NEON PREVENTIVE MAINTENANCE PROCEDURE: AIS & TIS THERMOMETRICS PLATINUM RESISTANCE THERMOMETER (PRT)

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See configuration management system for approval history.

The National Ecological Observatory Network is a project solely funded by the National Science Foundation and managed under cooperative agreement by Battelle. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Change Record

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
A	12/22/2017	ECO-05128	Initial release.

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1 DESCRIPTION

1.1 Purpose

Routine preventive maintenance is imperative to ensure the proper functional and operational capability of National Ecological Observatory Network (NEON) systems, and the preservation of NEON infrastructure. This document establishes mandatory procedures and recommended practices for preventive maintenance of the Aquatic Instrument System (AIS) and Terrestrial Instrument System (TIS) Thermometrics Platinum Resistance Thermometer (PRT) probe. AIS sites collecting upstream (S-1) and downstream (S-2) water temperature measurements use this PRT. TIS Tower and AIS Aquatic Meteorological (Met) Station sites collecting Aspirated Air Temperature (AAT) measurements. This also includes the PRT in the Wet Deposition Collector at TIS and applicable AIS sites.

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 and do **not** address corrective actions.

This document specifically addresses the preventive maintenance procedures for the Thermometrics PRT stream subsystems, Aspirated Air Temperature (AAT) sensor – Single/Triple, Heated/Non-heated/Extreme heated/Combined assemblies, and the PRT within the Wet Deposition collector. This also addresses the PRT calibration and validation requirements. This does not address the Aspirated Radiation Shield or Fan itself.

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	Environmental, Health, Safety And Security (EHSS) Policy, Program And Management Plan
AD [02]	NEON.DOC.004316	Operations Field Safety and Security Plan
AD [03]	NEON.DOC.050005	Field Operations Job Instruction Training Plan
AD [04]	NEON.DOC.000769	Electrostatic Discharge Prevention Procedure
AD [05]	NEON.DOC.001972	AIS Comm Interconnect Map
AD [06]	NEON.DOC.001436	TIS Comm Interconnect Map
AD [07]	NEON.DOC.004485	Water Temperature Stream Formal Verification Procedures
AD [08]	NEON.DOC.000620	AIS Verification Checklist
AD [09]	NEON.DOC.004637	TIS Verification Checklist
AD [10]	NEON.DOC.004460	Aspirated Air Temperature (AAT) Sensor Formal Verification Procedures
AD [11]	NEON.DOC.001059	NEON Sensor NEON Sensor Command, Control, and Configuration: Submersible PRT – Water Temp
AD [12]	NEON.DOC.000486	NEON Installation Procedure: Aspirated Air Temperature
AD [12]	NEON.DOC.000302	NEON Sensor NEON Sensor Command, Control, and Configuration: Single Aspirated Air Temperature
AD [13]	NEON.DOC.000385	NEON Sensor NEON Sensor Command, Control, and Configuration: Triple Redundant Aspirated Air Temperature

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.003880	NEON Preventive Maintenance Procedure: AIS Stream Infrastructure
RD [04]	NEON.DOC.004257	All Systems Standard Operating Procedure: Decontamination of Sensors, Field Equipment, and Field Vehicles
RD [05]	NEON.DOC.004821	NEON Preventive Maintenance Procedure: Aquatic Meteorological (Met) Station
RD [06]	NEON.DOC.003495	NEON Preventive Maintenance Procedure: Wet Deposition Collector
RD [07]	NEON.DOC.004453	Wet Deposition: Aquatic and Terrestrial Sites Formal Verification Procedures

2.3 Acronyms

Acronym	Explanation
AAT	Aspirated Air Temperature
ESD	Electrostatic Discharge
KING	Kings Creek, Domain 06
Met	Meteorological
P/N	Product Number
PRT	Platinum Resistance Thermometer
OKSR	Oksrukuyik Creek, Domain 18
S-1	Upstream Sensor Set 1
S-2	Downstream Sensor Set 2
RTD	Resistance Temperature Detector
TEP	Terminal Emulator Program
V	Volt

2.4 Terminology

The use of common names for NEON instrumentation and subsystems vary across departments and domains. This section aims to clarify and associate the common names with the technical names herein. The aim of this section is to marry up terms under one name so Technicians are aware of the component referenced in the procedures herein, but also aware they may be called another term in a group discussion with headquarters or training staff.

SYNONYMOUS COMMON NAME(S)	NEON TECHNICAL REFERENCE NAME
Aquatic PRT, PRT, Water Temperature Sensor, Aquatic RTD Sensor,	**Submersible PRT (Thermometrics Aquatic RTD Sensor P/N R032-00000048)** *Note: These are the Thermometrics PRT probes located in the Multisonde housing at S-1 and S-2 AIS Stream sites.*
Terrestrial PRT, Temperature Sensor, Aspirated Shield Temperature Sensors	**Aspirated Air Temperature (AAT) PRT** *Note: These are the Thermometrics PRT probes located in the Aspirated Shield at both TIS and AIS Sites.*
Power Box, Comm Box, National Electrical Manufacturers Association (NEMA) Enclosure, Power/Comm Infrastructure	**AIS Device Post**
NADP	**Wet Deposition Collector**

3 SAFETY AND TRAINING

Personnel working at a NEON site must be compliant with safe fieldwork practices in AD [01] and AD [02]. 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 work in unsafe conditions.

All technicians must complete safety training and procedure-specific training to ensure the safe implementation of this protocol per AD [03]. Refer to the site-specific EHSS plan via the NEON Safety document portal for electronic copies.

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.

4 SENSOR OVERVIEW

4.1 Platinum Resistance Thermometer (PRT) Overview

A PRT uses the known linear relationship between the electrical resistances of platinum and ambient temperature to determine temperature. It determines the temperature by measuring the electrical resistance of a piece of pure platinum wire. The measurement is a four-wire resistance measurement, which allows for consistency and accuracy over various sensor cable lengths across the Observatory.

