NEON PREVENTIVE MAINTENANCE PROCEDURE: HUMIDITY AND TEMPERATURE SENSOR

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See configuration management system for approval history.

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Change Record

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
A	04/24/2018	ECO-05508	Initial release
B	08/02/2021	ECO-06656	Removing offensive terminologies and updating NEON branding.
C	12/01/2022	ECO-06920	Minor formatting fixes

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1 DESCRIPTION

1.1 Purpose

The National Ecological Observatory Network (NEON) employs terrestrial and aquatic sensors to collect measurements from water, air, wind, soil, and sun across the United States (to include Alaska, Hawaii and Puerto Rico). Regular maintenance of these sensors and their infrastructure is necessary for the continued operation of the observatory and identify problems before they escalate.

This document details the procedures necessary for the preventive maintenance of the **Humidity and Temperature Sensor**.

1.2 Scope

Preventive Maintenance is the planned maintenance of infrastructure and equipment with the goal of improving equipment life by preventing excess depreciation and impairment. This maintenance includes, but is not limited to, inspecting, adjusting, cleaning, clearing, lubricating, repairing, and replacing, as appropriate. The procedures in this document are strictly preventive.

This document specifically addresses the preventive procedures to maintain the **Humidity and Temperature Sensor** for all applicable NEON terrestrial and aquatic sites. This covers the instrumentation, subsystem and infrastructure.

The procedures in this document are strictly preventive.

2 RELATED DOCUMENTS AND ACRONYMS

2.1 Applicable Documents

The following applicable documents (AD) contain mandatory requirements and/or supplementary information that are directly applicable to the topic and/or procedures herein. Visit the NEON Document Warehouse for electronic copies of these documents.

AD [01]	NEON.DOC.004300	NEON Environmental, Health, Safety And Security (EHSS) Policy, Program And Management Plan
AD [02]	NEON.DOC.004301	NEON Environmental, Health, Safety and Security (EHSS) Environmental Protection Manual
AD [03]	NEON.DOC.004316	Operations Field Safety and Security Plan
AD [04]	NEON.DOC.050005	Field Operations Job Instruction Training Plan
AD [05]	NEON.DOC.004257	NEON Standard Operating Procedure (SOP): Decontamination Of Sensors, Field Equipment And Field Vehicles
AD [06]	NEON.DOC.002768	TIS Subsystem Architecture, Site Configuration and Subsystem Demand by Site - SCMB Baseline
AD [07]	NEON.DOC.002767	AIS Subsystem Architecture, Site Configuration and Subsystem Demand by Site - SCMB Baseline
AD [08]	NEON.DOC.001427	TIS Communications Interconnect Map TIS Hut, Rack DAS and PDS Interconnect
AD [09]	NEON.DOC.001436	TIS Comm Interconnect Mapping
AD [10]	NEON.DOC.001972	AIS Comm Interconnect Mapping
AD [11]	NEON.DOC.000850	NEON Sensor Command, Control and Configuration – Humidity and Temperature Sensor
AD [12]	NEON.DOC.000851	NEON Algorithm Theoretical Basis Document – Humidity and Temperature Sensor
AD [13]	NEON.DOC.000498	NEON Installation Procedure: Tower Humidity
AD [14]	NEON.DOC.000846	NEON Installation Procedure: Soil Humidity

2.2 Reference Documents

The Reference Documents (RD) listed below may provide complimentary information to support this procedure. Visit the NEON Document Warehouse for electronic copies of these documents.

RD [01]	NEON.DOC.000008	NEON Acronym List
RD [02]	NEON.DOC.000243	NEON Glossary of Terms
RD [03]	NEON.DOC.000705	NEON Bolt Torque Specifications
RD [04]	NEON.DOC.000769	Electrostatic Discharge Prevention Procedure
RD [07]	NEON.DOC.004821	NEON Preventive Maintenance Procedure: Aquatic Meteorological (Met) Station
RD [08]	NEON.DOC.001637	Aquatic Met Station Installation Procedure
RD [09]	NEON.DOC.004613	NEON Preventive Maintenance Procedure: AIS Buoy
RD [10]	NEON.DOC.004638	AIS Verification Checklist

RD [11]	NEON.DOC.004637	TIS Verification Checklist
RD [12]	NEON.DOC.004057	Instruction, Assembly, Humidity Sensor Aquatic
RD [13]	NEON.DOC.004608	AIS Buoy Verification Procedures
RD [14]	NEON.DOC.004886	NEON Preventive Maintenance Procedure: Aquatic Portal & AIS Device Posts

2.3 External References

The External References (ER) listed below may contain supplementary information relevant to maintaining specific standards and/or commercial products pertaining to the Humidity and Temperature Sensor. These documents are external to the NEON project and Battelle Ecology. If an issue with a product requires the involvement of the manufacturer, NEON Headquarters (HQ) will contact the manufacturer or provide Field Operations (FOPS) the authority to contact via the NEON Issue Management System.

ER [01]	MSDSOnline (NEON Project Access) https://msdsmanagement.msdsonline.com/ec04e43d-e72d-4174-9369-c81635eb9493/ebinder/?nas=True
ER [02]	Vaisala Humidity and Temperature Probe HMP155 User's Guide in English https://www.vaisala.com/sites/default/files/documents/HMP155_User_Guide_in_English.pdf
ER [03]	Vaisala Humidity and Temperature Probe HMP155 Datasheet https://www.vaisala.com/sites/default/files/documents/HMP155-Datasheet-B210752EN-F.pdf
ER [04]	Vaisala HUMICAP Sensor for Measuring Relative Humidity https://www.vaisala.com/sites/default/files/documents/HUMICAP-Technology-description-B210781EN-C.pdf

2.4 Acronyms

Acronym	Description
A/R	As Required
AATS	Aspirated Air Temperature Shield
AIS	Aquatic Instrument Systems
BARR	Barrow Environmental Observatory, Domain 18
CPER	Central Plans Experimental Range, Domain 10
CLBJ	LBJ National Grassland, Domain 11
Comm	Communications
CVAL	Calibration, Validation and Audit Laboratory
CnC	Command and Control
DC	Direct Current
DSNY	Disney Wilderness Preserve, Domain 03
ESD	Electrostatic Discharge
FLNT	Flint River, Domain 03
FOPS	Field Operations

GWW	Ground Water Wells
IP	Ingress Protection
IP	Internet Protocol (in Section 7)
IP66	Ingress Protection where “66” is the specific rating[1]
JSA	Job Safety Analysis
LOGWAR	Logistics Warehouse
LOTO	Lock Out/Tag Out
ML	Measurement Level
MLx	Measurement Level where “x” is the measurement level
OKSR	Oksrukuyik Creek, Domain 18
PoE	Power Over Ethernet
PRIN	Pringle Creek, Domain 07
PRPO	Prairie Pothole, Domain 09
PRT	Platinum Resistance Thermometer
PTFE	Polytetrafluoroethylene
QR	Quick Response
SDS	Safety Data Sheet
SOAP	Soaproot Saddle, Domain 17
SP	Soil Plot
TEP	Terminal Emulator Program
TIS	Terrestrial Instrument Systems
V	Volt

2.5 Terminology

The use of common names for NEON instrumentation and subsystems vary across departments and domains. Equipment, tools, and instrumentation have one technically accurate name, and at times one or more “common” names describing the same item.

This section aims to clarify and associate “common” names with the technical names herein.

SYNONYMOUS AND COMMON NAME(S)	NEON TECHNICAL REFERENCE NAME
Humidity Sensor, RH Sensor, Relative Humidity Sensor, HMP155, Vaisala Humidity Sensor	Humidity and Temperature Sensor
12-Plate Solar Radiation and Precipitation Shield, Radiation Shield, Humidity Sensor Radiation Shield	Radiation Shield

3 SAFETY AND TRAINING

Personnel working at a NEON site must be compliant with safe fieldwork practices as outlined in AD [01] and AD [04].

The Field Operations Manager and the Lead Field Technician have primary authority to stop work activities based on unsafe field conditions; however, all employees have the responsibility and right to stop their work in unsafe conditions. All technicians must complete required safety training and protocol-specific training for safety and implementation of this protocol as required in AD [04].

Refer to the site-specific EHSS plan(s) and procedure-specific Safety Data Sheet (SDS) via the NEON Project's account on MSDSOnline or via the NEON Safety document portal for electronic copies. Conduct the appropriate Job Safety Analysis (JSA) before conducting any preventive maintenance.

Preventive maintenance of TIS and AIS Infrastructure may require the use of a special equipment to access the sensor subsystem assemblies. Follow Domain site-specific EHS plans via the Network Drive and NEON safety training procedures when conducting maintenance activities. Conduct a Job safety Analysis (JSA) prior to accessing the sensor subsystems onsite. Reference the Safety Office SharePoint portal for JSA templates and additional hazard identification information.

In the event the current method to conduct the procedures herein are no longer safe for use due to unforeseen or unknown site dynamics, consult with the NEON Safety Office via the NEON Project's Issue Management and Reporting System (i.e., JIRA or ServiceNow) for alternative methods to conduct TIS and AIS preventive/corrective maintenance and Sensor Refresh procedures.

3.1 Hazard Communication Safety Data Sheets (SDS)

Safety Data Sheets (SDS)s can always be accessed via the NEON Project's account on MSDSOnline.

If in the field and have internet connectivity, access to MSDSOnline can also be accessed via the following Quick Response (QR) code.

Neon Inc.

Scan to access an MSDS

4 SENSOR OVERVIEW

4.1 Associated Equipment

4.2 External Components

- 12-Plate Solar Radiation and Precipitation Shield
- Concord Grape G4, 24V Datalogger

4.2.1 Internal Components

- Vaisala Humidity and Temperature Probe HMP155
  - HUMICAP[1] Sensor
  - Pt100 Temperature Sensor

4.2.2 Other Components

- Mounting Assemblies
- Campbell Scientific Datalogger (AIS Buoy only)

4.3 Description

The Vaisala Humidity and Temperature Probe HMP155 (hereafter referred to as the Humidity and Temperature Sensor) uses single HUMICAP sensor for measurements of humidity (see **Figure 5**), and a platinum resistance thermometer (PRT; Pt100) for measurements of temperature (see **Figure 5**). The sensors themselves are located at the tip of the probe, enclosed and protected by a removable polytetrafluoroethylene (PTFE) (e.g. Teflon) filter (see **Figure 1** and **Figure 2**).

The HUMICAP sensor is a thin-film polymer sandwiched between two conductive electrodes and placed on a glass or ceramic substrate. A porous metal electrode protects the thin-film polymer surface from contamination and condensation.

The Humidity and Temperature Sensor is housed within a 12-Plate Solar Radiation and Precipitation Shield (hereafter referred to as simply the Radiation Shield). The louvered design allows the Humidity and Temperature Sensor to be naturally aspirated while also providing protection from direct solar radiation loading, and direct wetting due to precipitation events.

[1] HUMICAP is the Vaisala registered trademark name for their capacitive thin-film polymer sensor for relative humidity measurements. See also ER [04].

The Humidity and Temperature Sensor and associated Radiation Shield mounts to the tower top of TIS Towers, the soil array arbors at TIS Tower Soil Plots, AIS Met Stations, and AIS Lake and River Buoys. See for **Figure 8**, **Figure 9**, **Figure 10**, and **Figure 11** for the various NEON mounting locations.

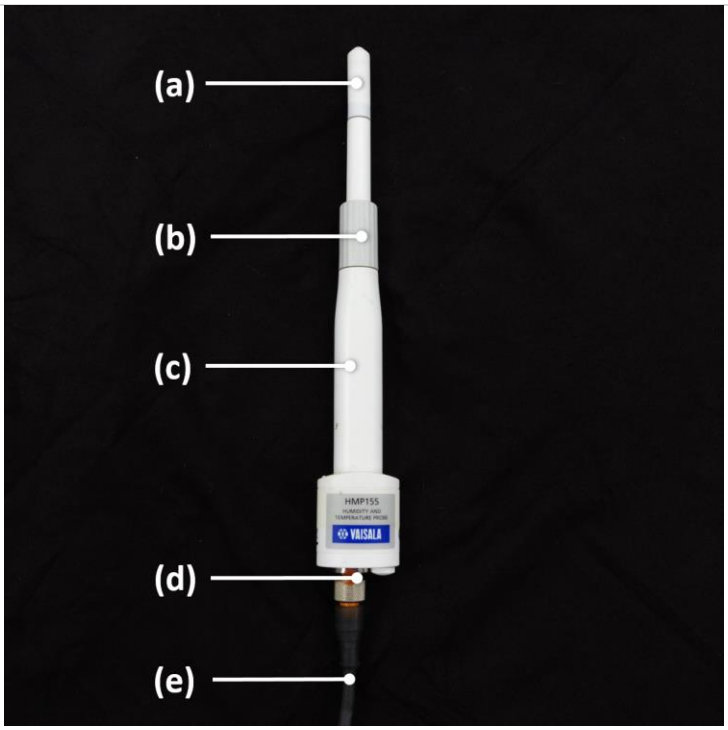


Figure 1. Picture and parts of the Humidity and Temperature Sensor.

a) PTFE Filter
b) Protective Cover
c) Probe Body
d) 8-Pin Male Connector
e) Power and Signal Cable

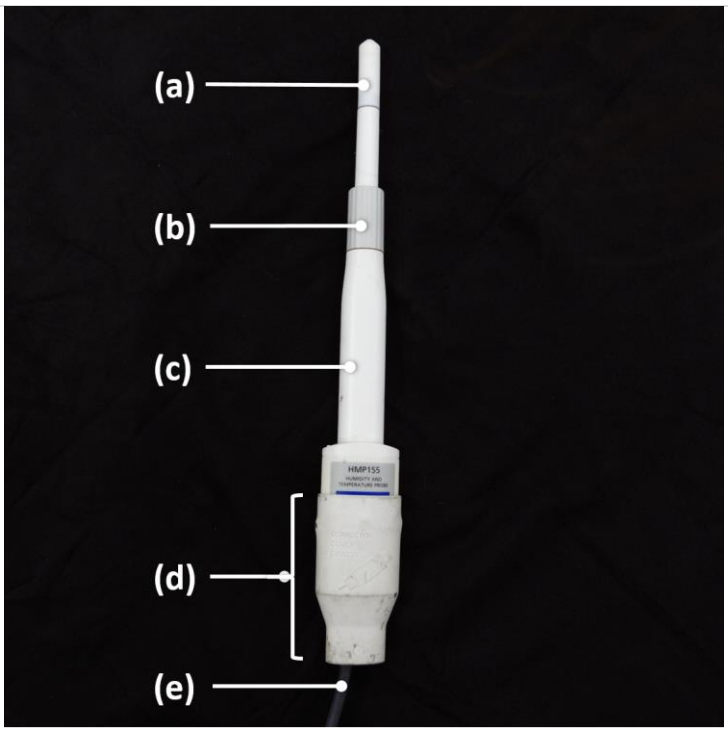


Figure 2. Picture and parts of the Humidity and Temperature Sensor with the Connection Cover attached.

a) PTFE Filter
b) Protective Cover
c) Probe Body
d) Connection Cover
e) Power and Signal Cable

Figure 3. Close-up view of the sensor connector.

