√) Cleaned	Notes & Comments

Notes & Comments:

Form Revision: A

CMF-5 Part-2

SR50 UltraSonic Snow Depth Measurement Instrument Tracking

Records Use Only

Campbell Scientific SR50 UltraSonic Distance Measurement Instrument **(Reference Section 5.8)**

Met. Site: **Check (√):** □ **As-Left** □ **As-Found** **Log Page #_____**

Tech. Name/Z#: **Tech. Signature:**

Campbell Scientific Model SR50 Ultra-Sonic Distance Sensor Tracking & Field Check

Date	Time	Tech. Initials	(√) Plumb Gauge	(inches) Measured Gauge Height	(√) Replace Desiccant	Datalogger Sensor Zero Ref. Reading	Datalogger Sensor Reading to Test Surface(s)

Notes & Comments:

Instruments are inspected & cleaned annually

File this sheet in the appropriate log book based on unit installation location.

Instrument Tolerance is +/-1cm & the Resolution is 0.1mm (with temperature compensation)

Form Revision: A

ATTACHMENT 23: CMF-6, 8-48 & PIR SOLAR RADIATION MEASUREMENT INSTRUMENTATION TRACKING AND VERIFICATION

CMF-6 8-48 Pyranometer & PIR Pyrgeometer Solar Radiation Instrument Tracking

Records Use Only

Los Alamos NATIONAL LABORATORY EST. 1943

Eppley 8-48 Pyranometer & Model PIR Pyrgeometer Solar Radiation Instruments **(Reference Sections 5.9 & 5.10)**

Met. Site:	**Check (√):** □ **As-Left** □ **As-Found** □ **Close-Out**	**Log Page #**_____
Tech. Name/Z#:	**Tech. Signature:**	**Calibration Date:**_____

Eppley 8-48 Pyranometer Calibration

Serial Number	Calibration Constant ($x10^{-6}$ V/Wm^{-2})	Installation		Tech. Initials	Data logger Multiplier Changed	Calibration Expiration Date	S&CL Calibration Certificate Info
		Date	Time				

Met. Site:	**Check (√):** □ **As-Left** □ **As-Found**	**Log Page #**_____
Tech. Name/Z#:	**Tech. Signature:**	**Calibration Date:**_____

Eppley PIR Pyrgeometer Calibration

Serial Number	Calibration Constant ($x10^{-6}$ V/Wm^{-2})	Installation		Tech. Initials	Data logger Multiplier Changed	Calibration Expiration Date	S&CL Calibration Certificate Info
		Date	Time				

Notes & Comments:
Standard Instrument Calibration/Verification is good for 4 years.
Calibration tracking documentation is maintained by the S&CL of LANL.
File this sheet in the appropriate log book based on unit installation location.

Form Revision: A

ATTACHMENT 24: CMF-7 DATA LOGGER TRACKING & VERIFICATION

Records Use Only

Campbell Scientific Model CR7, CR10X, & 21X Data Logger Instruments (Reference Section 5.11)

Met. Site: **Check (√):** □ **As-Left** □ **As-Found** □ **Close-Out** **Log Page #**_____

Tech. Name/Z#: **Tech. Signature:** **Calibration Date:**_____

Campbell Scientific Data Logger Instrument

Unit To/From Location	Date/time	Serial Number	Confirming Tech. Initials	Unit Cal. Date	Cal. Expiration Date	S&CL Calibration Certificate Info.

Notes & Comments:
The calibration interval is annually for these instruments.
The calibration records for these instruments are maintained by the S&CL (Standards and Calibration Laboratory) of LANL.