Figure 1. NEON PRT with Cable

4.2 AIS Submersible PRT

The NEON project uses the AIS submersible PRT (see Figure 1 and Figure 2) to measure water temperature at our wadeable S-1 and S-2 AIS sites. This PRT sits inside the Multisonde housing at S-1 and S-2. Voltage across the PRT(s) is provided by the Merlot (12V) Grape. The NEON project collects and records the subsequent voltage drop (the resistance) across the submersible PRT at S-1 and S-2 and converts it into surface water temperature data.

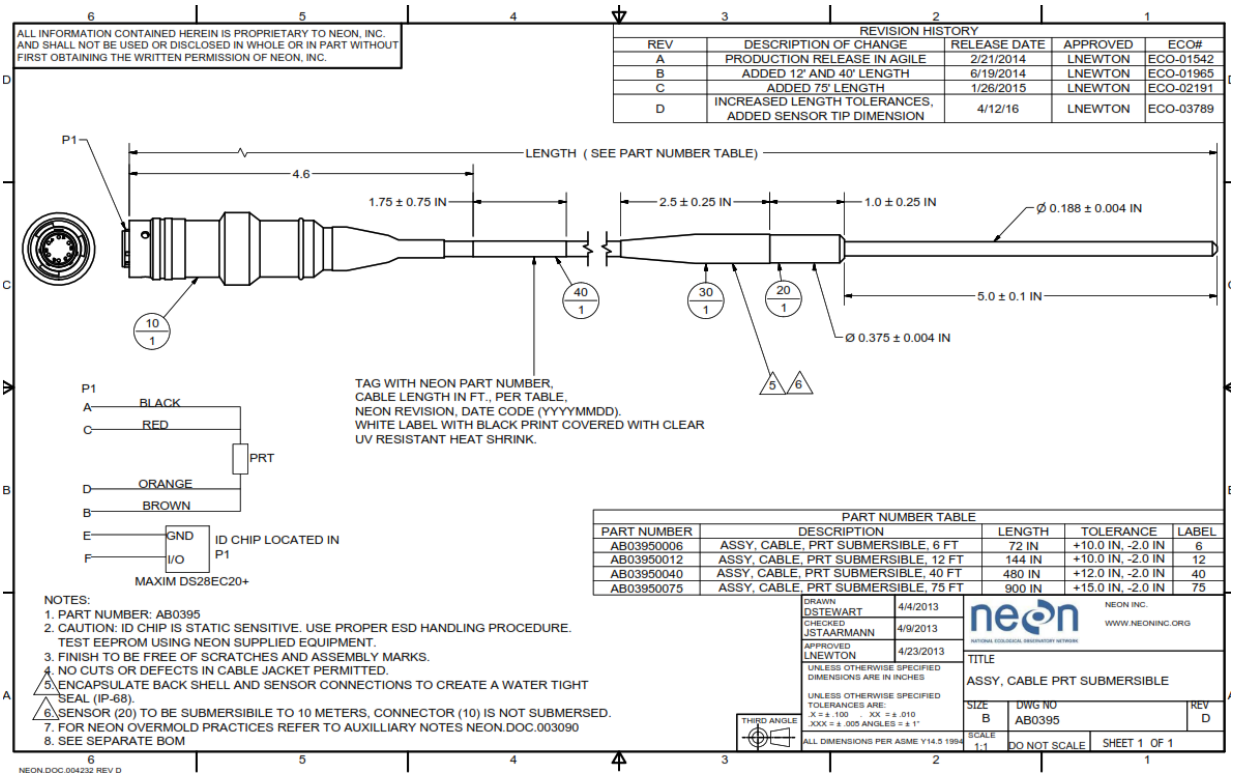

Figure 2. AB0395 Assy, Cable PRT Submersible

4.2.1 Subsystem Components

- HB06550000 Subsystem, Water Temperature, Stream

- HB06550010 Subsystem, Water Temperature, Stream, Extreme High Water Level

Note: Reference site-specific As-Built documentation to verify the assemblies at your site via the NEON Document Warehouse.

4.3 TIS and AIS Aspirated Air Temperature (AAT) PRT

The NEON project uses the AAT PRT at both TIS and AIS sites. At TIS sites, the PRT(s) reside inside the AAT on the Tower. At AIS Sites, the PRT(s) reside in the AAT on the Aquatic Meteorological (Met) Station. Figure 3 displays the mechanical drawing of the AAT PRT.