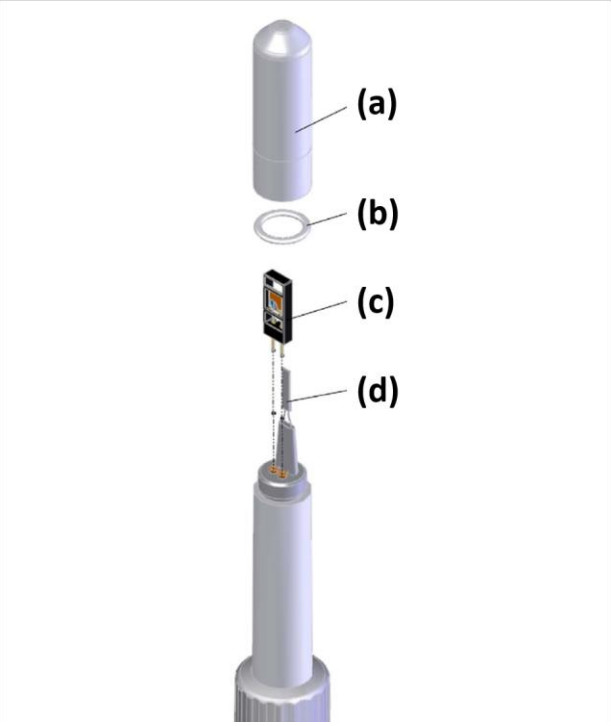


Figure 4. Expanded diagram of the Humidity and Temperature Sensor.

a) PTFE Filter
b) O-Ring (Silicone Gasket)
c) HUMICAP[1] Sensor
d) PRT (Pt100 Temperature Sensor)

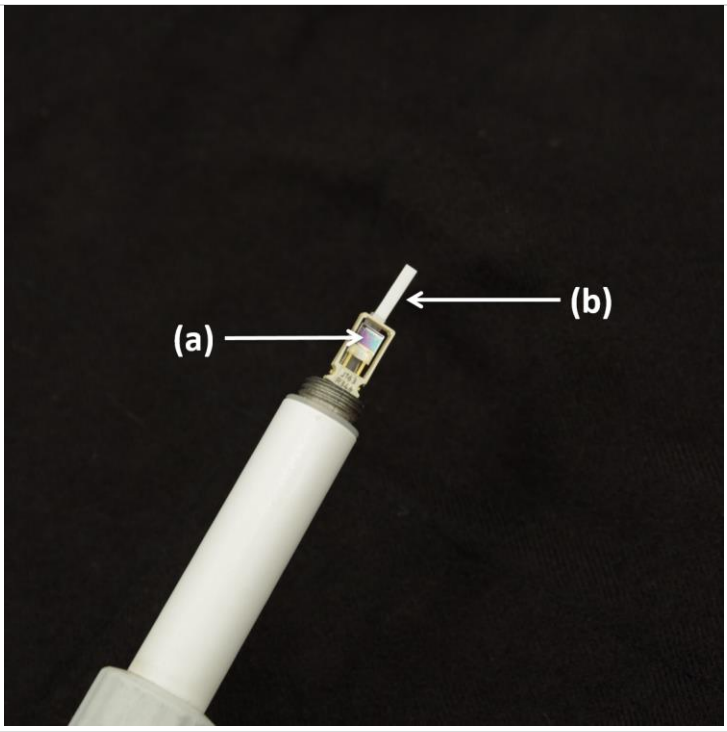


Figure 5. Close-up view of the humidity and PRT temperature sensors.

a) HUMICAP Humidity Sensor
b) PRT (Pt100) Temperature Sensor

NOTE: When the PTFE Filter is removed, the HUMICAP Humidity Sensor and PRT are exposed. These sensors are extremely fragile and should not be touched.

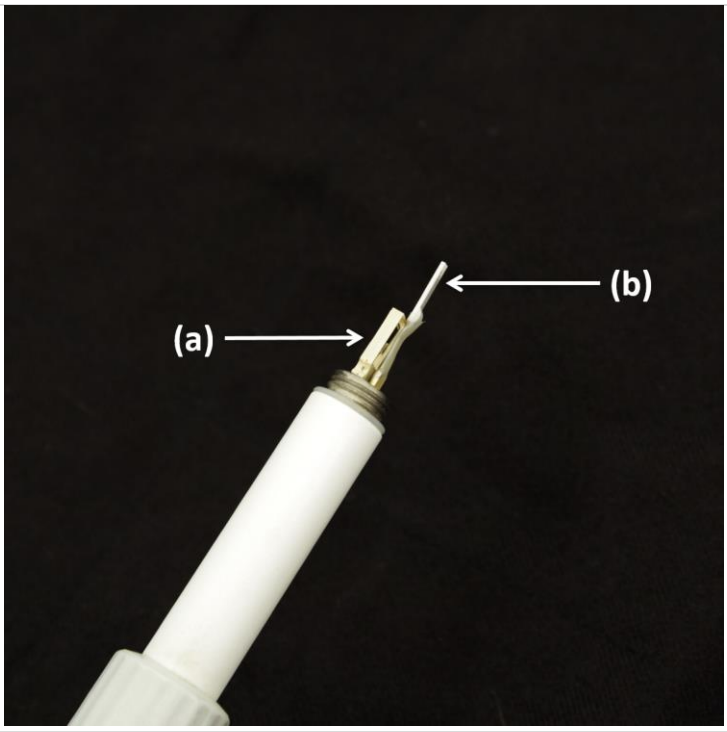


Figure 6. Side view of the humidity and PRT temperature sensors.

a) HUMICAP Humidity Sensor
b) PRT (Pt100) Temperature Sensor

NOTE: When the PTFE Filter is removed, the HUMICAP Humidity Sensor and PRT are exposed. These sensors are extremely fragile and should not be touched.

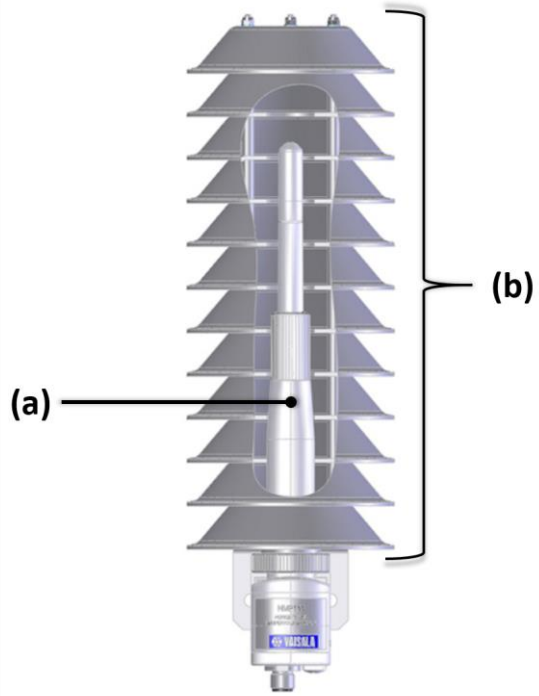


Figure 7. See through diagram of the Humidity and Temperature Sensor inside the Radiation Shield.

a) Humidity and Temperature Sensor
b) 12-Plate Solar Radiation and Precipitation Shield

Figure 8. TIS Tower mounted Humidity and Temperature Sensor with associated Grape.

NEON location: D11 CLBJ

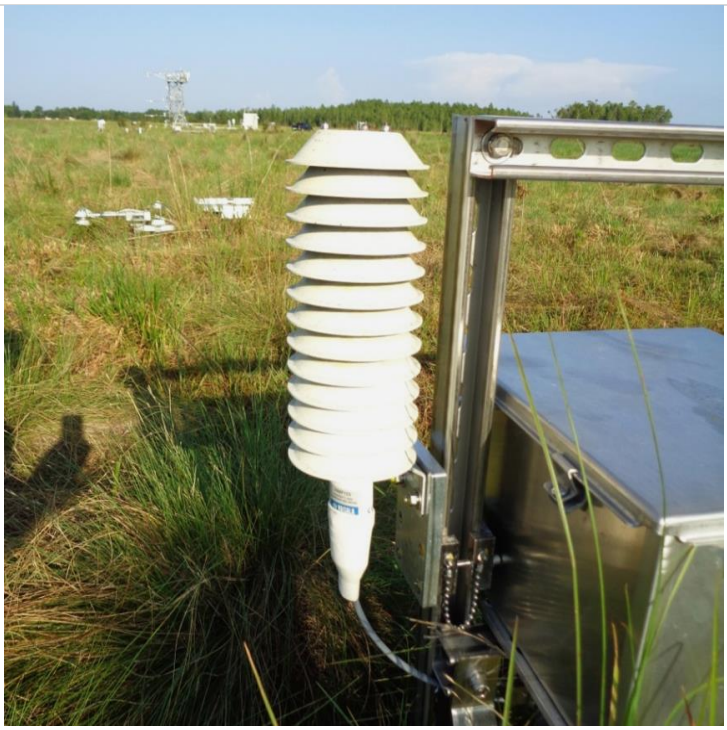


Figure 9. TIS Soil Array mounted Humidity and Temperature Sensor.

NEON location: D03 DSNY

Figure 10. Humidity and Temperature Sensor mounted on an AIS Met Station.

NEON location: D07 PRIN

Figure 11. Humidity and Temperature Sensor on the Met Mast of an AIS Buoy.

Location: D03 FLNT

4.4 Sensor Specific Handling Precautions

4.4.1 Instrument

When the PTFE Filter is removed, the HUMICAP Humidity Sensor and PRT are exposed. These sensors are extremely fragile and should not be touched (see **Figure 5** and **Figure 6**).

The HUMICAP and the PRT within the PTFE filter can be damaged if the PTFE filter is crushed. The PTFE Filter should also be kept clean and touching with ungloved hands should be avoided.

Keep the protective cover over the PTFE filter during handling, cleaning, and transport. Remove only when ready to install and insert into the radiation shield.

Figure 12. Sensor protective cover over the PTFE Filter during handling, cleaning, and transport.

NOTE: Humidity and Temperature Sensors will come from HQ with a yellow protective cover over the PTFE Filter. Do not throw away the protective cover; it is used during sensor maintenance and cleaning, and shipping.

4.4.2 Subsystem

Grapes and PoE devices contain electrostatic discharge sensitive parts; therefore, all Grapes require ESD (antistatic) packaging and handling during inter- and intra-site transport, reception, and storage. As a rule, when handling (installing, removing, and servicing) these electrical components, all Technicians must ground themselves.

Note: When handling Grapes, follow ESD protocols (see RD [04]) and never hot swap sensor connections. When power is ON, disconnect the RJF/Eth-To Comm Box cable BEFORE disconnecting the sensor cable. Connect the sensor cable BEFORE connecting the RJF/Eth-To Comm Box cable.

4.5 Operation

As humidity in the air changes, the thin-film polymer of the HUMICAP sensor either absorbs or releases water vapor. The dielectric properties of the thin-film polymer is proportional to the amount of absorbed water on the polymer. As humidity changes, the dielectric properties of the polymer change and alter the capacitance of the sensors. The instrument's electronics measure the change in capacitance and output a signal for humidity. Refer to ER [04] for further information.

5 INSPECTION AND PREVENTIVE MAINTENANCE

Begin preventive maintenance by first reviewing Section 5.1, Preventative Maintenance Procedural Sequence, to understand the order of the procedure.

5.1 Preventative Maintenance Procedural Sequence

1. Inspect and clean the Radiation Shield.
2. Inspect and clean sensor probe body and PTFE Filter. [Quarterly]
3. Inspect the O-Rings [Quarterly]
4. Inspect cables and connectors.
5. Inspect mounting hardware.

5.2 Preventive Maintenance Schedule

Table 1. Preventive Maintenance Frequency and Schedule.

Maintenance	Bi-weekly	Quarterly	Annual	As Needed	Type
Humidity and Temperature Sensor					
Remote Monitoring	X			X	P
Visual Inspection of Sensor and Shield	X			X	P
Clean 12-Plate Radiation Shield	*X*			X	P/R
Sensor Body Cleaning		*X*		X	P/R
Visual Inspection of PTFE Filter		X		X	P
Clean PTFE Filter				X	P/R
Replace PTFE Filter				X	R
Visual Inspection of O-Rings		X			P
Replace O-Rings				X	R

NOTE: The biweekly and annual inspections should be carried out regardless of whether they coincide or not. P = Preventive, R = Repair, X = Indicates preventive maintenance task time interval may increase due to environmental (season/weather) or unforeseen/unanticipated site factors.

5.3 Equipment

Table 2 lists the preventive maintenance equipment necessary to conduct the procedures herein. Equipment recommendations and applicability may adjust over time as the implementation of NEON sensors and subsystems mature.

Table 2. Tools, Consumables, and Resource Lists for Preventive Maintenance.

Part No.	Description	Quantity
Tools		
GENERIC	Hex or Allen Key Set (Imperial and Metric)	1
GENERIC	Soft-Bristle Brushes (Various Sizes)	A/R
GENERIC	Magnifying Glass	1

Part No.	Description	Quantity
Consumable items		
GENERIC	Formula 409, Multi-surface Cleaner (32 oz. spray bottle)	A/R
GENERIC	Distilled or Deionized water (Squirt/Spray Bottle)	A/R
GENERIC	95% Ethanol (Squirt/Spray Bottle)	A/R
GENERIC	0.1M Acetic Acid	A/R
GENERIC	Can of Compressed Air (10 oz.)	1
GENERIC	Cotton Swabs (Short- and Long-Stem)	A/R
GENERIC	Lint-free Cloths or Microfiber Towels	A/R
GENERIC	Toothpicks	A/R
GENERIC	Powder-free Nitrile Gloves	A/R
GENERIC	Trash bag(s)	A/R
GENERIC	Small Plastic Bags	A/R
GENERIC	Cloth Rags or Roll of Paper Towels	A/R
37230	Loctite QuickStix Silver Anti-Seize LB 8060 (for TIS Infrastructure)	1 (A/R)
80337	SAF-T-LOK SAFTEZE Food/Drug Grade Anti-Seize (for AIS Infrastructure)	1 (A/R)
219452SP	Sintered Teflon Filter + O-Ring	A/R
221318	Protection Set for Calibration Buttons: Protective Cover, 2 O-Rings, and Protective Plug	A/R
Resources		
1	Technician	2
2	Small Bucket or Catch Basin	1

5.4 Subsystem Location and Access

The Humidity and Temperature Sensor is located on TIS Towers, Soil Array Arbors, AIS Met Stations, and AIS Buoys for River and Lake sites.

- **TIS Towers:** Tower top.
- **TIS Soil Array:** Soil arbor (typically at Soil Plot 3).
- **AIS Aquatic Met Station:** Central post (see for e.g. **Figure 10**).
- **AIS Buoy:** Met Mast (reference RD [09] for specific location).

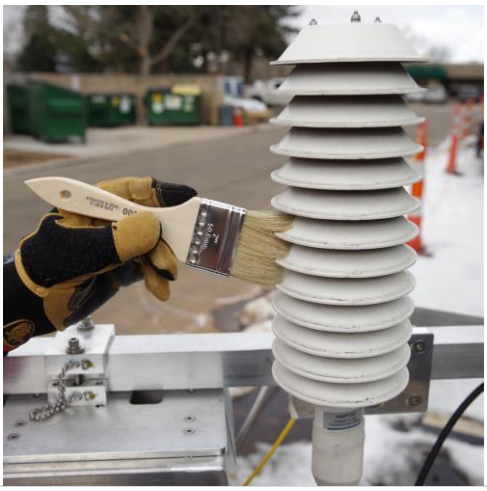
5.5 Maintenance Procedure

5.5.1 Inspecting and Cleaning the Radiation Shield

The Radiation Shield should be kept clean of any dirt and debris that blocks proper ventilation of the Humidity and Temperature Sensor within. The white surfaces of the Radiation Shield should be kept clean to ensure maximum reflectivity. For AIS sites, please submit a ticket with the Data Quality component tagged, if the power is not shut down for these next maintenance steps.