Form Revision: A

ATTACHMENT 25: CMF-8: METEOROLOGY STANDARDS CALIBRATION TRACKING WORKSHEET

Meteorology Standards Calibration Tracking Worksheet (5131-25)					
Ref #	**Standards/References**	**Serial #**	**S&CL File #**	**Last Cal. Date**	**Cal. Exp. Date**
1	8846A Fluke Multimeter	1447007	041524		
2	2675468 Platinum Fluke RTD	849593	041525		
3	8846A Fluke Multimeter	2476001			
4	2675468 Platinum Fluke RTD	893748			
5	18310 RM Young Torque Disc	None	N/A	N/A	
6	18331 RM Young Vane Torque Gage	1	100839		
7	18331 RM Young Vane Torque Gage	2			
8	18112 RM Young Vane Angle Fixture	None	N/A	N/A	
9	18802 RM Young Anemometer Drive	CA03715	041992		
10	18801 RM Young Anemometer Drive	None	010201		
11	300RPM RM Young Anemometer Drive	HSE8006	012687		
12	1800RPM RM Young Anemometer Drive	HSE8002	005332		
13	3600RPM RM Young Anemometer Drive	HSE8004	005334		

Items Calibrated/Verified by Above References			
Item Calibrated	**Ref. ID#**	**Item Calibrated**	**Ref. ID#**

ATTACHMENT 26: CMF-9 05305AQ WIND INSTRUMENT CALIBRATION WORKSHEETS

05305-AQ Horizontal Anemometer Calibration Work Sheet

☐ **As-Found** ☐ **As-Left**

☐ **To** ☐ **From** **Tower:**_____ **Level:**_____ **Instrument SN#**_____

☐ **6-Month Check** ☐ **Annual Calibration** ☐ **Other**

Wind Direction & Speed Verification

Wind Direction Test

Instrument Accuracy: +/- 3 °
Met. Prog. Accuracy Required: +/- 5 °

18112 Vane Angle Azimuth Test		° Deg. Azimuth Reading	P / F	% Error
LCL	27°			
Target	30°			
UCL	33°			
LCL	87°			
Target	90°			
UCL	93°			
LCL	177°			
Target	180°			
UCL	183°			
LCL	267°			
Target	270°			
UCL	273°			
LCL	327°			
Target	330°			
UCL	333°			

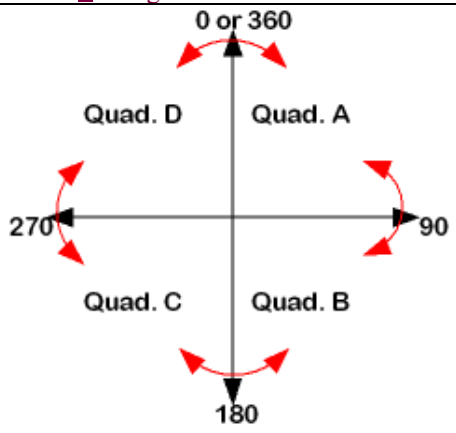
Wind Speed Test

Instrument Accuracy: +/- 0.2m/s or 1% of reading
Met. Prog. Accuracy Required: 0.2m/s or 5%

	(Hz) 1% of reading	Hertz Speed Reading	P / F	% Error
LCL	9.00			
Target	10.00			
UCL	11.00			
LCL	44.55			
Target	45.00			
UCL	45.45			
LCL	89.10			
Target	90.00			
UCL	90.90			
LCL	178.20			
Target	180.00			
UCL	181.80			
LCL	356.40			
Target	360.00			
UCL	363.60			

18331 Vane Threshold/Torque Test

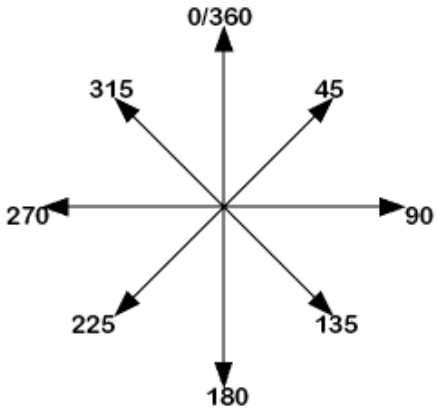
As-Found: ≤ 20.0gm-cm
As-Left: ≤ 10.0gm-cm