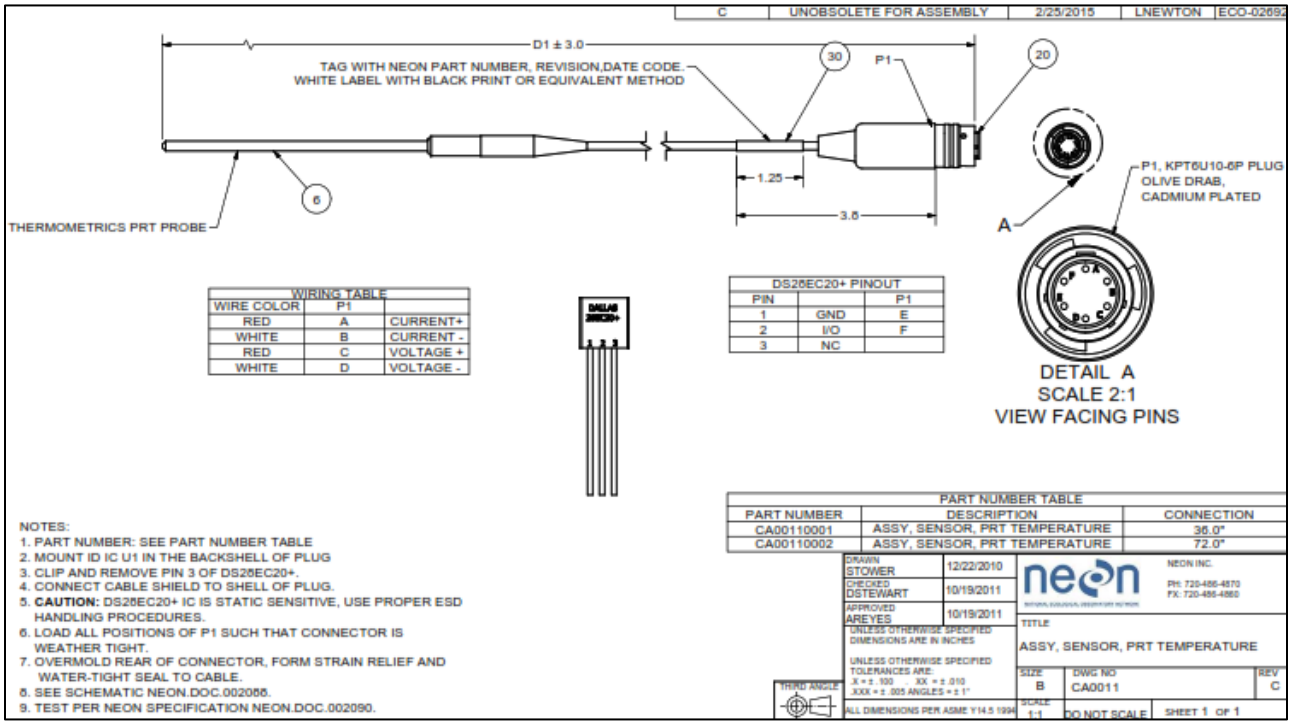

Figure 3. CA0011, Assy, Sensor, PRT Temperature

4.3.1 Subsystem Components

- CD05790000 Subsystem, Aspirated Shield Single, Non-Heated, Split
- CD05790010 Subsystem, Aspirated Shield Single, Heated, Split
- CD05790020 Subsystem, Aspirated Shield Single, Non-Heated, Combined
- CD05790030 Subsystem, Aspirated Shield Single, Heated, Combined
- CD05790040 Subsystem, Aspirated Shield Single, Non-Heated, Split, Level 1
- CD05790050 Subsystem, Aspirated Shield Single, Heated, Split, Level 1
- CD05790060 Subsystem, Aspirated Shield Single, Non-Heated, Combined, Level 1
- CD05790070 Subsystem, Aspirated Shield Single, Heated, Combined, Level 1
- CD05790080 Subsystem, Aspirated Shield Single, Extreme Heated, Split
- CD05790090 Subsystem, Aspirated Shield Single, Extreme Heated, Combined
- CD05790100 Subsystem, Aspirated Shield Single, Extreme Heated, Split, Level 1

- CD05790110 Subsystem, Aspirated Shield Single, Extreme Heated, Combined, Level 1
- CD05800000 Subsystem, Aspirated Shield Triple, Non-Heated, Split
- CD05800010 Subsystem, Aspirated Shield Triple, Heated, Split
- CD05800020 Subsystem, Aspirated Shield Triple, Non-Heated, Combined
- CD05800030 Subsystem, Aspirated Shield Triple, Heated, Combined
- CD05800040 Subsystem, Aspirated Shield Triple, Extreme Heated, Split
- CD05800050 Subsystem, Aspirated Shield Triple, Extreme Heated, Combined
- HA05790000 Subsystem, Aspirated Air Temperature, Aquatic Met Station, Non-Heated
- HA05790010 Subsystem, Aspirated Air Temperature, Aquatic Met Station, Heated
- HA05790020 Subsystem, Aspirated Air Temperature, Aquatic Met Station, Extreme Heated

Note: Reference site-specific As-Built documentation to verify the assemblies at your site via the NEON Document Warehouse.

4.4 TIS and AIS Wet Deposition PRT

The NEON project uses a Thermometrics PRT within the Wet Deposition collector at both TIS Tower and AIS sites. See Figure 8 for the location of the PRT within the Wet Deposition collectors. Reference RD [06] and RD [07] for more information on this subsystem.

4.5 Sensor Specific Handling Precautions

Employ ESD protocols per AD [04] when handling submersible PRTs for Sensor Refresh or while conducting maintenance activities.

Warning: *Do not bang or bump the sensor or it voids its calibration!*

In stream, the submersible PRT is in a disk that sits inside the PVC enclosure with the Multisonde. The disk uses gravity to hold the sensor in place (Figure 4). The design of the disk enables the sensor to lower into the correct hole, which has a bottom taper to stop and hold the sensor. The gravitational force is sufficient to stabilize and hold the sensor in the mounting disk. As a result, it is very easy to dislodge the submersible PRT from the disk when conducting maintenance on the Multisonde or during high-water/inclement weather events. If the disk is no longer holding the submersible PRT, the quality of the data degrades. Ensure proper placement of the submersible PRT after performing