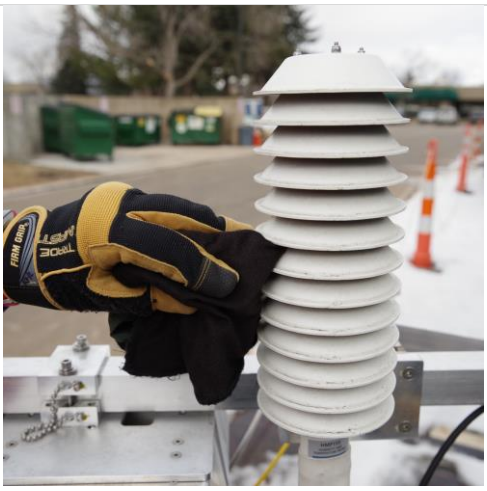
Step 1. Visually inspect the 12-Plate Radiation and Precipitation Shield for any dirt, debris, and/or insect nests.

NEON Location: D04 LAJA



Step 2. Use a soft-bristle brush and clean each “fin” of the radiation shield. This will remove light deposits of dust and dirt.

Step 3. Use a multi-surface cleaner and dampen a lint-free cloth or microfiber towel.



Step 4. Wipe down and clean each "fin" of the radiation shield. This will remove heavier deposits or caked-on dust and dirt.

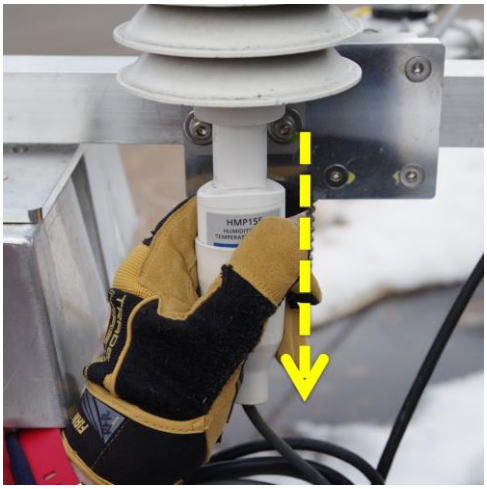
5.5.2 Inspecting the Sensor Probe Body and PTFE Filter [Quarterly]

The plastic body of sensor probe should not be damaged. The PTFE Filter should be clean and undamaged without any accumulated dust, caked on dirt, or other residue.

NOTE: Before performing the next procedure be sure to have the yellow protective cap available (see **Figure 12***).*

Step 1. Power down the sensor. See appropriate sections below.

- *Reference Appendix 8.1 - How to Power Down a Tower Measurement Level (ML)*
- *Reference Appendix 8.2 - How to Power Down an Aquatic Met Station*
- *Reference Appendix 8.3 - How to Power Down a Soil Plot (SP) Power Box*
- *Reference Table 8. Humidity and Temperature Sensor Removal/Replacement | AIS Buoy to power down the sensors on the AIS Buoy.*



Step 2. Remove the sensor probe from the Radiation and Precipitation Shield by pulling straight down on the sensor body.

If turning, instead of pulling downwards, to remove the sensor, please be aware this method may result in loosening the compression ring, enabling it to fall off into the Radiation Shield or from the sensor. This part is very difficult to replace. Maintain awareness on the compression ring when removing/replacing the sensor.

*NOTE: Reference **Figure 14** in **Table 5** for a visual on this removal method.*

Step 3. While removing the sensor probe be careful not to damage the PTFE Filter, by hitting it against the bottom of the radiation shield or supporting infrastructure.

Step 4. Visually inspect the PTFE Filter and Sensor Probe Body. It should be clean and white without any dust or dirt accumulation.

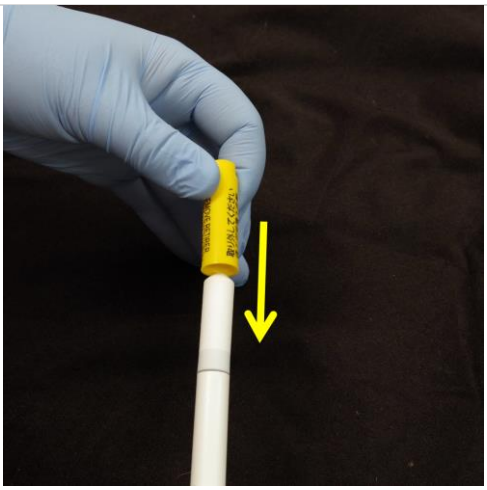
NOTE: Avoid touching the PTFE Filter without clean nitrile gloves. Dirt from field gloves or oils from bare hands may contaminate the filter and decrease the time between cleaning and replacement of the filter.

Step 5. Put on a fresh new pair of finely tailored powder-free nitriles gloves.

Step 6. Using a new or clean soft-bristle brush, gently remove any accumulated dust or dirt.

NOTE: If there is caked-on dirt that cannot be easily removed with a soft-bristle brush, the filter will have to be replaced and the old filter cleaned.

See Section 5.5.3 for PTFE Filter removal, and Section 5.5.5 for lab cleaning of the PTFE Filter.



Step 7. Slide the yellow protective cap over the PTFE Filter before proceeding to the next step.

Step 8. Use a multi-surface cleaner and dampen a lint-free cloth or microfiber towel.

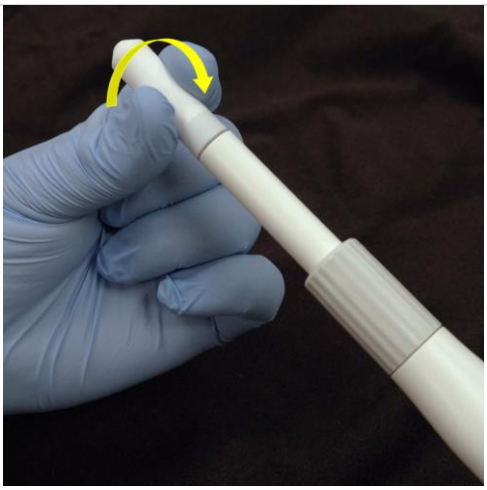
Step 9. Wipe down and clean the sensor probe body.

5.5.3 Removing the PTFE Filter

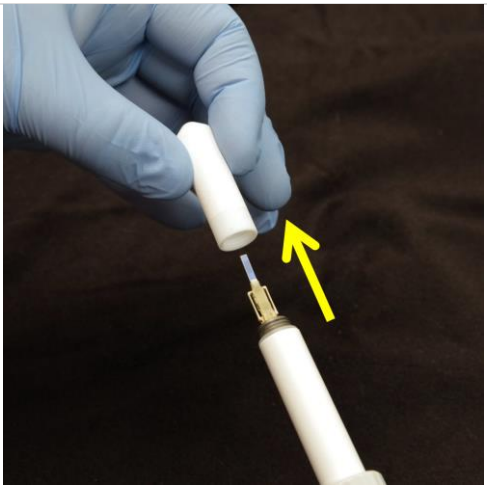
The steps below outline the procedure to remove the PTFE Filter.

Step 1. Follow the procedure on removal, inspection, and cleaning in Section 5.5.2, Inspecting the Sensor Probe Body and PTFE Filter [Quarterly] to ensure the sensor is clean before handling the PTFE Filter.

Step 2. Put on a fresh new pair of finely tailored powder-free nitriles gloves.



Step 3. Holding the sensor body with one hand, gently grab hold of the PTFE Filter and unscrew it.



Step 4. Once unscrewed, pull the PTFE Filter straight up and off the sensor. Avoid hitting or touching the HUMICAP or PRT while removing the filter.

*NOTE: When the PTFE Filter is removed, the HUMICAP Humidity Sensor and PRT are exposed. **Do not** touch these fragile components.*

5.5.4 Inspecting Sensor Probe O-Rings (Silicone Gaskets) [Quarterly]

There are three O-Rings (silicone gaskets) that help seal the Humidity and Temperature Sensor from water intrusion. One helps seal the PTFE Filter to the sensor body, and two others seal the sensor body cap.

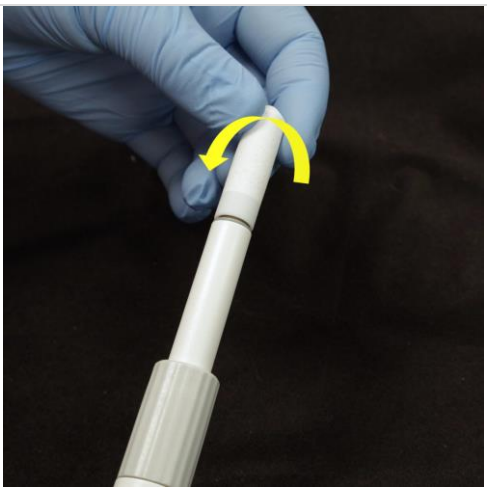
NOTE: Before performing the next procedure, be sure to have the yellow protective cap available (see **Figure 12***).*

Step 1. Follow the procedure in Section 5.5.3, Removing the PTFE Filter.

Step 2. Inspect the O-Ring for any rips or tears, and complete breaks.

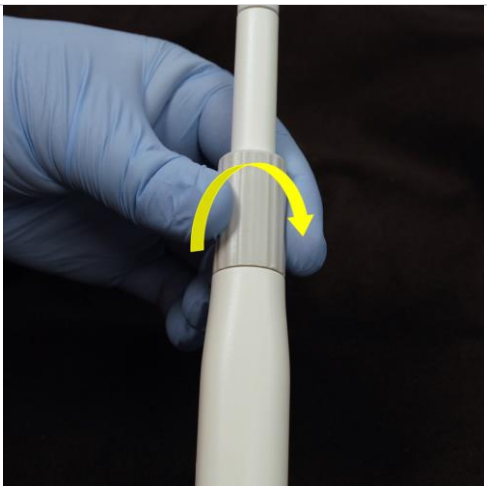
Replace if any damage is noted. O-ring part number is 219452SP (see also **Table 2**).

NOTE: The O-Ring is a transparent silicone rubber, and can be difficult to see clearly. Use a magnifying glass if necessary when inspecting the O-Ring.

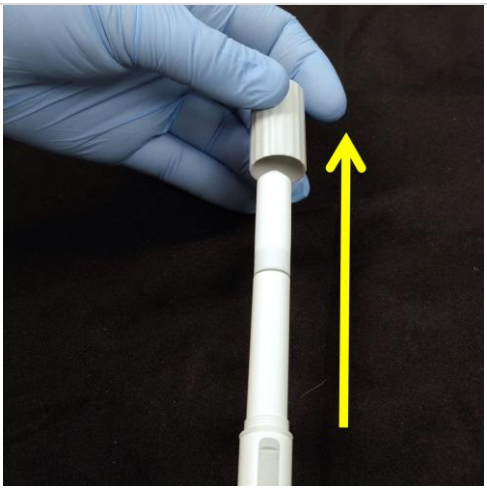


Step 3. Replace the PTFE Filter and screw on.

Do not overtighten or the O-ring will be damaged.



Step 4. Holding the sensor body with one hand, gently grab hold of and unscrew the sensor body cap.

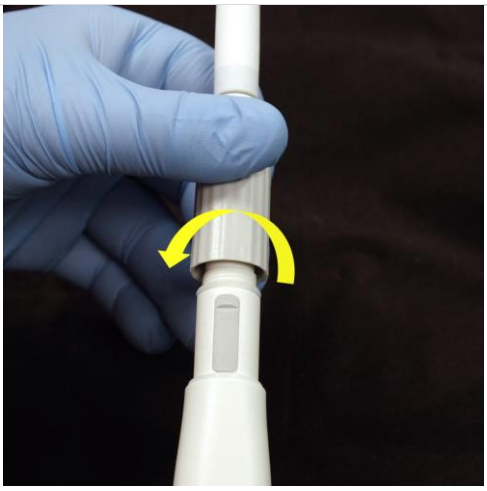


Step 5. Slide the sensor body cap up and off.

Step 6. Inspect the two O-Rings for any rips or tears, and complete breaks.

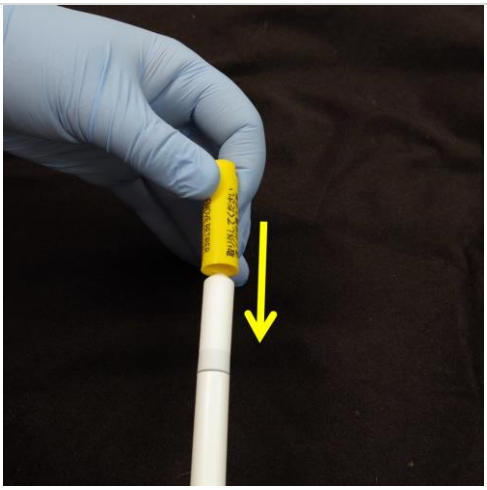
Replace if any damage is noted. O-ring part number is 221318 (see also **Table 2**).

NOTE: The O-Rings are a transparent silicone rubber and can be difficult to see clearly. Use a magnifying glass if necessary when inspecting the O-Rings.



Step 7. Replace the sensor body cap and screw on.

Do not overtighten or the two O-Rings will be damaged.



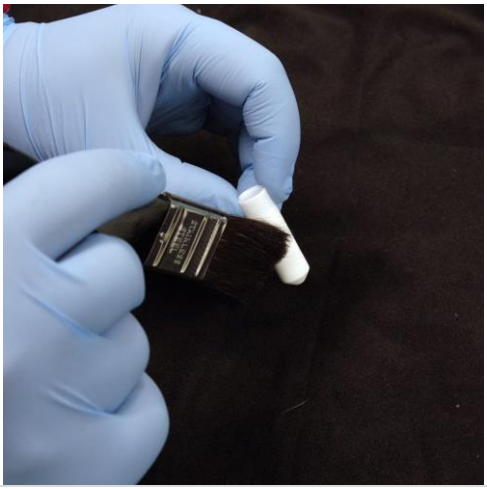
Step 8. Slide the yellow protective cap back over the PTFE Filter.

5.5.5 Cleaning the PTFE Filter

Over time, the PTFE Filter may accumulate enough dirt that following the cleaning procedure in Section 5.5.2 won't be able to fully clean. This is typically caked-on dirt that will require additional cleaning.

When the PTFE Filter has caked-on dirt that cannot be cleaned in the field, it is recommended that a new filter (part number is 219452SP - see **Table 2**) be put on and the old filter taken back to the lab for a more thorough cleaning. The procedure below outlines lab cleaning and requires the filter to be completely dry before placement back on to the sensor probe.

Step 1. Follow the procedure in Section 5.5.3, Removing the PTFE Filter.



Step 2. Using a soft-bristle brush, remove as much dust and dirt as possible.

Step 3. Using only distilled or deionized (DI) water, rinse the filter.

Step 4. Repeat Steps 2 and 3 above until filter is clean.

Step 5. Allow PTFE Filter to air dry completely before replacing on the sensor.

5.5.6 Specific Conditions Cleaning Procedures (SCCP)

5.5.6.1 SCCP – Winterization

There are no specific preventive maintenance procedures for winterization. This unit should operate throughout the winter.

5.5.6.2 SCCP – Severe Storms/Floods/Hurricanes

In anticipation of severe storms, seasonal floods, or hurricanes and if it is determined necessary to remove sensors from the TIS Towers, TIS Soil Arrays, or AIS Met Stations, remove the Humidity and Temperature Sensor along with the Radiation Shield.

5.5.6.3 SCCP – Rain

The Humidity and Temperature Sensor will operate normally under this condition.