☐ **Pass** ☐ **Fail**
Highest Reading:_____

18310 Propeller Threshold/Torque Test

As-Found: ≤ 1.0gm-cm
As-Left: ≤ 0.5gm-cm



☐ **Pass** ☐ **Fail**
Highest Reading:_____

☐ Confirm Environmental Conditions (5131-26) Form Revision: A

ATTACHMENT 27: CMF-10 27106T WIND INSTRUMENT CALIBRATION WORKSHEETS

27106T Vertical Anemometer Calibration Worksheet

As-Found **As-Left**

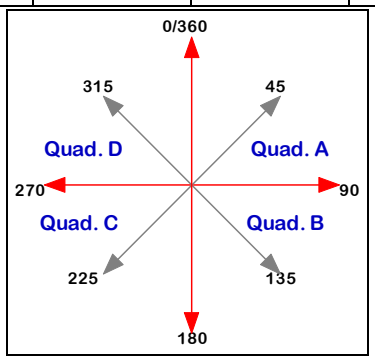
☐ **To** ☐ **From** **Tower:**_____ **Level:**_____ **Instrument SN#**_____

☐ **6-Month Check** ☐ **Annual Calibration** ☐ **Other**

Calibration Date:_____ **Calibration Expiration Date:** _____

Propeller 4-Quadrant Threshold/Torque Test

Quad. A 45°	Quad. A 90°	Quad. B 135°	Quad. C 225°	Quad. C 270°	Quad. D 315°	Highest Threshold	P / F



Threshold/Torque Specifications

As-Found: < or = 1.0gm-cm

As-Left: < or = 0.5gm-cm

Wind Speed Transducer Output Test (+/- 2.5 mV)

RPM	(mV) millivolts	[+] CW	[-] CCW	Average	P / F	Acceptable Range (mV) UCL mV	LCL mV
200	55.53mV					58.03mV	53.03mV
300	83.30mV					85.8mV	80.8 mV
1800	500.0mV					502.5 mV	497.5 mV
3600	1000.0mV					1002.5 mV	997.5 mV

Notes/Comments:

% = [Part/Whole] x 100.

☐ Confirm Environmental Conditions (5131-26) Form Revision: A

ATTACHMENT 28: TEMPERATURE PROBE RESISTANCE TO TEMPERATURE CONVERSION CHART

Deg. C.	Resistance @ Temp. C	Deg. C.	Resistance @ Temp. C	Deg. C.	Resistance @ Temp. C	Deg. C.	Resistance @ Temp. C
32.00	**16325**	31.60	16477	31.21	16625	30.81	16779
31.99	16329	31.60	16477	31.20	16629	30.80	16782
31.98	16333	31.59	16481	31.19	16633	30.79	16786
31.97	16336	31.58	16485	31.18	16637	30.78	16790
31.96	16340	31.57	16488	31.17	16640	30.77	16794
31.95	16344	31.56	16492	31.16	16644	30.76	16798
31.94	16348	31.55	16496	31.15	16648	30.75	16802
31.93	16352	31.54	16500	31.14	16652	30.74	16806
31.92	16355	31.53	16504	31.13	16656	30.73	16809
31.91	16359	31.52	16507	31.12	16659	30.72	16813
31.90	16363	31.51	16511	31.11	16663	30.71	16817
31.89	16367	31.50	16515	31.10	16667	30.70	16821
31.88	16371	31.49	16519	31.09	16671	30.69	16825
31.87	16374	31.48	16523	31.08	16675	30.68	16829
31.86	16378	31.47	16526	31.07	16678	30.67	16833
31.85	16382	31.46	16530	31.06	16682	30.66	16837
31.84	16386	31.45	16534	31.05	16686	30.65	16840
31.83	16390	31.44	16538	31.04	16690	30.64	16844
31.82	16393	31.43	16542	31.03	16694	30.63	16848
31.81	16397	31.42	16545	31.02	16697	30.62	16852
31.80	16401	31.41	16549	31.01	16701	30.61	16856
31.79	16405	31.40	16553	**31.00**	**16705**	30.60	16860
31.78	16409	31.39	16557	30.99	16709	30.59	16864
31.77	16412	31.38	16561	30.98	16713	30.58	16868
31.76	16416	31.37	16564	30.97	16717	30.57	16871
31.75	16420	31.36	16568	30.96	16720	30.56	16875
31.74	16424	31.35	16572	30.95	16724	30.55	16879
31.73	16428	31.34	16576	30.94	16728	30.54	16883
31.72	16431	31.33	16580	30.93	16732	30.53	16887
31.71	16435	31.32	16583	30.92	16736	30.52	16891
31.70	16439	31.31	16587	30.91	16740	30.51	16895
31.69	16443	31.30	16591	30.90	16744	30.50	16898
31.68	16447	31.29	16595	30.89	16748	30.49	16902
31.67	16450	31.28	16599	30.88	16751	30.48	16906
31.66	16454	31.27	16602	30.87	16755	30.47	16910
31.65	16458	31.26	16606	30.86	16759	30.46	16914
31.64	16462	31.25	16610	30.85	16763	30.45	16918
31.63	16466	31.24	16614	30.84	16767	30.44	16922
31.62	16469	31.23	16618	30.83	16771	30.43	16926
31.61	16473	31.22	16621	30.82	16775	30.42	16929