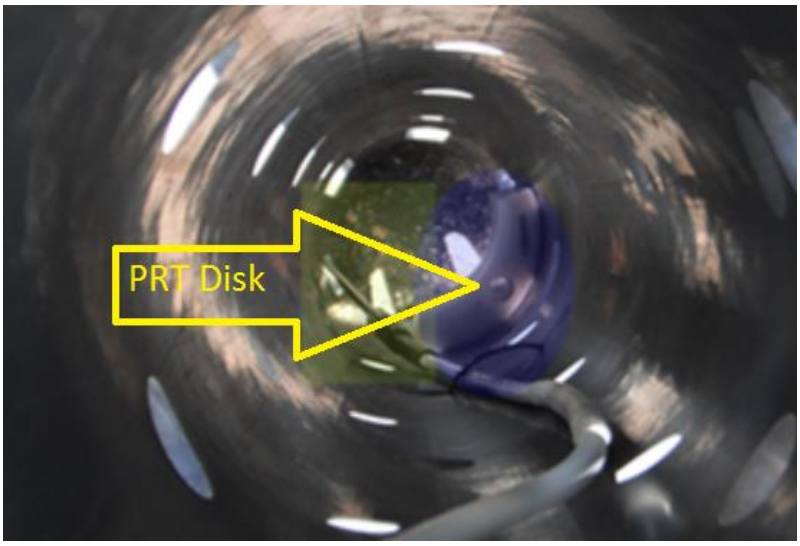

Figure 4. Submersible PRT in Multisonde PVC Housing (Looking Down into the PVC Housing)

preventive maintenance activities that may affect its placement or after high-water/inclement weather events at S-1 and S-2.

4.5.1 Grapes

Grapes contain ESD 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. Reference AD [04].

4.6 Operation

Submersible PRT instrumentation at stream sites consists of the Thermometrics Aquatic RTD sensor and the NEON custom cable with 10-6 Amphenol connector. AIS submersible PRTs connect to the S-1 or S-2 Merlot 12V Grape with the Multisonde and the PQS1. The AIS and TIS AAT PRTs are also Thermometrics PRTs with a NEON custom cable that connects to a 10-6 Amphenol connector on a Concord 24V Grape with other nearby sensor assemblies.

The Grape provides the voltage output used to measure resistances. The PRT uses a well-documented linear relationship between the changes in resistance with temperature. Platinum has the most accurate linear relationship for changes in resistance to temperature over the greatest temperature range (−200 to 650°C) of any metal. Normally, when evaluating temperatures over the entire range of the PRT, the relationship between temperature and resistance for a PRT is expressed by two equations due a divergence from linearity. However, NEON is concerned with only a fraction of the PRT's functional range. Thus, within NEON's desired temperature range, the relationship between temperature and resistance is simplified.

5 INSPECTION AND PREVENTIVE MAINTENANCE

5.1 Equipment

Table 1. Thermometrics PRT Maintenance Equipment List

P/N	MX or NEON P/N	Description	Quantity
Tools			
NEON IT		NEON Laptop (to verify data transmission via PuTTy)	1
GENERIC		Soft Bristle Toothbrush	1
GENERIC		Soft Sponge	1
GENERIC		Bucket (to prevent environmental contamination)	1
Consumables			
GENERIC		Zip ties	A/R
GENERIC		Clean tap water	1L
GENERIC		Isopropanol	1L
Resources			
	PuTTy: http://www.putty.org/		1

5.2 Subsystem Location and Access

5.2.1 AIS Submersible PRT

The AIS submersible PRT resides in the same PVC enclosure at S-1 and S-2 as the Multisonde. These PRTs share a Merlot 12V Grape with the Multisonde and PQS1 at S-1 and S-2. Reference Figure 5 for an example of S-2 in Domain 18, OKSR.

For high-water stream sites, the Merlot 12V Grape sits on a separate infrastructure post on high ground next to the stream (Figure 6). It connects to the sensors using 75ft. cable lengths.

Figure 6. High-water Subsystem Infrastructure (Domain 06, KING)

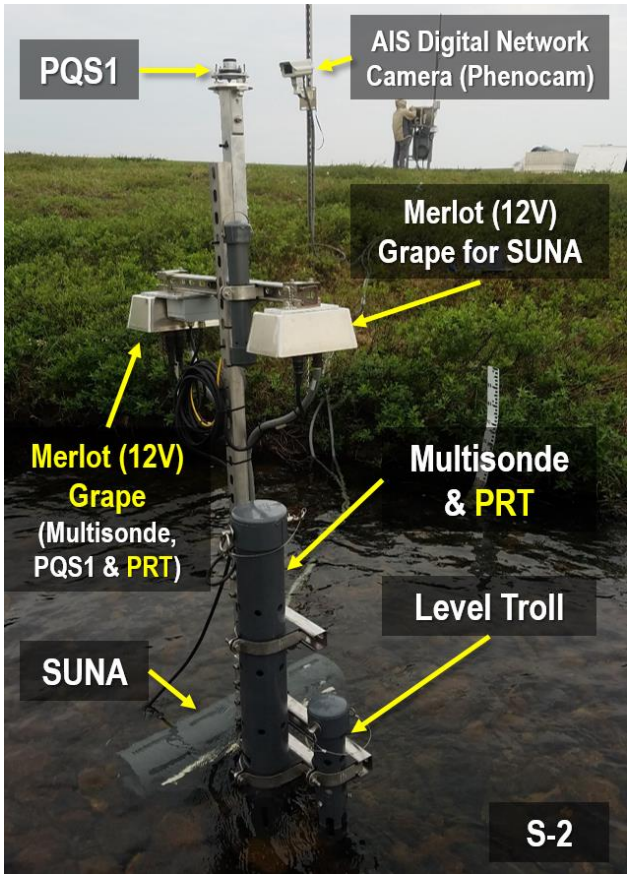

Figure 5. Downstream (S-2) Sensor Location Example, Domain 18 OKSR S-2

5.2.2 AIS and TIS AAT PRT

Thermometrics PRTs reside in the AATs single/triple, heated/non-heated/extreme heated or combined subsystem assemblies on the TIS Tower and AIS Aquatic Met Station. Figure 7 is an example of three AAT assembly locations: AAT with three PRTs on the tower top ML, AAT with a single PRT on the tower profile ML, and an AAT with a single PRT on the Aquatic Met Station.