1. If it is actively raining, perform routine preventive maintenance on the Radiation Shield only (see Section 5.5.1).

5.5.6.4 SCCP – Dew, Fog, Mist

The Humidity and Temperature Sensor will operate normally under this condition.

1. Perform routine preventive maintenance on the Radiation Shield only (see Section 5.5.1).

5.5.6.5 SCCP - Frost

The Humidity and Temperature Sensor will operate normally under this condition.

1. Temperature **above** freezing.
    a. Using a soft-bristle brush and a sweeping motion, remove excess frost from the fins of the Radiation Shield.
    b. Perform routine preventive maintenance outlined in Section 5.5.1 and Section 5.5.2.
2. Temperature **below** freezing.
    a. Using a soft-bristle brush and a sweeping motion, remove excess frost from the fins of the Radiation Shield.
    b. Place a small container or catch basin underneath the sensor to catch excess dirt, water, or ethanol runoff.

c. Using a spray bottle, or squire bottle, spray:

   i. Hot distilled or DI water

   OR

   ii. 95% ethanol

   on to the "fins" of the shield. Do not spray water or ethanol into the Radiation Shield.

d. Allow the hot water or ethanol to melt the ice.

   i. Repeat application of hot water or ethanol until frost/ice is cleared.

e. Using a lint-free cloth or microfiber towel, wipe the fins of the Radiation Shield dry.

f. Perform routine preventive maintenance outlined in Section 5.5.1 and Section 5.5.2.

5.5.6.6 SCCP – Snow

The Humidity and Temperature Sensor will operate normally under this condition.

NOTE: During times when the ground snow depth is higher than the sensor itself, no Preventive Maintenance should be performed on this sensor. If the sensor is covered in snow but above the ground snow depth, sensor maintenance should be performed as described.

1. Using a soft-bristle brush and a sweeping motion, remove excess snow from the fins of the Radiation Shield.
2. Follow procedure outlined in Section 5.5.6.5, SCCP - Frost.

5.5.6.7 SCCP – Ice

The Humidity and Temperature Sensor will operate normally under this condition.

1. Follow procedure outlined in Section 5.5.6.5, SCCP - Frost.

5.5.6.8 SCCP - Salt Deposits

The Humidity and Temperature Sensor will operate normally under this condition.

Salt deposits can accumulate on the Radiation Shield. These deposits can be seen as a thin white film or white spots or accumulations. The cleaning procedure in Section 5.5.1 should remove light salt deposits, though heavier buildup may require the use of a solvent (e.g. 0.1 M acetic acid) to dissolve the deposits.

1. Follow the cleaning procedure in Section 5.5.1.
2. If the salt deposits remain, or are caked-on, use of 0.1 M acetic acid may be required.

a. Place a catch basin, or towel underneath the Radiation Shield to catch any overflow.

b. Using a spray or squirt bottle, apply 0.1M acetic acid on to the areas with salt deposits. Allow the acetic acid to dissolve the salt deposits.

    i. Gentle scrubbing motion with a lint-free cloth, microfiber towel, or cotton swab may be used to help facilitate salt deposit removal.

c. Repeat as necessary until salt deposits are removed.

3. Follow the cleaning procedure in Section 5.5.1.

5.5.6.9 SCCP - Insect Nests

The Humidity and Temperature Sensor will operate normally under this condition. However, spiders or other insects may form nests on, in, or around the fins for the Radiation Shield.

1. Use a brush or cotton swab (depending on nest size) to remove any insect nests or spider webbing on, in, or around any part of the Barometric Pressure Sensor.

2. Follow the cleaning procedure in Section 5.5.1.

5.5.6.10 SCCP - Bird and Other Droppings

The Humidity and Temperature Sensor will operate normally under this condition. However, it would be to your benefit to clean the unit of bird or other droppings as allowing it to cake-on will just make your life much worse when it comes to decontaminate it for sensor refresh.

1. Place small container or catch basin underneath the sensor to catch any excess liquid runoff.

2. Using a spray or squirt bottle, apply multi-surface cleaner to the areas with bird droppings, allowing it to “soak in” and loosen the debris.

3. Continue spraying with distilled or DI water, attempting to loosen and remove the debris with the water.

4. If droppings remain, use a cotton swab or microfiber towel to aid in loosening and removing the debris. Use only gentle pressure and continue spraying with water.

    - The liquid should be allowed to do the cleaning, not mechanical force.

5. Once the debris is removed, follow the cleaning procedure in 5.5.1.

5.5.6.11 SCCP – Wildlife

The Humidity and Temperature Sensor will operate normally under this condition. However, the flat surface of the Radiation Shield may attract wildlife, particularly birds and lizards, and sometimes even snakes.

1. Use common sense on whether it would be safe, easy, and/or appropriate to try to ward off any wildlife on the Radiation Shield.

2. Consult with local agencies and authorities regarding nesting birds.

5.5.7 Cables and Connectors

The cables and connectors should be intact without any breaks or cracks, and the cables should be securely fastened to the support arm.

1. Visually inspect cables and connectors for damage from the elements (sun, wind, water), animals, and insects.

    a. Replace missing, broken, or brittle cable ties.

5.5.8 Mounting Nuts and Bolts

The mounting nuts and bolts should be clean of corrosion that would prevent easy removal of the radiation shield or component sections.

1. Visually inspect nuts and bolts.

    a. If light corrosion is present

        i. Clean with a small wire brush.

    b. If heavy corrosion is present,

        i. Clean with a small wire brush

        ii. Remove the nut or bolt.

        iii. Apply the appropriate anti-seize compound (see **Table 2**) to the threads, and replace the nut or bolt.

6 REMOVAL AND REPLACEMENT (SUBSYSTEM ONLY)

6.1 Equipment

Table 3 contains a list of equipment to conduct sensor refresh at TIS and AIS sites for specific instrumentation and/or subsystem components that require calibrations and validations. This also includes unique equipment necessary for removal and replacement procedures. Equipment recommendations and applicability may adjust over time as the implementation of NEON sensors and subsystems mature.

Table 3. Removal and Replacement Equipment List.

P/N	MX/NEON	Description	Quantity
Tools			
4620	MX103120	3M Antistatic Wristband (ESD Requirement)	1
NEON, IT		NEON Laptop (for AIS only to connect to Aquatic Portal)	1
GENERIC		Ethernet Cable (for AIS only to connect to Aquatic Portal)	1
GENERIC		3/16” Allen Wrench (to remove mounts to Grapes and Sensors)	1
GENERIC		Speed Wrench (to remove sensor mounting hardware)	1
GENERIC		Hex Wrench Set	1
GENERIC		Phillips-Head Screwdriver (to Access Power Box Breakers)	1
Safety		Site-Specific PPE for AIS or TIS sites, as applicable	A/R
Safety		LOTO Equipment (required over 50 Volts)	A/R
GENERIC		Flush cutters (to cut zip ties flush)	1
GENERIC		Scissors (to remove zip ties)	1
GENERIC		Wood plank, rubber mat, or similar (~60 x 40 cm) for standing	1
Consumable Items			
3M	*See below*	ESD Bags for Sensor Refresh	1
	MX105865	3M Bag, ESD Shielded, 8 inch x 11 inch, Cushioned	A/R
	MX105931	3M Bag, ESD, Static Shield, 6 x 8 Inches, Zip Closure, Non-Cushioned	A/R
	MX105864	3M Bag, ESD Shield, 6 Inch X 7 Inch, Cushioned	A/R
	MX105866	3M Bag, ESD Shielded, 14 Inch X 15 Inch Cushioned	A/R
	MX105935	3M Bag, ESD, Static, 15 x 18 Inches, Zip-Closure Top	A/R
	MX110345	3M Bag, ESD Static Shield, 12 inch x 12 inch, Zip Closure	A/R
GENERIC		Towel (To Leverage Grip or Wipe-off Items)	1
GENERIC		Microfiber/Lint-free cloth	1-2
1HAB2	MX104219	Grainger Red Inspection Tag, Paper, Rejected, PK1000	A/R
Various	CB08180000	Kit, Grape Dust Caps	4-6
GENERIC		Multi-colored Zip-ties or Electrical Tape (to label Heater Ports)	4 Colors
GENERIC		Black Zip ties (to re-dress cables)	A/R
80337	0355220000	SAF-T-LOK SAFTEZE Food/Drug Grade Anti-Seize (for AIS stainless steel Infrastructure, such as bolts) *Temperature Range: Lubricant -65 to 450°F | Anti-Seize -65°F to 2600°F*	1
37230		Loctite QuickStix Silver Anti-Seize LB 8060 (for TIS Infrastructure)	1

Resources			
GENERIC	MX106639	Sturdy Container and/or Backpack (Transport sensors)	1

NOTE: When working on power systems, use tools with insulated handles. Always shutdown the power prior to removing or replacing any components. Do not hot-swap (Power is ON) any component or sensor connections at TIS or AIS sites.

6.2 Removal and Replacement Procedure

The FOPS Domain Manager is responsible for managing the removal and replacement of the sensors on site for preventive maintenance and/or sensor swaps and manages field calibration and validation of sensors, as appropriate. The NEON project Calibration, Validation and Audit Laboratory (CVAL) is responsible for the calibration and validation of select sensors and manages Domain sensor refresh (swap) schedules.

To minimize data downtime and optimize the availability of sound data, coordinate instrumentation and subsystem annual calibration, validation and preventive maintenance requirements to occur within the same timeframe. See **Table 4** for sensor refresh requirements for the sensor and subsystem infrastructure for the Humidity and Temperature Sensors at TIS and AIS sites.

Table 4. Humidity and Temperature Sensor Refresh Requirements.

	LOCATION		TIMEFRAME			
	CVAL	*FIELD*	*BIWEEKLY*	*ANNUAL*	*NA*	COMMENTS
Concord (24V) Grape Humidity and Temperature Sensor (HMP155)	X			X		Follow ESD protocols.
	X			X		Follow ESD protocols. The Radiation Shield may remain with the Domain. The sensor requires a yellow protective cap (see Figure 33) over the filter for shipping/handling. *See Table 3 for P/N to order replacement yellow protective caps for each site.*

6.2.1 TIS Tower Removal/Replacement

Table 5 provides guidance to remove and replace a Humidity and Temperature sensor from a TIS Tower.

Table 5. Humidity and Temperature Sensor Removal/Replacement | TIS Tower.

STEP 1 | Power down the ML where the sensor subsystem resides (Power Box on Tower Top ML). *Reference Appendix 8.1,* How to Power Down a Tower Measurement Level (ML).

Figure 13. Humidity & Temp Sensor & Subsystem TIS Tower (D18 BARR).

STEP 2 | Disconnect the Eth-to-Comm (RJF) and sensor (12-8) connections from the Concord (24V) Grape per AD [09]. For TIS Tower sites, the Humidity and Temperature sensor Concord Grape resides in close proximity to the sensor on the Tower Top ML (**Figure 13**).

Cut and remove zip ties, as appropriate.

Remove Grape for Sensor Refresh; *reference Section 6.2.5 for Grape removal guidance.*

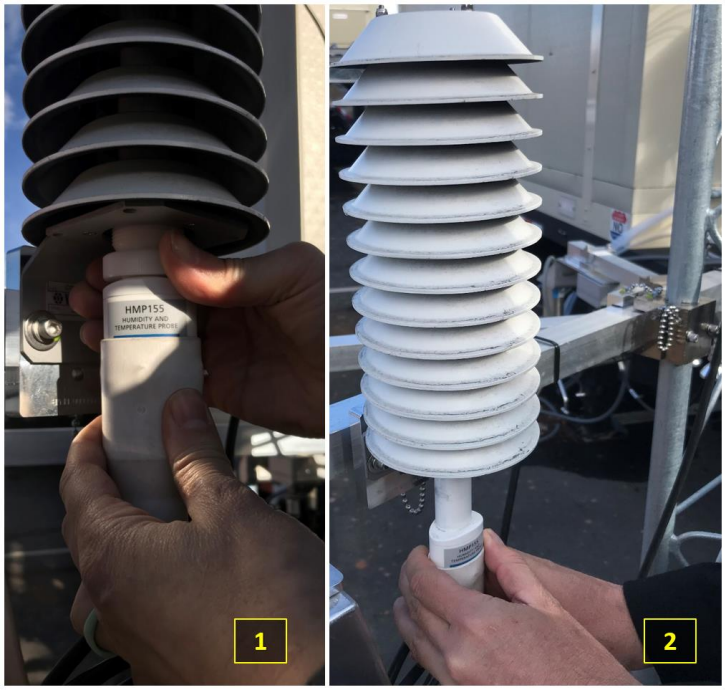


Figure 14. Remove Sensor from Shield[2].

STEP 3 | Remove the sensor from the radiation shield by hand (**Figure 14**).

1. First, loosening the gland nut enough to allow the sensor to gently pull downwards.
2. Gently pull the sensor downwards. As the sensor is pulled downwards, ensure the rubber compression ring does not drop out and fall to the ground.

*NOTE: **Figure 14** is from our Rohn Tower assembly, part of the Mobile Deployment Platform (MDP), which is part of the NEON project's Assignable Assets program. The process to remove the sensor from the radiation shield is the same across TIS and AIS sites.*

[2] Hand models: Genevieve Faria (left) and Geoff Simonds (right)

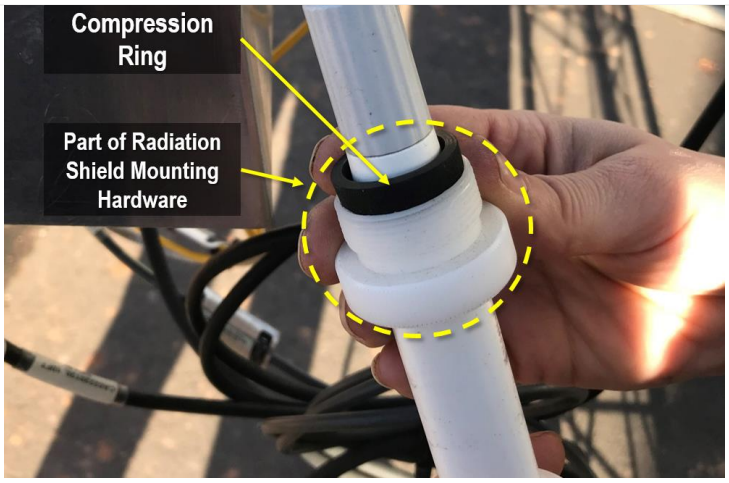


Figure 15. Remove Mounting Hardware[3].

STEP 4 | Remove the compression ring and gland nut from the radiation shield (**Figure 15**). Slide these components onto the new "refreshed" Humidity and Temperature Sensor.

The nut should slide all the way to the sensor shoulder and the compression ring inserted into the small counterbore on the gland nut.

STEP 5 | Reinstall the "refreshed" sensor the same way it was removed, but in reverse. Do not forget to remove the yellow protective cap! Tighten the gland nut hand tight and verify that the sensor is firmly seated in the shield.