Deg. C.	Resistance @ Temp. C	Deg. C.	Resistance @ Temp. C	Deg. C.	Resistance @ Temp. C	Deg. C.	Resistance @ Temp. C
30.41	16933	30.01	17088	29.61	17246	29.21	17404
30.40	16937	**30.00**	**17092**	29.60	17250	29.20	17408
30.39	16941	29.99	17096	29.59	17254	29.19	17412
30.38	16945	29.98	17100	29.58	17258	29.18	17416
30.37	16949	29.97	17104	29.57	17262	29.17	17420
30.36	16953	29.96	17108	29.56	17266	29.16	17424
30.35	16957	29.95	17112	29.55	17270	29.15	17428
30.34	16960	29.94	17116	29.54	17274	29.14	17432
30.33	16964	29.93	17120	29.53	17278	29.13	17436
30.32	16968	29.92	17124	29.52	17282	29.12	17440
30.31	16972	29.91	17128	29.51	17286	29.11	17444
30.30	16976	29.90	17132	29.50	17290	29.10	17448
30.29	16980	29.89	17135	29.49	17293	29.09	17451
30.28	16984	29.88	17139	29.48	17297	29.08	17455
30.27	16988	29.87	17143	29.47	17301	29.07	17459
30.26	16991	29.86	17147	29.46	17305	29.06	17463
30.25	16995	29.85	17151	29.45	17309	29.05	17467
30.24	16999	29.84	17155	29.44	17313	29.04	17471
30.23	17003	29.83	17159	29.43	17317	29.03	17475
30.22	17007	29.82	17163	29.42	17321	29.02	17479
30.21	17011	29.81	17167	29.41	17325	29.01	17483
30.20	17015	29.80	17171	29.40	17329	**29.00**	**17487**
30.19	17018	29.79	17175	29.39	17333	28.99	17491
30.18	17022	29.78	17179	29.38	17337	28.98	17495
30.17	17026	29.77	17183	29.37	17341	28.97	17499
30.16	17030	29.76	17187	29.36	17345	28.96	17503
30.15	17034	29.75	17191	29.35	17349	28.95	17507
30.14	17038	29.74	17195	29.34	17353	28.94	17511
30.13	17042	29.73	17199	29.33	17357	28.93	17515
30.12	17046	29.72	17203	29.32	17361	28.92	17519
30.11	17049	29.71	17207	29.31	17365	28.91	17523
30.10	17053	29.70	17211	29.30	17369	28.90	17527
30.09	17057	29.69	17214	29.29	17372	28.89	17531
30.08	17061	29.68	17218	29.28	17376	28.88	17535
30.07	17065	29.67	17222	29.27	17380	28.87	17539
30.06	17069	29.66	17226	29.26	17384	28.86	17543
30.05	17073	29.65	17230	29.25	17388	28.85	17547
30.04	17077	29.64	17234	29.24	17392	28.84	17551
30.03	17080	29.63	17238	29.23	17396	28.83	17555
30.02	17084	29.62	17242	29.22	17400	28.82	17559