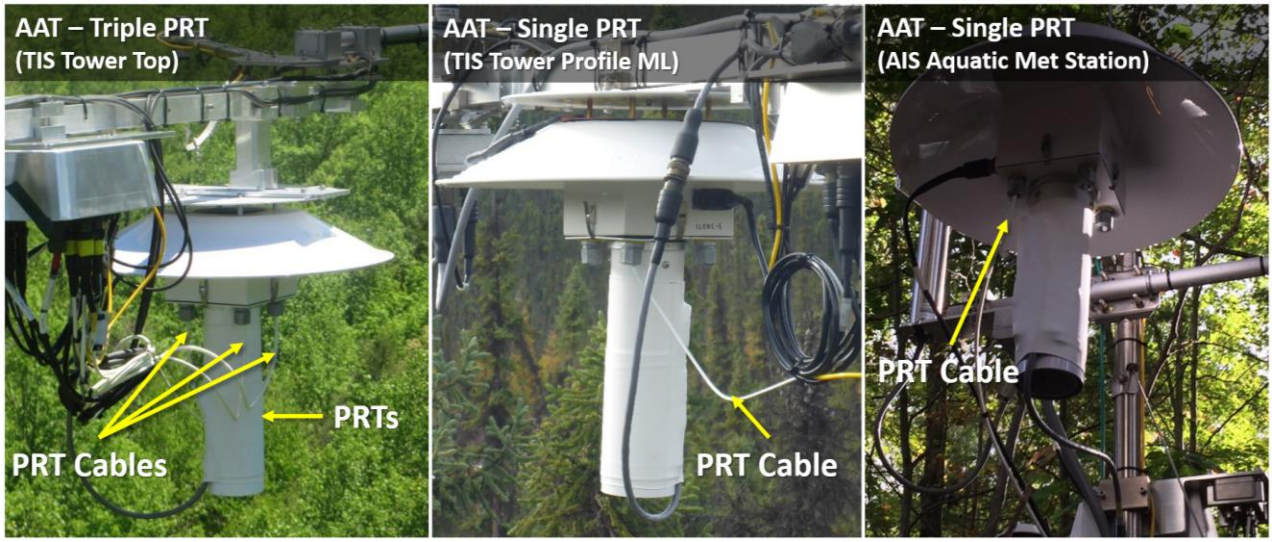

Figure 7. Examples of AATs Assemblies Left to Right: D07 GRSM, D19 BONA, D05 LIRO

5.2.3 TIS and AIS Wet Deposition PRT

A Thermometrics PRT resides within the Wet Deposition collector at TIS Tower and AIS sites Wet. The PRT is inside the collector between the two sampling bottles (see Figure 8).

5.3 Maintenance Procedure

5.3.1 Remote Monitoring

Verify AIS/TIS Thermometrics PRTs are sending data to HQ via the SAS Report. For PRT data streams that are missing/red via SAS, conduct a real time verification of each missing/failed PRT data stream to double check if the PRT data streams are online, but failing to transmit data streams to HQ. Conduct this check using a Terminal Emulator Program (TEP), such as PuTTy or MobaXterm, to connect to each Grape (Submersible PRTs connect to a Merlot Grape and AAT PRTs connect to a Concord Grape). The data state of health presents indicators to focus preventive maintenance efforts; anomalies in the

Figure 8. Thermometrics PRT in TIS and AIS Wet Deposition Collector

data or if the PRT is off the network may dictate preventive maintenance tasks for investigation to determine if onsite corrective action is necessary. Use the Grape MAC address/Sensor EPROM ID with the command prompts in Table 2.

PRO TIP: *To perform these functions, Technicians must acquire the Grape MAC address and/or the EEPROM ID (from Maximo) of the sensor. Use this to verify function of Grapes and Sensors post-Sensor Refresh, too.*

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

Table 2. Verify Grape Function (MAC and EPROM ID are Examples for this Command)

PuTTy Commands	Description
`vd | grep 7CE0440015FD`	This displays the data from the grape 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.

Per AD [10], in Data Monitor, PRT temperature value is in °C, and should sample at 1Hz and match other nearby PRTs. For any other program, use a conversion table to convert resistance raw data into °C or °F temperature values.[i] The AAT on the tower top level uses three PRTs. AAT on profile measurement levels use one PRT. The Aquatic Met Station AAT uses one PRT.

5.3.2 Visual Inspection

Conduct a bi-weekly visual inspection of the visible PRT components to monitor the condition of the cable, the Grape and connection to the Grape. Inspect for damage from the elements (sun, wind), animals, and insects or if there is any evidence of tampering from the public. Redress the cables, if necessary, if objects in the stream or inclement weather events moved the cable/broke worn zip ties, etc. Replace missing, broken, or brittle cable ties.

5.3.3 PRT Cleaning

The external surface of the PRT should be kept clean and free of biological and other terrestrial or aquatic materials (e.g., sediment, other debris). Accumulation of materials along the external surface of the sensor will lead to additional thermal effects on temperature measurements, causing bias in the measurement magnitude and time lags on the response time.

Removal of aquatic or terrestrial materials adhered on the sensor surface can be performed by using a soft sponge for light loose debris and a soft bristle tooth brush for more rigorously adhered items.

If a gentle cleaning is insufficient to remove the aquatic or terrestrial material from the sensor surface, the sensor may be soaked in an isopropanol solution for a few minutes. Gently brush the sensor surface while in the isopropanol solution to assist in chemically softening and removing the debris from the

sensor. Rinse with clean tap water. Conduct the soak and rinse over a bucket to prevent contaminating the surrounding environment.

5.3.3.1 AIS Submersible PRT

For AIS stream sites, inspect PRT external surfaces bi-weekly for biofouling when the Multisonde is receiving bi-weekly maintenance.

5.3.3.2 TIS and AIS AATs PRTs

For TIS and AIS AATs sites, monitor the PRT data streams for inconsistencies and/or inspect the inside of the AATs area where the PRTs reside quarterly to determine if a cleaning is necessary. Reference Figure 9 to inspect/access PRT(s) inside an AAT sensor.