[3] Hand: Model: Genevieve Faria

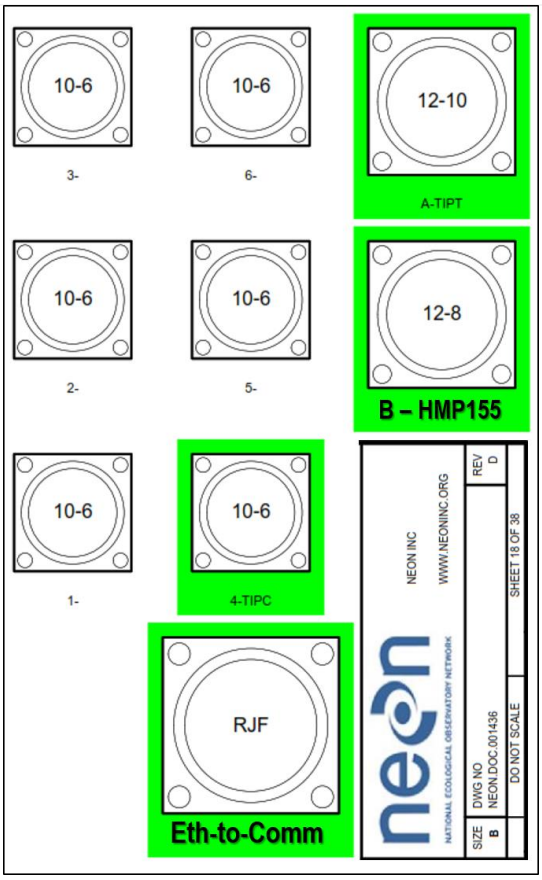


Figure 16. "Grape Tower Top HMP155/2ndry Precip" (Source: AD [09]).

STEP 6 | Connect sensor (12-8) and Eth-to-Comm (RJF) connections to Concord (24V) Grape in accordance with **Figure 16** per AD [09].

The Humidity and Temperature sensor shares a Grape with the Secondary Precipitation sensor on the Tower Top ML.

Replace Grape for Sensor Refresh; *reference Section 6.2.5 for Grape removal guidance.*

*Note: AD [09] supersedes **Figure 16** in the event the TIS Grape Mapping Interconnect is updated for these assemblies.*

STEP 7 | Per AD [13], dress the cable down the tower leg, then in the 45° angle iron tower brace toward the Comm box at the base of the tower. Use zip ties to make a loop below the Comm box to control the excess cable length and serve as a drip loop.

STEP 8 | Reapply power to the Tower Top Measurement Level power box and verify sensor shows up in SAS the next day and data streams per RD [11].

6.2.2 TIS Soil Plot Removal/Replacement

Table 6 provides guidance to remove and replace a Humidity and Temperature sensor from a TIS Soil Plot.

Table 6. Humidity and Temperature Sensor Removal/Replacement | TIS Soil Plot.

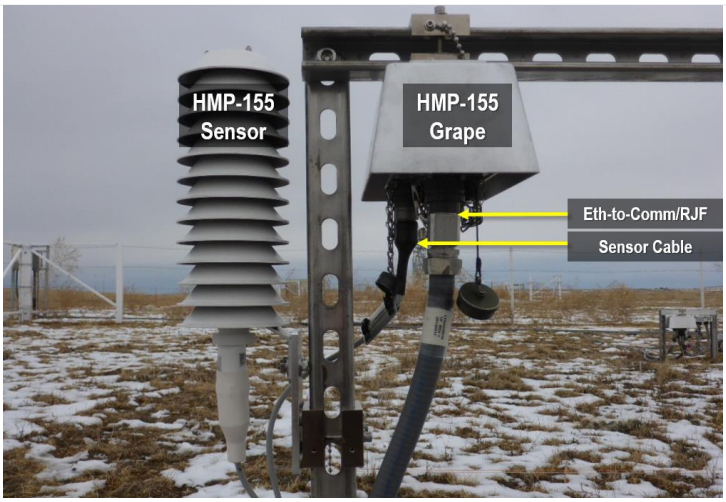


Figure 17. Soil Plot Long Arbor - Sensor & Subsystem (D10 CPER).

STEP 1 | The Humidity and Temperature sensor and subsystem resides on the long arbor within a Soil Plot (**Figure 17**). Power down the Soil Plot at the Power Box.

Reference Appendix 8.3 How to Power Down a Soil Plot (SP) Power Box.

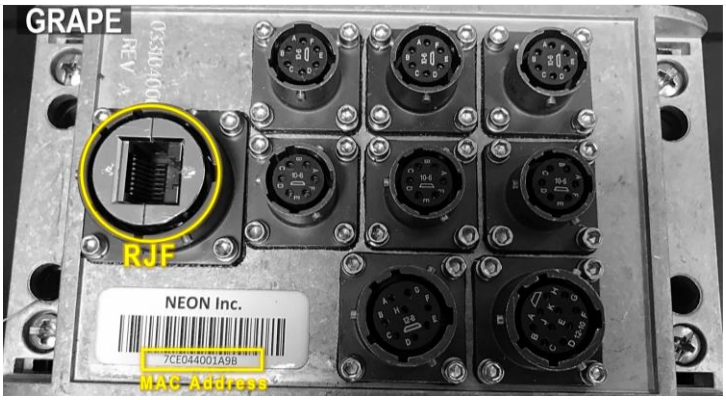
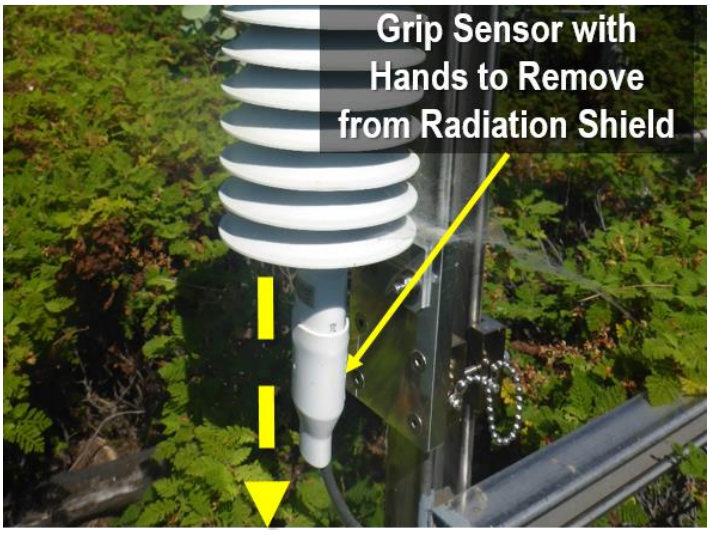


Figure 18. Disconnect Eth-to-Comm (RJF) Connector to Sensor Grape.

STEP 2 | Disconnect Eth-to-Comm (RJF) (**Figure 18**) and sensor (12-8) connections from Concord (24V) Grape per AD [09]. For Soil Plots, the Grape resides in close proximity to the sensor on the long arbor (see **Figure 17** above).

Cut zip ties, as appropriate.

Remove Grape for Sensor Refresh; *reference Section 6.2.5 for Grape removal guidance.*



STEP 3 | Remove the sensor from the radiation shield (**Figure 30**).

1. First, loosening the gland nut enough to allow the sensor to gently pull downwards.
2. Gently pull the sensor downwards. As the sensor is pulled downwards, ensure the rubber compression ring does not drop out and fall to the ground.

*NOTE: Reference **Figure 14** in **Table 5** for a visual on this removal method.*

Figure 19. Remove Sensor for Radiation Shield (D17 SOAP).

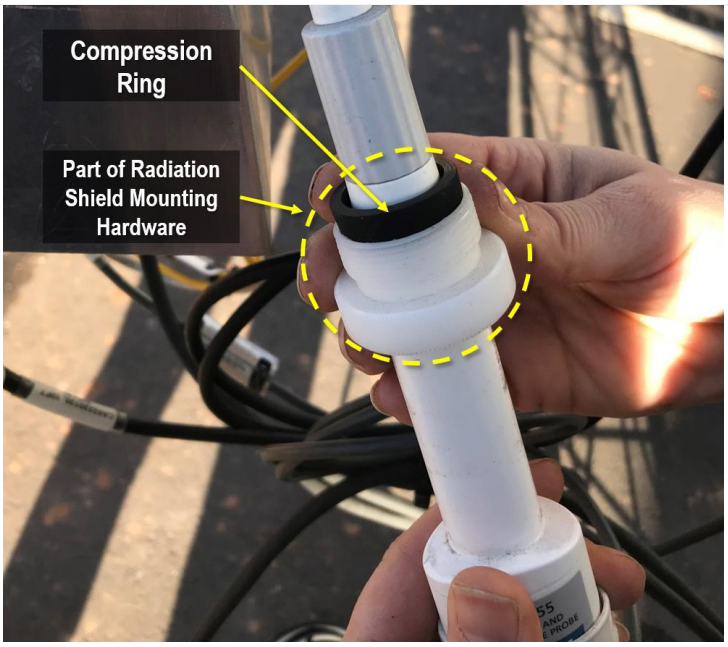


Figure 20. Remove Mounting Hardware[3].

STEP 4 | Remove the compression ring and gland nut from the radiation shield (**Figure 20**).

Slide these components onto the new "refreshed" Humidity and Temperature Sensor.

The nut should slide all the way to the sensor shoulder and the compression ring inserted into the small counterbore on the gland nut.

STEP 5 | Reinstall the "refreshed" sensor the same way it was removed, but in reverse. Do not forget to remove the yellow cap! Tighten the gland nut hand tight and verify that the sensor is firmly seated in the shield.

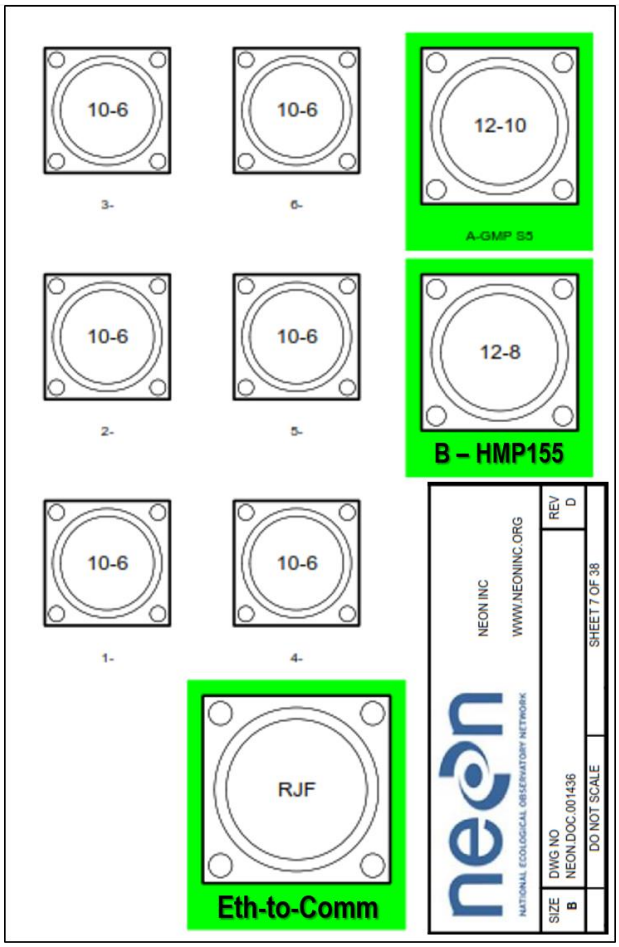


Figure 21. "Grape Soil HMP155" Port Mapping (Source: AD [09]).

STEP 6 | Connect sensor (12-8) and Eth-to-Comm (RJF) connections to Concord (24V) Grape in accordance with **Figure 21** per AD [09].

Replace Grape for Sensor Refresh; *reference Section 6.2.5 for Grape removal guidance.*

*Note: AD [09] supersedes **Figure 21** in the event the TIS Grape Mapping Interconnect is updated for these assemblies.*

STEP 7 | Per AD [14], Route the sensor cable downward to create a drip loop, then upward along the vertical leg of the arbor using zip ties liberally to ensure that the cable stays flat against the arbor.

STEP 8 | Reapply power to the Soil Plot power box and verify sensor shows up in SAS the next day and data streams per RD [11].

6.2.3 AIS Aquatic Met Station Removal/Replacement

Table 7 provides guidance to remove and replace a Humidity and Temperature sensor from an Aquatic Met Station.

Table 7. Humidity and Temperature Sensor Removal/Replacement | Aquatic Met Station.

STEP 1 | Power down the Aquatic Met Station via its power box. *Reference Section 8.2 How to Power Down an Aquatic Met Station.*

Figure 22. Subsystem - Concord Grape (24V) (D03 FLNT).

STEP 2 | Disconnect Eth-to-Comm (RJF) and sensor (12-8) connections from Concord (24V) Grape per AD [10]. The Humidity and Temperature sensor shares a Concord Grape with the Barometric Pressure sensor (**Figure 22**). Cut zip ties, as appropriate.

Remove Grape for Sensor Refresh; *reference Section 6.2.5 for Grape removal guidance.*

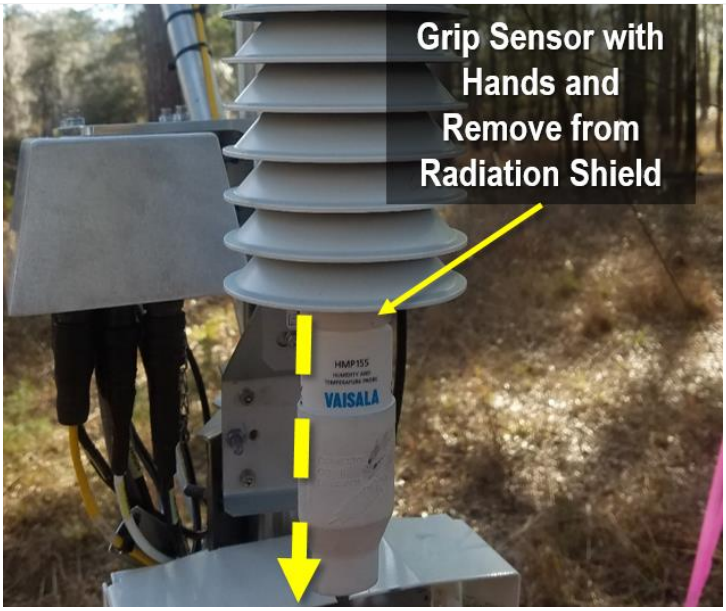


Figure 23. Remove Sensor from Radiation Shield (D03 FLNT).

STEP 3 | The Humidity and Temperature Sensor is located above the Barometric Pressure sensor on the Aquatic Met Station. Remove the sensor from the radiation shield (**Figure 23**).

1. First, loosening the gland nut enough to allow the sensor to gently pull downwards.
2. Gently pull the sensor downwards. As the sensor is pulled downwards, ensure the rubber compression ring does not drop out and fall to ground.

*NOTE: Reference **Figure 14** in **Table 5** for a visual on this removal method.*

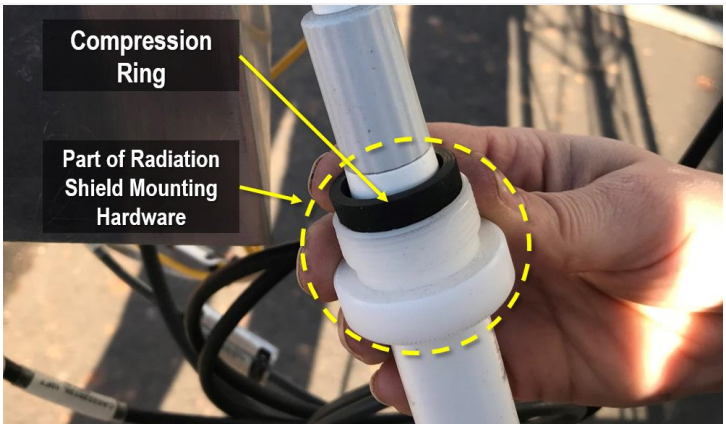


Figure 24. Remove Mounting Hardware[3].

STEP 4 | Remove the compression ring and gland nut from the radiation shield (**Figure 20**).