Deg. C.	Resistance @ Temp. C	Deg. C.	Resistance @ Temp. C	Deg. C.	Resistance @ Temp. C	Deg. C.	Resistance @ Temp. C
28.81	17563	28.41	17724	28.01	17885	16.64	23097
28.80	17567	28.40	17728	**28.00**	**17889**	16.63	23103
28.79	17571	28.39	17732			16.62	23108
28.78	17575	28.38	17736			16.61	23113
28.77	17579	28.37	17740	**17.00**	**22911**	16.60	23118
28.76	17583	28.36	17744	16.99	22916	16.59	23123
28.75	17588	28.35	17748	16.98	22921	16.58	23129
28.74	17592	28.34	17752	16.97	22927	16.57	23134
28.73	17596	28.33	17756	16.96	22932	16.56	23139
28.72	17600	28.32	17760	16.95	22937	16.55	23144
28.71	17604	28.31	17764	16.94	22942	16.54	23149
28.70	17608	28.30	17768	16.93	22947	16.53	23154
28.69	17612	28.29	17772	16.92	22952	16.52	23160
28.68	17616	28.28	17776	16.91	22958	16.51	23165
28.67	17620	28.27	17780	16.90	22963	16.50	23170
28.66	17624	28.26	17784	16.89	22968	16.49	23175
28.65	17628	28.25	17789	16.88	22973	16.48	23180
28.64	17632	28.24	17793	16.87	22978	16.47	23186
28.63	17636	28.23	17797	16.86	22984	16.46	23191
28.62	17640	28.22	17801	16.85	22989	16.45	23196
28.61	17644	28.21	17805	16.84	22994	16.44	23201
28.60	17648	28.20	17809	16.83	22999	16.43	23206
28.59	17652	28.19	17813	16.82	23004	16.42	23211
28.58	17656	28.18	17817	16.81	23009	16.41	23217
28.57	17660	28.17	17821	16.80	23015	16.40	23222
28.56	17664	28.16	17825	16.79	23020	16.39	23227
28.55	17668	28.15	17829	16.78	23025	16.38	23232
28.54	17672	28.14	17833	16.77	23030	16.37	23237
28.53	17676	28.13	17837	16.76	23035	16.36	23243
28.52	17680	28.12	17841	16.75	23041	16.35	23248
28.51	17684	28.11	17845	16.74	23046	16.34	23253
28.50	17688	28.10	17849	16.73	23051	16.33	23258
28.49	17692	28.09	17853	16.72	23056	16.32	23263
28.48	17696	28.08	17857	16.71	23061	16.31	23268
28.47	17700	28.07	17861	16.70	23066	16.30	23274
28.46	17704	28.06	17865	16.69	23072	16.29	23279
28.45	17708	28.05	17869	16.68	23077	16.28	23284
28.44	17712	28.04	17873	16.67	23082	16.27	23289
28.43	17716	28.03	17877	16.66	23087	16.26	23294
28.42	17720	28.02	17881	16.65	23092	16.25	23300