See Section 6.2.2 for instructions on powering down to remove/replace AAT sensor assemblies to inspect and/or clean the PRTs inside in hard to reach locations.

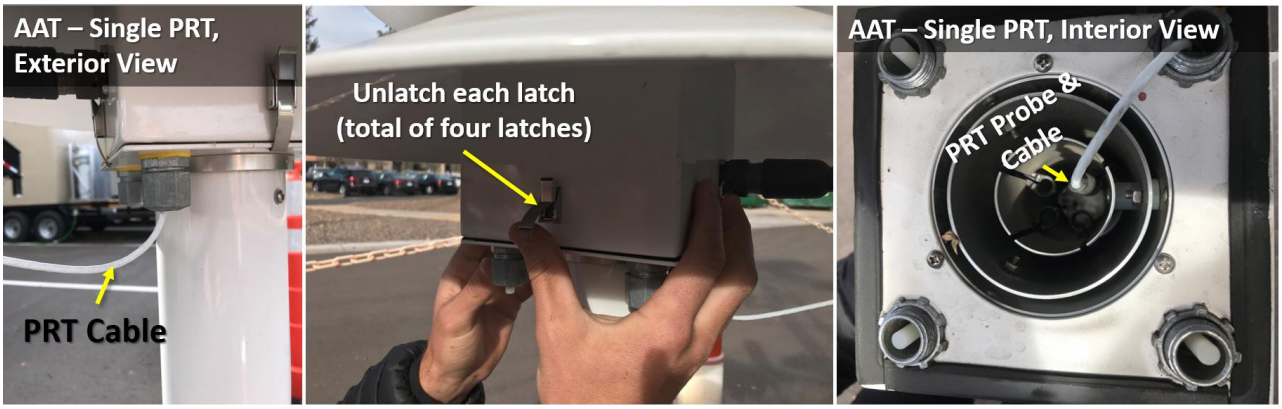

Figure 9. Access PRTs inside AATs

PRO TIP: *Secure a lanyard around the measurement section (or "snout") and the boom arm to prevent it from falling on TIS Towers. Figure 10 displays two ways to secure the measurement section using this lanyard.*

5.3.3.3 TIS and AIS Wet Deposition PRT

Refer to RD [06] for preventive maintenance and RD [07] for verification information on the PRT in the Wet Deposition collectors. This PRT does not require annual calibration and validation from CVAL.

Figure 10. Security Lanyard

6 REMOVAL AND REPLACEMENT

6.1 Equipment

Table 3 contains a list of equipment to conduct sensor refresh at AIS and TIS 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. Thermometrics PRT Removal and Replacement Equipment List

P/N	MX/NEON	Description	Quantity
Tools			
4620	MX103120	3M Antistatic Wristband (ESD Requirement)	1
GENERIC		3/16" Allen Wrench	1
		Hex Wrench Set	1
		Stream Waders/Pajamas	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
S-2670		ESD wrap: ULINE Color-tined Cast Goodwrappers - Plastic Wrap (Palletizing for Sensor Refresh) in Red (S-2670R), Blue (S-2670BLU), Green (S-2670G), Orange (S-2670O), and Black (S-2670BL)	A/R
GENRIC		Towel (To Leverage Grip or Wipe-off Items)	1
GENERIC		Microfiber/Lint-free cloth	1-2
GENERIC		10% Bleach Mixture (9 parts water, 1 part bleach)	A/R
1HAB2	MX104219	Grainger Red Inspection Tag, Paper, Rejected, PK1000	A/R
		Plastic Grape Dust Caps	2-6
S-16061FO		ULINE Stake Flags - 2 1⁄2 x 3 1⁄2", Fluorescent Orange or Fiberglass Snow Stakes	A/R
Resources			
GENERIC	MX106639	Sturdy Container and/or Backpack (Transport sensors from site location)	1

6.2 Removal and Replacement Procedure

The Field Operations Domain Manager is responsible for managing the removal and replacement of the sensors onsite 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 AIS submersible and TIS/AIS AAT PRTs.

Table 4. AIS and TIS Thermometrics PRT Sensor Refresh Requirements

	LOCATION		TIMEFRAME			
	CVAL	*FIELD*	*BIWEEKLY*	*ANNUAL*	*NA*	COMMENTS
Merlot (12V) Grape	X			X		The Multisonde and PQS1 use this same Grape at S-1 and S-2 (next to the Splitter).
Concord (24V) Grape	X			X		AAT PRTs connect to a Concord Grape (24V).
Thermometrics PRT	X			X		***This is not applicable for the PRT in the Wet Deposition collector. The PRT in the Wet Deposition does not require annual calibration via CVAL.***

Note: Always shutdown the power prior to removing or replacing any components. Remove the Ethernet Cable from the Grape to power down the submersible PRT and Grape.

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

6.2.1 Remove/Replace the Submersible PRT on an AIS site

1. Wear an anti-static wristband. Employ ESD protocols when handling Grapes. Reference AD [04].
2. Power down the site or sensor.
    a. Power down the site via the AIS Combo Device post. *Reference Section 10: APPENDIX C – How to Power Down an AIS Device Post: Combo Box for Stream Sites.*
    b. Power down the senor by detaching the armored Ethernet cable from Grape (RJF connection). This action will power down the Grape. (This must occur to prevent damage to the Grape.) For high water installations, the Grape is on a separate device post, next to the stream (see Figure 6 on page 12).
3. Place a size 10 Amphenol cap on the 10-16 Grape port and the sensor cable Amphenol connector to prevent dust and water from entering them.
4. Remove all cable ties using flush cuts (undress the cable).
5. Remove the clip (Figure 11) that hold the cap onto the PVC housing for the Multisonde and PRT.