Slide these components onto the new "refreshed" Humidity and Temperature Sensor. The nut should slide all the way to the sensor shoulder and the compression ring inserted into the small counterbore on the gland nut.

STEP 5 | Reinstall the "refreshed" sensor the same way it was removed, but in reverse. Do not forget to remove the yellow protective cap! Tighten hand tight and verify that the sensor is firmly seated in the shield.

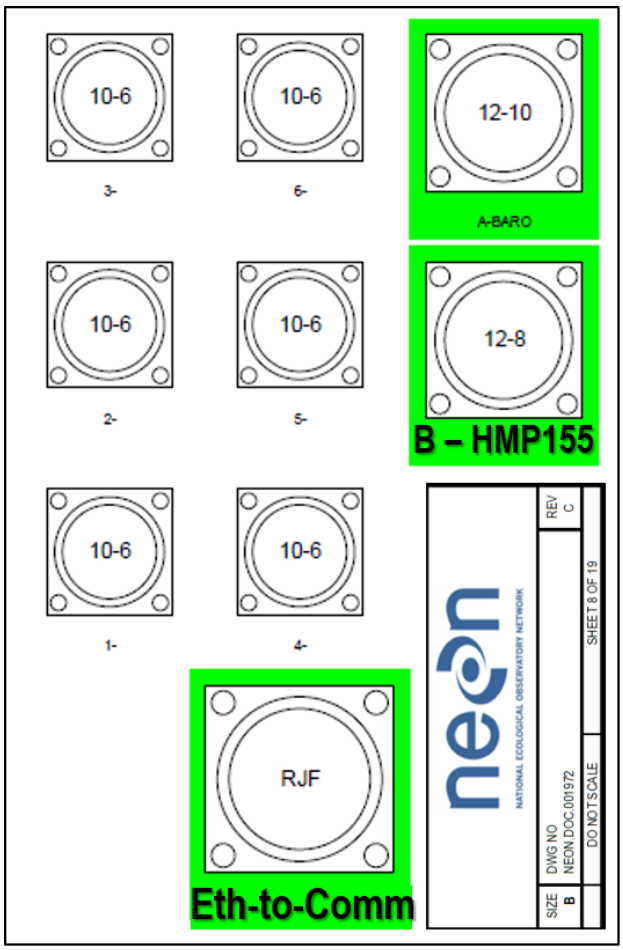


Figure 25. "Grape Met Baro" Port Mapping (Source: AD [10]).

STEP 6 | Connect Eth-to-Comm (RJF) and sensor (12-8) connections from Concord (24V) Grape per AD [10]. Dress cables using zip ties.

Replace Grape for Sensor Refresh; *reference Section 6.2.5 for Grape removal guidance.*

*Note: AD [10] supersedes **Figure 25** in the event the TIS Grape Mapping Interconnect is updated for these assemblies.*

STEP 7 | Restore power to the Aquatic Met Station and verify sensor shows up in SAS the next day and data streams per RD [10].

6.2.4 AIS Buoy Removal/Replacement

Table 8 provides guidance to remove and replace a Humidity and Temperature sensor from an AIS Buoy at Lake or River AIS site locations.

Table 8. Humidity and Temperature Sensor Removal/Replacement | AIS Buoy.

Figure 26. Unlatch to Remove Fiberglass T-Frame Covers (D09 PRPO).

STEP 1 | Unlatch (**Figure 26**) and slide off the T-Frame cover where the Profiler Canister resides.

NOTE: The handles for the fiberglass T-Frame cover are not for lifting purposes; they guide the housing on and off the track.

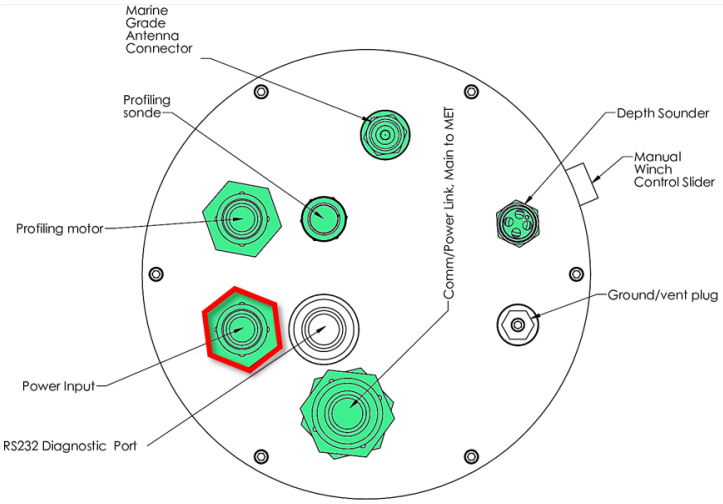


Figure 27. Profile Canister Port Mapping (Source: AD [10]).

STEP 2 | For annual Sensor Refresh, Power down the buoy by disconnecting the battery terminals or unplug the Power Input cord from the profiler canister. (Power Input port is in red in **Figure 27**)

Reference AD [10] for the complete AIS Buoy Canister port mapping.

PRO TIP: The AIS Buoy uses Campbell Scientific data loggers instead of Grapes. Reference RD [09] for more information on the AIS Buoy.

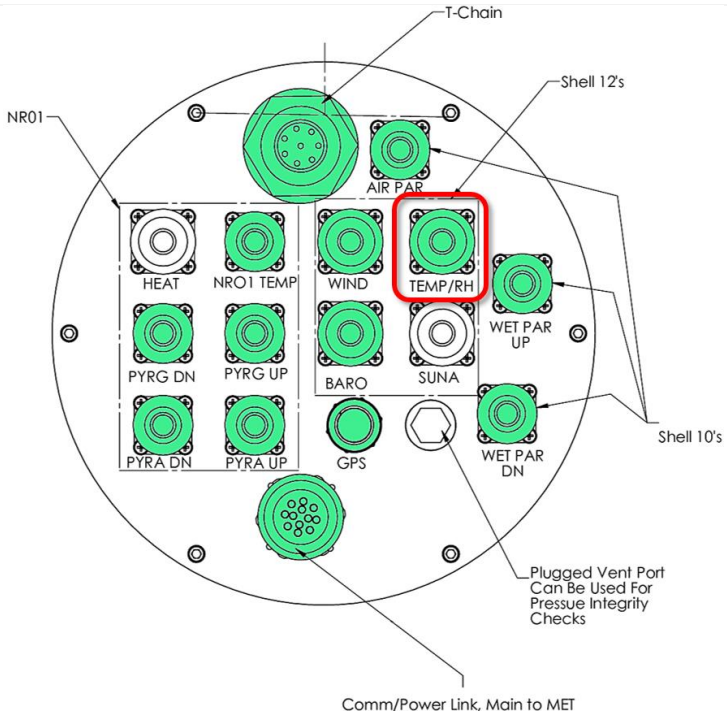


Figure 28. Met Canister Port Mapping (Source: AD [10]).

STEP 3 | Disconnect the Humidity and Temperature sensor power cord from the Met Canister. **Figure 28** identifies the port in red.

Reference AD [10] for the complete AIS Buoy Canister port mapping.

NOTE: Grapes are not part of the AIS Buoy sensor assemblies. Power derives from an onboard DC (direct current) system (solar and battery combo) created by YSI, Inc.

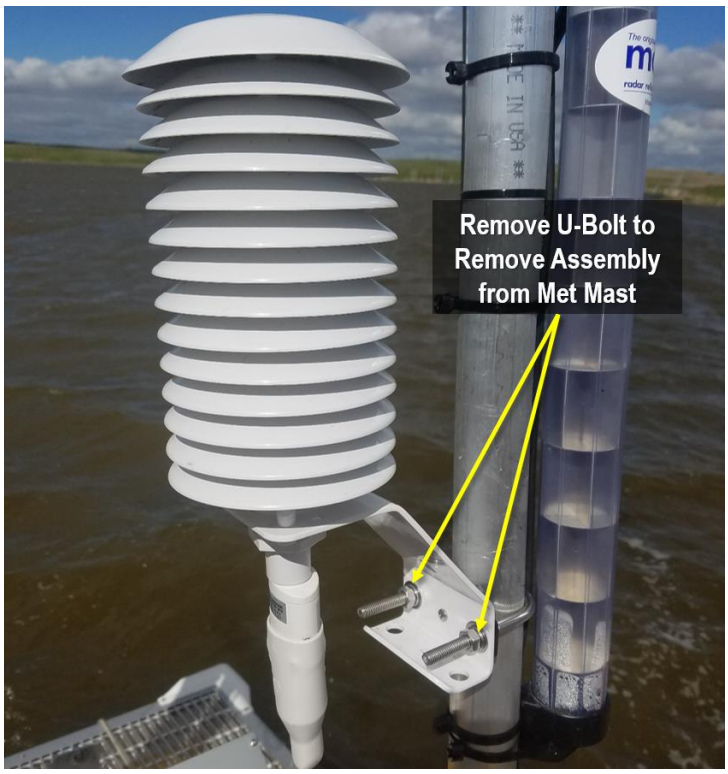


Figure 29. Remove Assembly from Met Mast via U-Bolt Mount (D09 PRPO).

STEP 4 | The Humidity and Temperature sensor is relatively easy to access on the AIS Buoy, either in the water or onshore/docked.

If Sensor Refresh is aligning with AIS Buoy Winterization, please remove the entire assembly (**Figure 29**) using a speed wrench. Maintain the hardware in storage and send the sensor to CVAL.

For AIS Buoys in D03 and D08: Please remove the sensor only for Sensor Refresh. The Radiation Shield may remain on the Met Mast without a sensor, if a sensor swap is not immediate. There are no winterization requirements for these Domains with AIS Buoys.

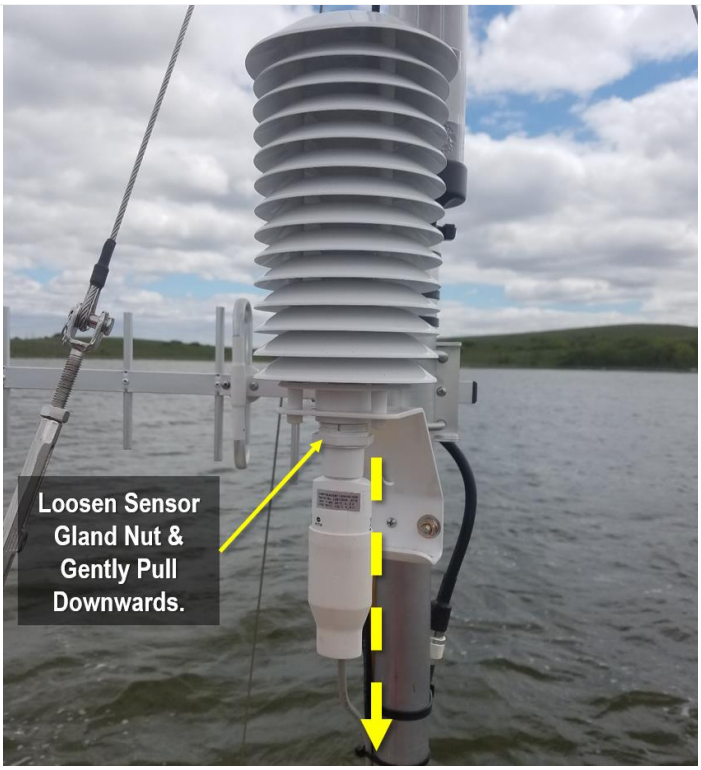


Figure 30. Remove Sensor from Radiation Shield (D09 PRPO).

STEP 5 | Remove the sensor from the radiation shield (**Figure 30**).

1. First, loosening the gland nut enough to allow the sensor to gently pull downwards.
2. Gently pull the sensor downwards. As the sensor is pulled downwards, ensure the rubber compression ring does not drop out and fall to ground

*NOTE: Reference **Figure 14** in **Table 5** for a visual on this removal method.*

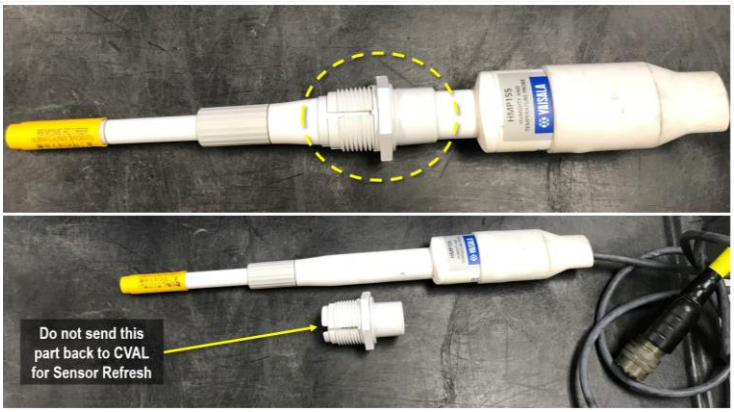


Figure 31. Sensor Mounting Gland Nut Remains with Domain.

STEP 6 | The hardware remains with the with AIS Buoy/in Domain storage until the AIS Buoy is redeployed in the Spring (**Figure 31**).

The gland nut part of the mounting hardware for the sensor.

STEP 7 | Reinstall the "refreshed" sensor the same way it was removed, but in reverse. Do not forget to remove the yellow protective cap! Turn and tighten hand tight. Verify that the sensor is firmly seated by the gland nut and will not drop down.

STEP 8 | Connect the Humidity and Temperature sensor power cord to the Met Canister. **Figure 28** identifies the port in red above. *Reference AD [10] for the complete AIS Buoy Canister port mapping.*

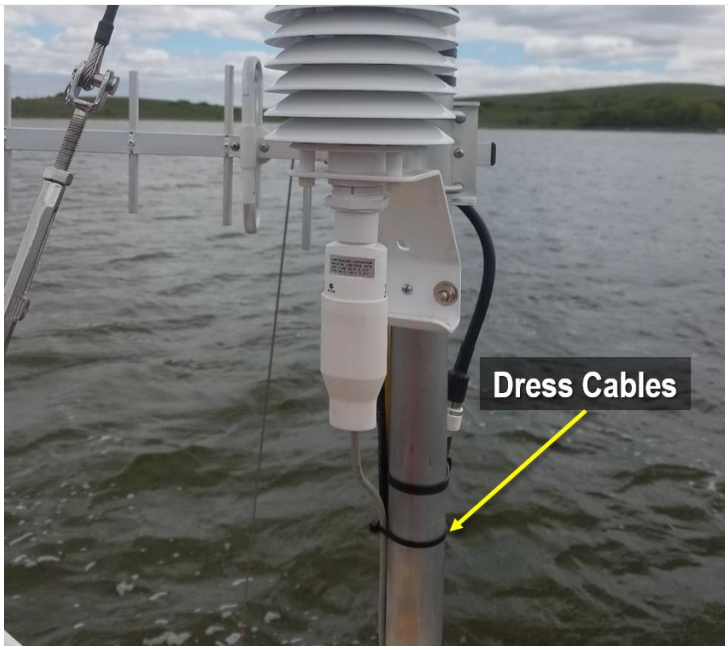


Figure 32. Dress Sensor Cables.

STEP 9 | Use zip ties to re-dress the sensor cable on the Met Mast to the Met Canister (**Figure 32**). Cut remaining from zip tie with flush cutters.

STEP 10 | Restore power to the AIS Buoy from the Profile Canister. Guide the T-frame cover over the tracks to close it and secure it via its latches. Verify sensor shows up in SAS the next day and data streams per RD [13].

6.2.5 Grape Removal/Replacement Procedure

1. Record EPROM ID/MAC Address, "Property of" Asset Tag number, Removal/Replacement date and time. The following template is an example for capturing Sensor Refresh information to update logistic records and monitor the Grape state of health via the LC pre- and post-swap.