Deg. C.	Resistance @ Temp. C	Deg. C.	Resistance @ Temp. C	Deg. C.	Resistance @ Temp. C	Deg. C.	Resistance @ Temp. C
16.24	23305	15.84	23514	15.44	23726	15.04	23938
16.23	23310	15.83	23519	15.43	23731	15.03	23943
16.22	23315	15.82	23524	15.42	23736	15.02	23948
16.21	23320	15.81	23530	15.41	23742	15.01	23954
16.20	23325	15.80	23535	15.40	23747	**15.00**	**23959**
16.19	23331	15.79	23540	15.39	23752	14.99	23964
16.18	23336	15.78	23546	15.38	23758	14.98	23970
16.17	23341	15.77	23551	15.37	23763	14.97	23975
16.16	23346	15.76	23556	15.36	23768	14.96	23981
16.15	23351	15.75	23562	15.35	23774	14.95	23986
16.14	23356	15.74	23567	15.34	23779	14.94	23992
16.13	23362	15.73	23572	15.33	23784	14.93	23997
16.12	23367	15.72	23577	15.32	23789	14.92	24002
16.11	23372	15.71	23583	15.31	23795	14.91	24008
16.10	23377	15.70	23588	15.30	23800	14.90	24013
16.09	23382	15.69	23593	15.29	23805	14.89	24019
16.08	23388	15.68	23599	15.28	23811	14.88	24024
16.07	23393	15.67	23604	15.27	23816	14.87	24029
16.06	23398	15.66	23609	15.26	23821	14.86	24035
16.05	23403	15.65	23615	15.25	23826	14.85	24040
16.04	23408	15.64	23620	15.24	23832	14.84	24046
16.03	23413	15.63	23625	15.23	23837	14.83	24051
16.02	23419	15.62	23630	15.22	23842	14.82	24057
16.01	23424	15.61	23636	15.21	23848	14.81	24062
16.00	**23429**	15.60	23641	15.20	23853	14.80	24067
15.99	23434	15.59	23646	15.19	23858	14.79	24073
15.98	23440	15.58	23652	15.18	23864	14.78	24078
15.97	23445	15.57	23657	15.17	23869	14.77	24084
15.96	23450	15.56	23662	15.16	23874	14.76	24089
15.95	23456	15.55	23668	15.15	23879	14.75	24095
15.94	23461	15.54	23673	15.14	23885	14.74	24100
15.93	23466	15.53	23678	15.13	23890	14.73	24105
15.92	23471	15.52	23683	15.12	23895	14.72	24111
15.91	23477	15.51	23689	15.11	23901	14.71	24116
15.90	23482	15.50	23694	15.10	23906	14.70	24122
15.89	23487	15.49	23699	15.09	23911	14.69	24127
15.88	23493	15.48	23705	15.08	23917	14.68	24132
15.87	23498	15.47	23710	15.07	23922	14.67	24138
15.86	23503	15.46	23715	15.06	23927	14.66	24143
15.85	23509	15.45	23721	15.05	23932	14.65	24149

Deg. C.	Resistance @ Temp. C	Deg. C.	Resistance @ Temp. C	Deg. C.	Resistance @ Temp. C	Deg. C.	Resistance @ Temp. C
14.64	24154	14.24	24371	13.84	24590	13.44	24812
14.63	24160	14.23	24376	13.83	24595	13.43	24817
14.62	24165	14.22	24382	13.82	24601	13.42	24823
14.61	24170	14.21	24387	13.81	24606	13.41	24828
14.60	24176	14.20	24393	13.80	24612	13.40	24834
14.59	24181	14.19	24398	13.79	24618	13.39	24840
14.58	24187	14.18	24403	13.78	24623	13.38	24845
14.57	24192	14.17	24409	13.77	24629	13.37	24851
14.56	24197	14.16	24414	13.76	24634	13.36	24856
14.55	24203	14.15	24420	13.75	24640	13.35	24862
14.54	24208	14.14	24425	13.74	24645	13.34	24867
14.53	24214	14.13	24431	13.73	24651	13.33	24873
14.52	24219	14.12	24436	13.72	24656	13.32	24878
14.51	24225	14.11	24441	13.71	24662	13.31	24884
14.50	24230	14.10	24447	13.70	24668	13.41	24828
14.49	24235	14.09	24452	13.69	24673	13.40	24834
14.48	24241	14.08	24458	13.68	24679	13.39	24840
14.47	24246	14.07	24463	13.67	24684	13.38	24845
14.46	24252	14.06	24468	13.66	24690	13.37	24851
14.45	24257	14.05	24474	13.65	24695	13.36	24856
14.44	24263	14.04	24479	13.64	24701	13.35	24862
14.43	24268	14.03	24485	13.63	24706	13.34	24867
14.42	24273	14.02	24490	13.62	24712	13.33	24873
14.41	24279	14.01	24496	13.61	24717	13.32	24878
14.40	24284	**14.00**	**24501**	13.60	24723	13.31	24884
14.39	24290	13.99	24507	13.59	24729	13.30	24889
14.38	24295	13.98	24512	13.58	24734	13.29	24895
14.37	24300	13.97	24518	13.57	24740	13.28	24901
14.36	24306	13.96	24523	13.56	24745	13.27	24906
14.35	24311	13.95	24529	13.55	24751	13.26	24912
14.34	24317	13.94	24534	13.54	24756	13.25	24917
14.33	24322	13.93	24540	13.53	24762	13.24	24923
14.32	24328	13.92	24545	13.52	24767	13.23	24928
14.31	24333	13.91	24551	13.51	24773	13.22	24934
14.30	24338	13.90	24557	13.50	24779	13.21	24939
14.29	24344	13.89	24562	13.49	24784	13.20	24945
14.28	24349	13.88	24568	13.48	24790	13.19	24951
14.27	24355	13.87	24573	13.47	24795	13.18	24956
14.26	24360	13.86	24579	13.46	24801	13.17	24962
14.25	24365	13.85	24584	13.45	24806	13.16	24967