Figure 11. Multisonde/PRT PVC Housing Cap Clip (Removed from PVC Housing Cap) (D06, KINGS)

6. Remove Multisonde, if necessary (optional step).

7. Pull the sensor up from the sensor mount disk inside the Multisonde PVC housing to remove the sensor.

8. Gently pull the PRT cabling from the split tube housing as you work your way back from the sensor to the Grape. Remove any cable ties interfering with removal. Replace any cable ties securing other instrument's cabling.

9. Clean and/or swap the submersible PRT sensor and cable on-site to prevent the transportation of insects and aquatic invasive species offsite.

Reverse these instructions to reassemble the submersible PRT. Remove the Multisonde to reinstall if there are issues with returning it to its original place in the PVC housing. Connect the Grape Ethernet cable (RJF, Cat 5 cable) after connecting the sensor to the Grape 10-6 port. *Never hot swap sensor connections on the Grape.*

6.2.2 Remove/Replace the AAT PRT(s) on a TIS and AIS site

The procedures herein address AAT PRTs on a TIS Tower site and AIS Aquatic Met Station.

Note: Follow all Tower safety climbing and harness and Ladder safety protocols, as applicable, when working on AAT removal/replacement procedure per AD [01].

1. Access the AATs assembly.

    a. For a TIS site, climb tower to the ML where the AAT requires removal/replacement (with exception of MLs that Technicians can reach on the ground) and pull in the boom.

    b. For an AIS site, bring a ladder/stool to reach the AAT on the Aquatic Met Station.

2. Wear an anti-static wristband. Employ ESD protocols when handling Grapes. Reference AD [04].

3. Power down the site or sensor assembly.

    c. Power down a TIS site via the Tower ML. *Reference Section 8: APPENDIX A – How to Power Down a Tower Measurement Level.*

    d. Power down an AIS site via the AIS Device post. *Reference Section 9: APPENDIX B – How to Power Down an AIS Device Post: Power Box for Met Station.*

    e. Power down the senor at either site by detaching the Ethernet cable from the Concord Grape (RJF connection)[ii]. This action will power down the Grape. (This must occur to prevent damage to the Grape.) For TIS sites, on combined tower measurement levels, this assembly has two Grapes.

4. Remove the assembly from the TIS or AIS infrastructure. The instructions for removal are the same for both sites. The brackets for each site are slightly different in design, but are functionally the same (AIS mounts to a circular boom and TIS mounts to a square boom).

    a. Loosen the two allen bolts per clamp that secures the AAT mount bracket to boom arm. Secure the assembly from falling; use two Techs and the security cable on TIS towers. Fully remove the respective assemblies and bring them into the tower/remove from Aquatic Met Station.

    b. For a TIS combined site, loosen the radiation-mounting clamp. **Do not loosen all the way.** Secure assemblies from falling. Fully remove the respective assemblies and bring them into the tower.

5. Remove/replace the PRT(s) from the AAT assembly/assemblies. Reference Table 5.

Table 5. Remove PRT from AAT Assembly

 **Figure 12. Unlatch the Four Locking Latches**	**STEP 5.1** | After removing the AATs assembly from the Tower or Aquatic Met Station boom, unlatch the four locking latches that holds the measrement section (or "snout") (Figure 12).

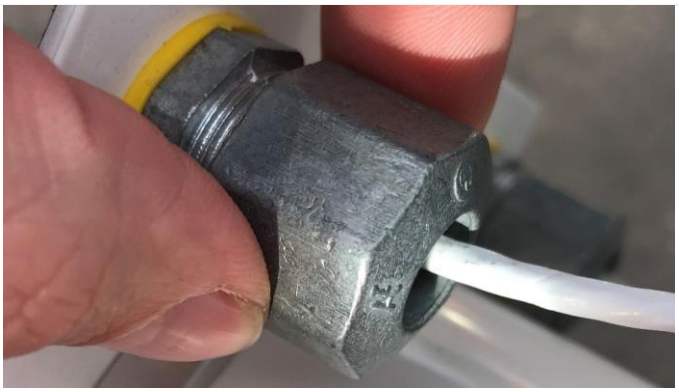

Figure 13. Unthread the Strand Relief Gland with the PRT Cable

STEP 5.2 | Unthread the strain relief gland that with the PRT cable (Figure 13).

Figure 14. Remove White Cable Clamp

STEP 5.3 |Remove the cable clamp (Figure 14).

PRO TIP: *This assembly contains small parts that are easy to lose onsite. Place each part in a safe area or carry/clip on a bag to hold the small parts while conducting sensor swaps.*

Figure 15. Remove PRT from Assembly

STEP 5.5 | Remove the PRT from the assembly. Guide it through the nut and remove the black PRT retaining clip circled in yellow in Figure 15.

Figure 16. Decontaminate the AAT Assembly & Return Black PRT Retaining Clip

STEP 5.6 | Conduct decontamination on the AAT sensor assembly piece and return the black PRT retaining clip as a placeholder to secure the small part when swapping or maintenancing the PRT (Figure 16).

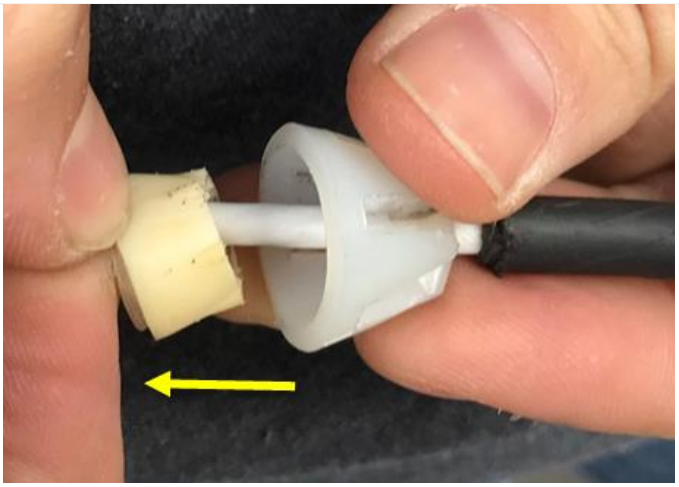

Figure 17. Separate Grommet from Cable Clamp

STEP 5.4 | Separate grommet from cable clamp to remove from PRT (Figure 17).