AIS / TIS (Circle One) | Site Name: _____
Merlot / Concord / Catawba (Circle One) Grape | Location: S - ___ / ML - ___ / Other _____

	Old Grape	New Grape
EPROM ID/ MAC Address		
14-digit Asset Tag (Property of)		
Uninstall / Install Date and Time		
Moved in Maximo?		

1. Employ ESD protocols when handling Grapes. Reference RD [04].

2. Power down the site at the TIS Tower ML, AIS Device Post or TIS SP Arbor Device Post.

a. *Reference Appendix 8.1* - How to Power Down a Tower Measurement Level (ML)
b. *Reference Appendix 8.2 - How to Power Down an Aquatic Met Station.*
c. *Reference Appendix 8.3 - How to Power Down a Soil Plot (SP) Power Box.*

3. On the Grape, disconnect the armored Ethernet cable connecting to the RJF/Eth to Comm connection.

4. Disconnect sensor connection(s).

5. Remove the Concord (24V) Grape from Grape Shield. Remove the four screws that affix the Grape to the Grape Shield using a hex wrench. If there is a need to remove the Grape Shield(s) from the Tower/Aquatic Met Station/Soil Plot Arbor, remove the Grape Shield Unistrut mount/clamp using a 3/16” hex wrench.

PRO TIP: It is easier to reinstall the Grape in the Grape Sheild when the mount is removed from the infrastructure.

6. Install dust caps on open Amphenol connectors of old Grape.

7. Reinstall new Grape to the Grape Shield by threading the four screws that affix the Grape to the Grape Shield using a hex wrench.

8. Remove dust caps on sensor connectors and Eth-To-Comm connector. Re-connect sensor and armored Ethernet cable in accordance with AD [09] or AD [10].

9. Re-energize site power.

    a. Reconnect heater ports, first. Ensure they connect to the correct ports per AD [09] or AD [10]. These port connections must be in accordance with AD [09] for TIS sites and AD [10] for AIS sites for LC Command and Control (CnC) programming.

    b. Apply site power from the AIS Device Post power box breakers or TIS Tower Top ML/Soil Plot power box breakers.

10. Re-energize the site and verify Grape function. Connect locally to verify function: Use the LC in the Instrument Hut at TIS sites or the Aquatics Portal Power over Ethernet (PoE) Switch with a laptop and Ethernet cable at AIS sites. Use a Terminal Emulator Program (TEP), such as PuTTY or MobaXterm, to execute the commands in **Table 9**.

PuTTy Login Username: **user** | Password: **resuresu**

Table 9. Grape Verification TEP Commands (PuTTY).

TEP Commands	Description
`vd | grep 7CE0440015FD`	This displays the data from the grape (**grep**) with the MAC Address (e.g., using "7CE0440015FD"). Enter either in decimal or hexadecimal format. Use "**grep –i**" to ignore case.
`vd –s [sensor eeprom id]`	To view data from a sensor. For example "root@D23-HQTW-LC1:~# vd -s 3171982"
`vd –s [sensor eeprom id] –r [stream number]`	To view data from a sensor and specific data stream.

6.3 Cleaning & Packaging of Returned Sensor

Field Operations staff clean, package, and ship the sensors back to the CVAL at the NEON project HQ (Battelle Ecology) for annual sensor swap/calibration requirements. For this procedure, the items requiring CVAL calibration is the Concord (24V) Grape, and the Humidity and Temperature Sensor. Reference **Table 3** for the equipment, tools and consumables necessary for conducting the NEON HQ, CVAL Sensor Refresh procedures.

As a reminder, please maintain ESD (antistatic) packaging and handling during inter- and intra-site transport, reception, and storage of Grapes.

NOTE: If the Humidity and Temperature Sensor is defective, submit a trouble ticket and affix a red tag with the trouble ticket number on it. See Section 7 for additional guidance).

Please conduct decontamination (see AD [05]*) on the sensors/subsystems returning to NEON HQ.*

For the cleaning and packaging of Grapes and Sensors post-removal, conduct the following steps:

1. Check mounting holes for spiders and spider webs. Remove biologics and carefully clean connectors with a lint-free cloth.
2. Cap cables/connectors, as applicable, on each device. Cap all Amphenol connectors on the Grape.
3. Conduct decontamination on the exterior per AD [05]. Remove any additional biologics from the devices.
4. Place each device (Sensor in **Figure 33** and Grape) in an ESD bag and shipping container.

Figure 33. Return Sensor with Yellow Protective Cap to CVAL Post-Decontamination[4].

5. Update asset records via the NEON's project Asset Management and Logistic Tracking System (e.g., MAXIMO). NEON HQ, Logistics Warehouse (LOGWAR) receives the Grapes for refresh and distributes to CVAL.

NOTE: In general, to minimize errors for CI, all devices leaving a CFGLOC must move to SITE first, then TRANSIT/DxxSUPPORT.

6. Provide an electronic packing list to CVAL with the Box number and Asset Tag number (14-digit Property Tag ID ("Property of") number) of each item. CVAL uses this information to verify items via LOGWAR/general HQ distribution of shipments.

7. Prepare a Bill of Lading.

NOTE: For any Non-CVAL initiated sensor returns, please notify CVAL of the return.

Package sensor items via original packaging, as requested or outlined via the Issue Management System and return to the NEON project HQ using the following address:

BATTELLE ECOLOGY, **ATTN: CVAL**
1685 38TH STREET, SUITE 100
BOULDER, CO 80301

[4] Hand model: Alex Cooper

Only include sensors/subsystems for refresh. Additional equipment must ship separately as they may require attention from other NEON HQ departments. Sensor refresh shipments go direct to CVAL. If sensors are shipping to HQ to address a trouble ticket, per guidance via the Issue Management System, return to the NEON project HQ using the following address:

BATTELLE ECOLOGY, **ATTN: REPAIR LAB**
1685 38TH STREET, SUITE 100
BOULDER, CO 80301

6.4 Sensor Refresh Record Management of Assets

In addition to the physical movement of devices, the sensor refresh process requires dedicated and accurate record management of asset movement and location.

6.4.1 NEON Asset Management and Logistic Tracking System Requirements

Technicians must update the instrumentation records via the NEON's project Asset Management and Logistic Tracking System (MAXIMO). NEON HQ must maintain accurate record keeping on the location, date, and time offline of an instrument to ensure NEON HQ, Computer Infrastructure, Data Products, and CVAL are aware to apply the correct algorithms, calibrations, and processing factors. Ensure the CFG location reflects the current site of the sensor. All devices leaving a CFGLOC must move to SITE first, then TRANSIT/DxxSUPPORT.

7 ISSUE REPORTING OUTPUTS

FOPS must report issues encountered while conducting preventive maintenance in the NEON project Issue Management/Reporting System. To ensure a quick response and remedy to an issue, please include as much information and detail, as possible. This includes, but is not limited, to the following:

- Domain and Site name
- Date and Time
- Technician Full Name
- Issue Narrative (detailed narrative of the issue, specific location of issue on tower infrastructure, relevant 2nd/3rd order effects to infrastructure, possible cause [e.g., weather event, obstruction, human activity])
- Multiple Photographs (to capture vantage points/perspectives for remote diagnostic)
- Provide Part Number/Manufacturer Information, EPROM ID, Asset Tags, IP Address, MAC Address, etc.
- Provide Diagnostic Information (from firmware, if applicable), such as error codes, values, etc. Provide screenshots.

Table 10. Metadata Output Checklist.

Issue Reporting Datasheet		
Datasheet field	**Entry**	
NEON Site Code		
Maintenance Date		
Maintenance Technician		
Preventive Maintenance	**Issue Noted**	**Issue Summary**
Cables & Connectors - Condition Check	☐	
Sensor - Condition Check	☐	
Sensor - Configuration Check	☐	
Sensor – Clean	☐	
Sensor - Other Specific Checks	☐	
Environmental Information	☐	
Notes		

For Humidity and Temperature Sensor corrective actions, ensure proper tracking of the asset via the NEON issue management and tracking system (e.g., JIRA) to establish a chain of custody of the asset between Engineering Repair Laboratory and CVAL.

Conduct the following tasks to ensure the proper management of the asset between sites:

1. For each issue where NEON, HQ is replacing a defective instrument/subsystem at a TIS site, please create a sub-task in the NEON Issue Management and Reporting System for the defective asset from the reported issue. Resolution of an issue does not occur with the installation of a replacement, but with the root cause analysis of the issue deriving from the defective asset. FOPS may resolve the ticket upon installation of the replacement if a sub-task exists for the defective asset for NEON HQ to conduct root cause analysis[5].

2. Ship all defective equipment/assets with a red "Rejected" tag. **Figure 34** displays the minimum information requirements for each tag.

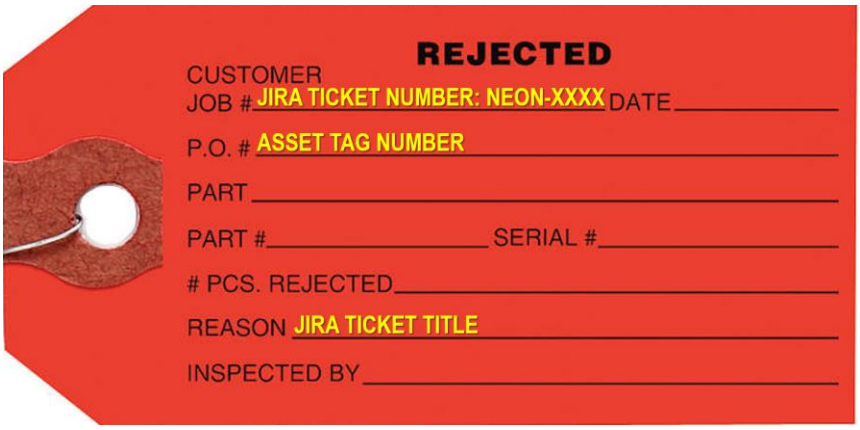


Figure 34. Red Rejected Tag for Defective Assets (MX104219).

[5] JIRA-5848 is a good example for reference.

8 APPENDIX

8.1 How to Power Down a Tower Measurement Level (ML)

Power down the Measurement Level (ML) power box via the adjacent Communications (Comm) box providing power to tower ML.

NOTE: When working on power systems, use tools with insulated handles.

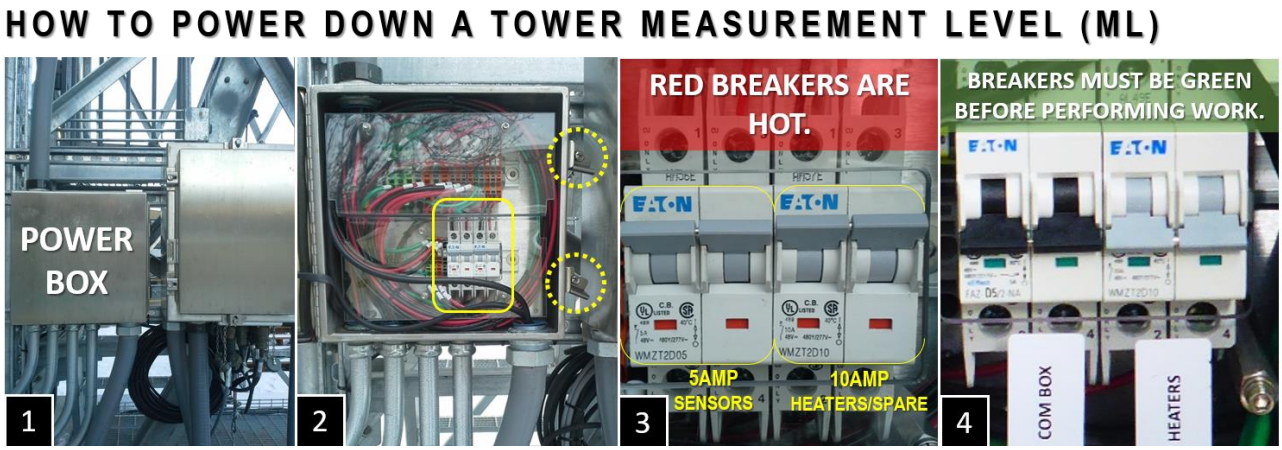


Figure 35. How to Power Down a Tower ML.

To power down a Tower ML to conduct preventive maintenance and/or to swap sensors and subsystems, conduct the following steps in accordance with **Figure 35**.

1. Locate the ML power box.

    a. ***Connections may reside on multiple levels if ports are unavailable. Please ensure this procedure occurs for all applicable power boxes for the ML.*** *For example, short towers combine ML 1 and 2 for power and communications; therefore, the sensors on ML1 connect to the Comm and power box on ML2.*

2. Open the power box using a Phillips-head screwdriver on the two clasps on the right. **Figure 35** identifies the location of the two clasps and the location of the breakers in image number 2.

3. Locate the breakers. A 5 Amp breaker is on the left and A 10 Amp breaker is on the right.

    a. The 5 Amp breaker turns the power on/off to the sensors (via their Comm box).

    b. The 10 Amp breaker turns the power on/off for sites employing heaters. If a site does not employ a heater, then it is a spare breaker.

    c. Red breakers indicate the power is ON – live voltage.

4. Flip the breakers down on the 5 Amp and the 10 Amp breakers to de-energize the ML.

    a. <u>The color on the breaker is green, signifying the power is OFF.</u>

b. If the site is unheated or Technicians are conducting maintenance on unheated sensor assemblies, proceed with the Preventive Maintenance, Sensor Refresh and/or Corrective Maintenance.

c. If Technicians are conducting maintenance on heated sensor assemblies or conducting Sensor Refresh for a heated site, Technicians must disconnect the sensor heaters at the ML Comm box in accordance with NEON Safety Office's TIS Electrical Safety Training. After disconnecting the (12-3) heater port(s), conduct Lock Out/Tag Out (LOTO) procedures for equipment over 50V (such as these heaters), and proceed with the Preventive Maintenance, Sensor Refresh and/or Corrective Maintenance

Note: These heater ports are not interchangeable; FOPS must label each port to ensure they plug back into the correct port post-sensor swap. Heater port locations are critical for LC CnC Software to operate properly!

8.2 How to Power Down an Aquatic Met Station

Powering down the site enables Technicians to perform work with fewer hazards to themselves and to the equipment. It also mitigates requiring NEON Headquarters to conduct data quality analysis when Technicians are onsite close enough to the sensors to influence data collection. This procedure shuts down power at the Aquatic Met Station and the Groundwater Wells (GWW) data transmission, if the Grape and Base Radio for the GWWs connects to the Aquatic Met Station Comm box. This procedure allows Technicians to conduct work on the sensors on the infrastructure in the Aquatic Met Station. This does not shut down power at the GWWs. A DC system provides power to the GWW Aqua TROLL and remote radio. *Reference RD [14] for additional information.*

1. Power down the site from the AIS Device Post power box via the breakers. Use **Figure 36** for this procedure.
    a. Open the Power Box using a Philips head screwdriver.
    b. Flip both breakers from RED to GREEN: 5 Amp Breakers for Sensors and 10 Amp Breakers for Heaters. Disregard the 10 Amp Breakers if they are spares/no-heaters present onsite.
    c. Conduct LOTO procedures (required for FOPS personnel on equipment over 50V).