Deg. C.	Resistance @ Temp. C	Deg. C.	Resistance @ Temp. C	Deg. C.	Resistance @ Temp. C	Deg. C.	Resistance @ Temp. C
13.15	24973	1.78	32304	1.38	32603	0.98	32903
13.14	24978	1.77	32311	1.37	32611	0.97	32911
13.13	24984	1.76	32319	1.36	32618	0.96	32919
13.12	24989	1.75	32326	1.35	32626	0.95	32926
13.11	24995	1.74	32334	1.34	32633	0.94	32934
13.10	25000	1.73	32341	1.33	32641	0.93	32942
13.09	25006	1.72	32349	1.32	32648	0.92	32950
13.08	25012	1.71	32356	1.31	32656	0.91	32957
13.07	25017	1.70	32364	1.30	32663	0.90	32965
13.06	25023	1.69	32371	1.29	32671	0.89	32973
13.05	25028	1.68	32379	1.28	32678	0.88	32980
13.04	25034	1.67	32386	1.27	32686	0.87	32988
13.03	25039	1.66	32394	1.26	32693	0.86	32996
13.02	25045	1.65	32401	1.25	32701	0.85	33003
13.01	25050	1.64	32409	1.24	32708	0.84	33011
13.00	**25056**	1.63	32416	1.23	32716	0.83	33019
		1.62	32424	1.22	32723	0.82	33026
		1.61	32431	1.21	32731	0.81	33034
2.00	**32139**	1.60	32439	1.20	32738	0.80	33042
1.99	32146	1.59	32446	1.19	32746	0.79	33049
1.98	32154	1.58	32454	1.18	32753	0.78	33057
1.97	32161	1.57	32461	1.17	32761	0.77	33065
1.96	32169	1.56	32469	1.16	32768	0.76	33073
1.95	32176	1.55	32476	1.15	32776	0.75	33080
1.94	32184	1.54	32484	1.14	32783	0.74	33088
1.93	32191	1.53	32491	1.13	32791	0.73	33096
1.92	32199	1.52	32499	1.12	32798	0.72	33103
1.91	32206	1.51	32506	1.11	32806	0.71	33111
1.90	32214	1.50	32514	1.10	32813	0.70	33119
1.89	32221	1.49	32521	1.09	32821	0.69	33126
1.88	32229	1.48	32528	1.08	32828	0.68	33134
1.87	32236	1.47	32536	1.07	32836	0.67	33142
1.86	32244	1.46	32543	1.06	32843	0.66	33149
1.85	32251	1.45	32551	1.05	32851	0.65	33157
1.84	32259	1.44	32558	1.04	32858	0.64	33165
1.83	32266	1.43	32566	1.03	32866	0.63	33173
1.82	32274	1.42	32573	1.02	32873	0.62	33180
1.81	32281	1.41	32581	1.01	32881	0.61	33188
1.80	32289	1.40	32588	**1.00**	**32888**	0.60	33196
1.79	32296	1.39	32596	0.99	32896	0.59	33203