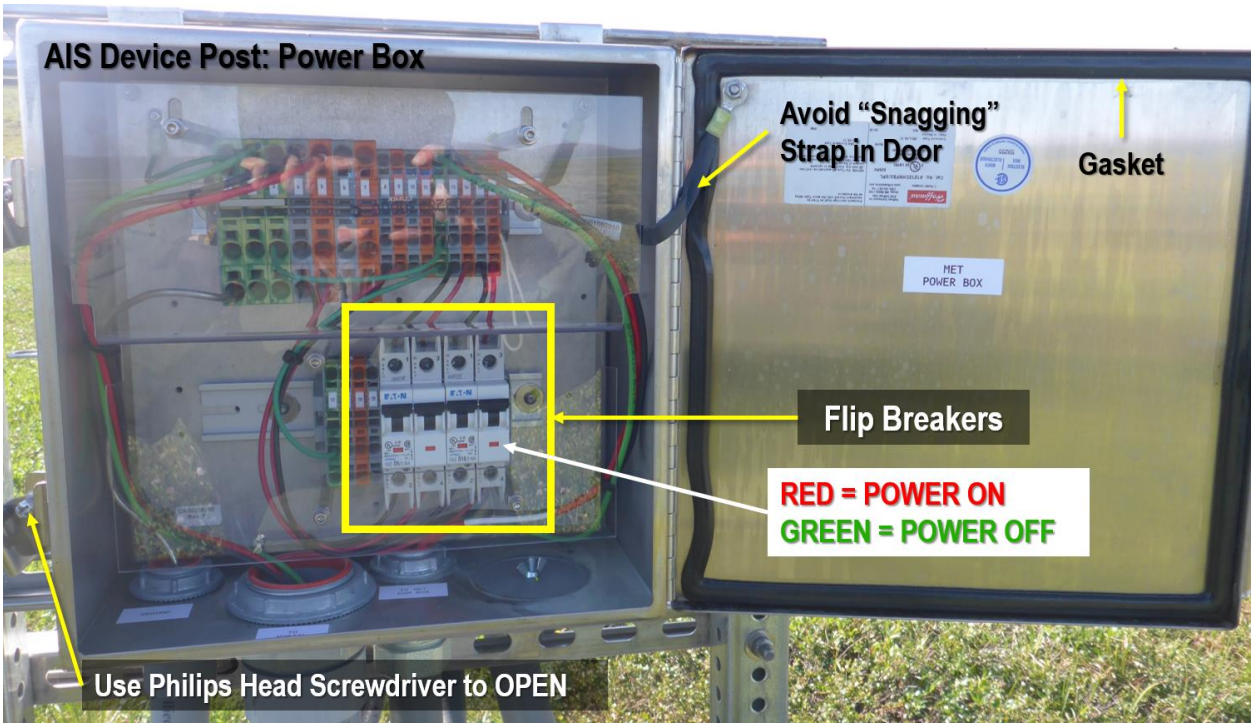


Figure 36. AIS Device Post: Power Box Components (D18 OKSR AIS Aquatic Met Station).

2. **FOR HEATED SITES ONLY:** After disabling power from the Power Box, disconnect all Comm Box heater ports before servicing or replacing sensors for Sensor Refresh. *Use AD [10] to verify heater ports onsite where Comm Boxes are grouped together (i.e., sites that have the Secondary*

Precipitation share a Comm Box with the Aquatic Met Station). Heater ports are the 12-3 connectors on the Comm box.

a. The **Aquatic Met Station Comm Box** provides power to the Aspirated Air Temperature Shield (AATS) and 2D Wind heaters. The 2D wind heater port is in front of the AATS heater port in **Figure 37** per AD [10]. (*PRO TIP: The AATS cable is larger in diameter than the 2D wind cable. The 2D Wind heater transformer mounts directly to the AIS Device Post, which allows Technicians to visually verify the cable connection and port*).

NOTE: These heater ports are not interchangeable; FOPS must label each port to ensure they plug back into the correct port post-sensor swap. Heater port locations are critical for LC CnC Software to operate properly!

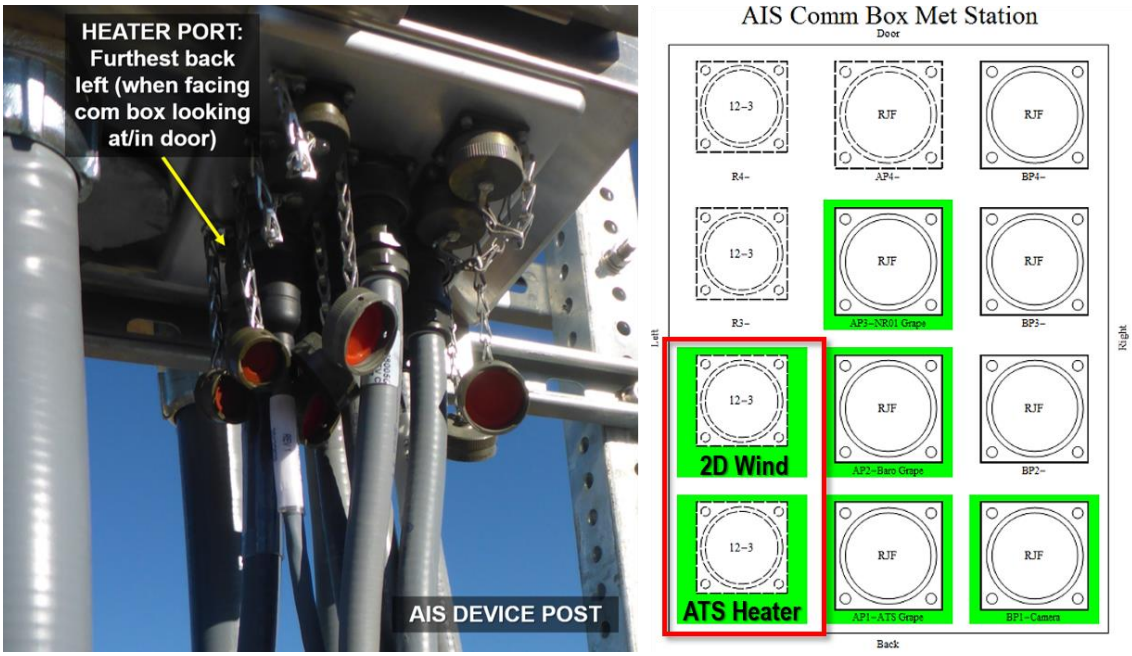


Figure 37. AIS Device Post: Comm Box Heater Ports for Aspirated Air Temperature Shield (AATS) and 2D Wind (Source: AD [10]).

*PRO TIP: How to tell the difference between Heater ports and Grape ports are, as follows: Heater ports consist of four 12-3 ports total onsite and use 3-pin connectors (***Figure 37***). Inside the Comm box at a TIS or AIS site, wires run directly to the ports (hardwired in the Comm box). Comm ports consist of seven or eight ports and have RJF/Ethernet connectors. Inside the Com box at TIS or AIS site, Ethernet pass-thru connectors, typically with white 1-ft Ethernet jumper cables, connect to the PoE Switch.*

If there is a need to remove a sole sensor assembly onsite, then power down the sensor assembly from its Grape. Remove the armored Ethernet cable from the Merlot or Concord Grape RJF/Eth-To-Comm connector before disconnecting or connecting sensor connections. Removing sensor connections without removing the RJF/Eth-To-Comm cable is best practice to avoid accidental hot swapping when the power is ON. *Reference AD [10] for Aquatic Met Station Grape mapping.* Follow ESD procedures in RD [04].

8.3 How to Power Down a Soil Plot (SP) Power Box

Powering down the soil plot enables Technicians to perform work with fewer hazards to themselves and to the equipment. It also mitigates requiring NEON Headquarters to conduct data quality analysis when Technicians are onsite close enough to the sensors to influence data collection.

1. Power down the plot from the Soil Plot Device Post Power Box.

    a. Open the Power Box using a Philips head screwdriver (**Figure 38**).

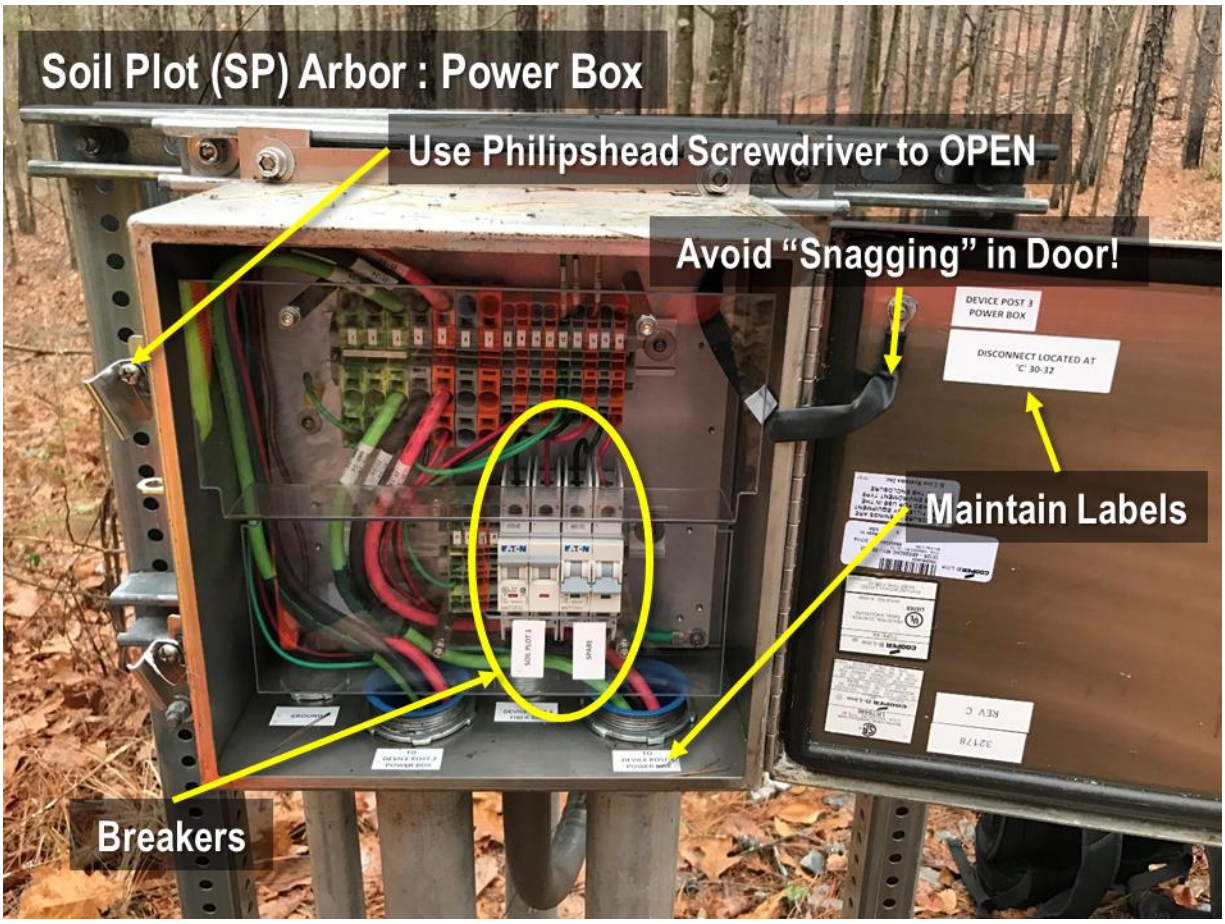


Figure 38. Open Soil Plot Device Post Power Box.

    b. Flip both breakers from RED to GREEN to de-energize the sensors (**Figure 39**).

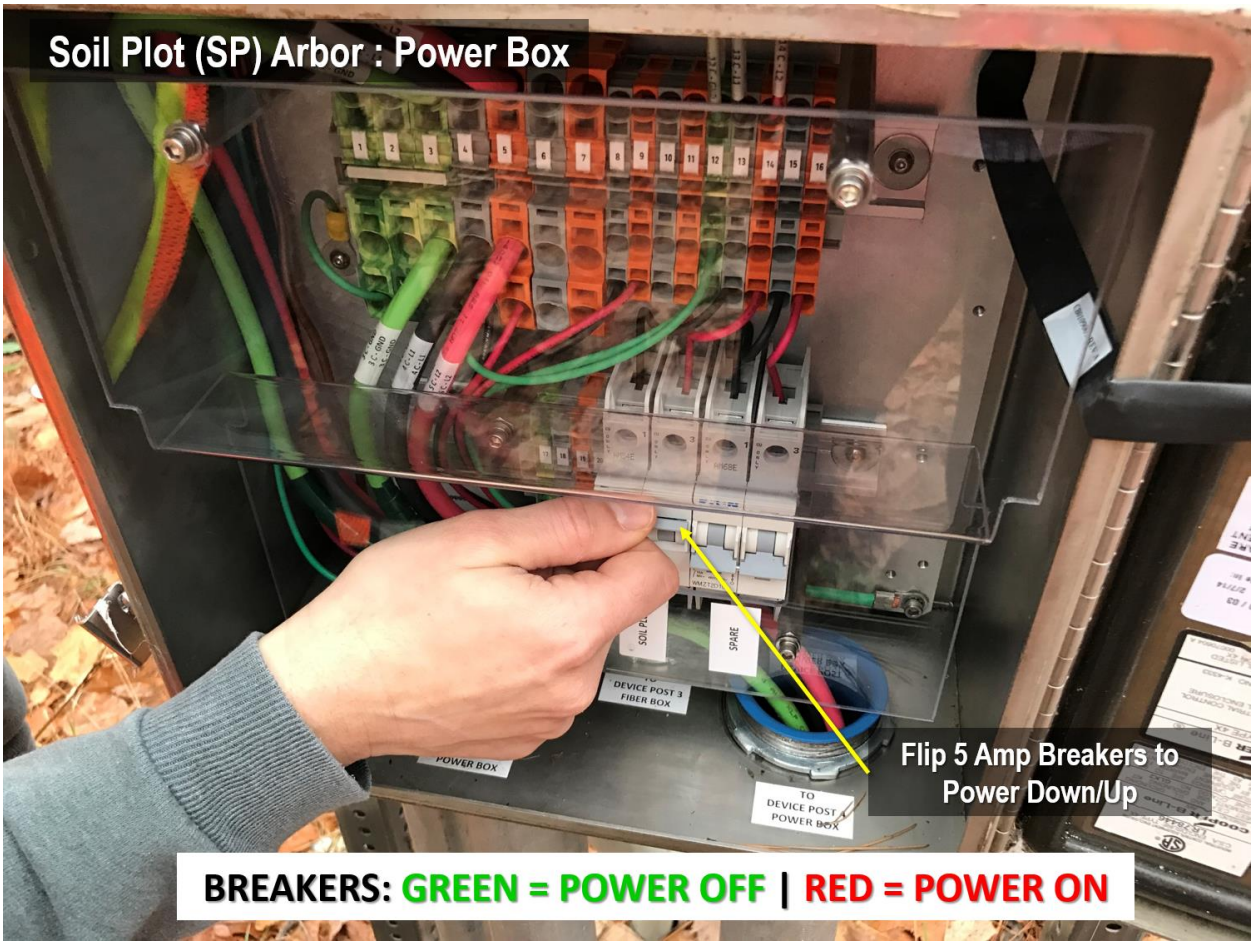


Figure 39. Flip 5-Amp Breakers.

c. Conduct LOTO procedures (required for FOPS personnel on equipment over 50V).

d. Proceed with the Preventive Maintenance, Sensor Refresh and/or Corrective Maintenance.

If there is a need to remove a sole sensor assembly onsite, then power down the sensor assembly from its Grape. Remove the Ethernet cable from the Merlot Grape RJF/Eth-To-Comm connector before disconnecting or connecting sensor connections.