Deg. C.	Resistance @ Temp. C	Deg. C.	Resistance @ Temp. C	Deg. C.	Resistance @ Temp. C	Deg. C.	Resistance @ Temp. C
0.58	33211	0.18	33519	-0.22	33831	-0.62	34147
0.57	33219	0.17	33526	-0.23	33839	-0.63	34155
0.56	33226	0.16	33534	-0.24	33847	-0.64	34163
0.55	33234	0.15	33542	-0.25	33855	-0.65	34171
0.54	33242	0.14	33549	-0.26	33862	-0.66	34178
0.53	33249	0.13	33557	-0.27	33870	-0.67	34186
0.52	33257	0.12	33565	-0.28	33878	-0.68	34194
0.51	33265	0.11	33572	-0.29	33886	-0.69	34202
0.50	33273	0.10	33580	-0.30	33894	-0.70	34210
0.49	33280	0.09	33588	-0.31	33902	-0.71	34218
0.48	33288	0.08	33595	-0.32	33909	-0.72	34226
0.47	33296	0.07	33603	-0.33	33917	-0.73	34233
0.46	33303	0.06	33611	-0.34	33925	-0.74	34242
0.45	33311	0.05	33619	-0.35	33933	-0.75	34250
0.44	33319	0.04	33626	-0.36	33941	-0.76	34257
0.43	33326	0.03	33634	-0.37	33949	-0.77	34265
0.42	33334	0.02	33642	-0.38	33957	-0.78	34273
0.41	33342	0.01	33649	-0.39	33965	-0.79	34281
0.40	33349	**0.00**	**33657**	-0.40	33973	-0.80	34289
0.39	33357	-0.01	33665	-0.41	33981	-0.81	34297
0.38	33365	-0.02	33673	-0.42	33989	-0.82	34305
0.37	33372	-0.03	33681	-0.43	33997	-0.83	34313
0.36	33380	-0.04	33689	-0.44	34005	-0.84	34321
0.35	33388	-0.05	33697	-0.45	34013	-0.85	34329
0.34	33396	-0.06	33704	-0.46	34020	-0.86	34336
0.33	33403	-0.07	33712	-0.47	34028	-0.87	34344
0.32	33411	-0.08	33720	-0.48	34036	-0.88	34352
0.31	33419	-0.09	33728	-0.49	34044	-0.89	34360
0.30	33426	-0.10	33736	-0.50	34052	-0.90	34368
0.29	33434	-0.11	33744	-0.51	34060	-0.91	34376
0.28	33442	-0.12	33752	-0.52	34068	-0.92	34384
0.27	33449	-0.13	33760	-0.53	34076	-0.93	34392
0.26	33457	-0.14	33768	-0.54	34084	-0.94	34400
0.25	33465	-0.15	33776	-0.55	34092	-0.95	34408
0.24	33472	-0.16	33783	-0.56	34099	-0.96	34415
0.23	33480	-0.17	33791	-0.57	34107	-0.97	34423
0.22	33488	-0.18	33799	-0.58	34115	-0.98	34431
0.21	33496	-0.19	33807	-0.59	34123	-0.99	34439
0.20	33503	-0.20	33815	-0.60	34131	**-1.00**	**34447**
0.19	33511	-0.21	33823	-0.61	34139		

ATTACHMENT 29: WIND INSTRUMENT REFURBISHMENT CHECKLIST

6-Month Check 27106T Vertical Anemometer			Annual Refurbishment 27106T Vertical Anemometer	
Unit Serial #_____ Date:_____			Unit Serial #_____ Date:_____	
	Confirmed			Confirmed
Replaced Upper Bearing			Replaced Upper Bearing	
Replaced Lower Bearing			Replaced Lower Bearing	
Inspect for Physical Damage			Replace Wind Speed Transducer	
			Inspect for Physical Damage	
6 Month 05305-AQ Horizontal Anemometer			Annual 05305-AQ Horizontal Anemometer	
Unit Serial #_____ Date:_____			Unit Serial #_____ Date:_____	
	Confirmed			Confirmed
Replaced Upper Vertical Shaft Bearing			Replaced Upper Vertical Shaft Bearing	
Replaced Lower Vertical Shaft Bearing			Replaced Lower Vertical Shaft Bearing	
Replaced Forward Horizontal Shaft Bearing			Replaced Forward Horizontal Shaft Bearing	
Replaced Rear Horizontal Shaft Bearing			Replaced Rear Horizontal Shaft Bearing	
Inspect for Physical Damage			Replaced Wind Speed Transducer	
			Replaced Wind Direction Transducer	
			Inspect for Physical Damage	