PRO TIP: *Use a screwdriver to remove the grommet from the cable clamp.*

Figure 18. Remove Cable Clamp from PRT Cable

STEP 5.7 | Open the cord grip on the cable clamp or remove it from the notch in the clamp (Figure 18).

PRO TIP: *Use a screwdriver to expand the claws to make it easier to remove from the PRT.*

Figure 19. Cap PRT Probe for Shipping/Handling

STEP 5.8 | Conduct decontamination and cap the probe. Cap and coil the cable and package the PRT in an ESD compliant bag. *See Section 6.3 Cleaning and Packaging of Returned Parts for decontamination and shipping guidance*.

Figure 19 is an example of PRT probes and cables with caps. Package these in an ESD bag when shipping to CVAL for annual sensor refresh.

Note: All Thermometrics PRTs use these caps when shipping/receiving/transporting between sites/HQ for annual sensor refresh and/or corrective action.

STEP 5.9 | Reassemble the small AAT parts onto the "freshly" calibrated PRT (Figure 20).

Figure 20. Reverse Order to Reassemble PRTs with AATs

Figure 21. Reassemble PRT and Install Black PRT Retaining Clip

STEP 5.10 | Guide the PRT though the hole in the AAT and slide the black retaining clip to the thicker part of the PRT (Figure 21).

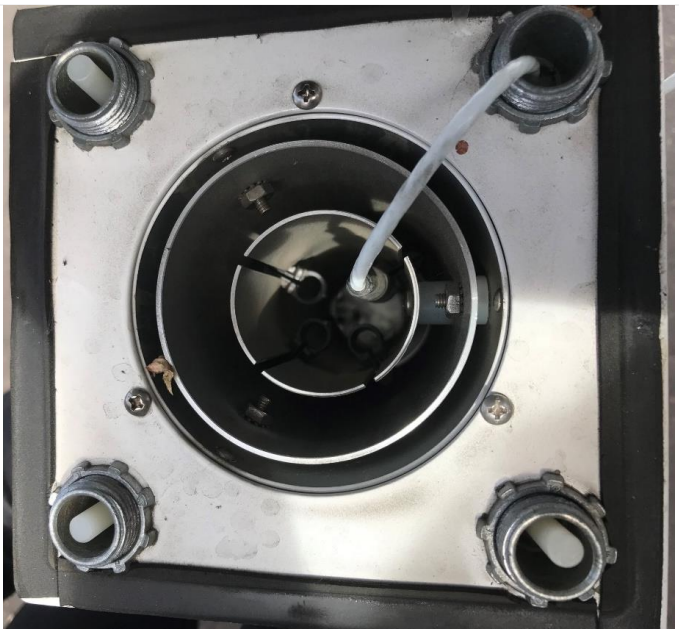

Figure 22. Install PRT in AAT Measurement Section

STEP 5.11 | Reassemble all the components on the PRT cable. Adjust the cable for dressing – allow some slack and prevent straining the cable (Figure 22). Tighten the strain relief gland and dress cables.

STEP 5.12 | Re-energize the sensor. Connect the Grape Ethernet cable (RJF, Cat 5 cable) after connecting the sensor to the Grape 10-6 port. *Never hot swap sensor connections on the Grape.* Flip the breakers on the applicable device post.

STEP 5.13 | Verify sensor function. *Reference Section 5.3.1 Remote Monitoring.*

6.2.3 Grape Removal/Replacement Procedure

This procedure is applicable to both the Merlot and Concord Grapes associated with these sensor assemblies at both TIS and AIS site locations.

1. Record EPROM ID/MAC Address, "Property of" Asset Tag number, Removal/Replacement date and time. The following template is a great 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?		

2. Wear an anti-static wristband. Employ ESD protocols when handling Grapes. Reference AD [04].
3. Power down the site at the applicable TIS Measurement Level Power Box or AIS Device Post.
    a. *Reference Section 8: APPENDIX A – How to Power Down a Tower Measurement Level.*
    b. *Reference Section 9: APPENDIX B – How to Power Down an AIS Device Post: Power Box for Met Station.*
    c. *Reference Section 10: APPENDIX C – How to Power Down an AIS Device Post: Combo Box for Stream Sites.*
4. Disconnect the armored Ethernet cable connecting to the RJF/Eth to Comm connection.
5. Disconnect sensor connections.
6. Remove Concord 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 from the pipe, remove the Grape Shield mount/clamp using a 3/16” hex wrench/key.

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

7. Place dust caps on Amphenol connectors of old Grape.
8. Reinstall new Grape to the Grape Shield by threading the four screws that affix the Grape to the Grape Shield using a hex wrench.
9. Remove dust caps on sensor connectors and Eth-To-Comm connector. Re-connect sensor and armored Ethernet cable in accordance with AD [05] or AD [06].
2. Re-energize site power.
    a. Reattach the armored Ethernet cable to the Grape after the sensor connections are secure.
    b. Apply site power from the AIS device post combo/power box breakers or tower ML power box breakers.
10. Verify Grape and sensor function. Connect locally to the AIS Aquatics Portal and/or TIS Instrument Hut or from the Domain using a TEP and Table 2. Verify Grape Function (MAC and EPROM ID are Examples for this Command) in Section 5.3.1.

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

6.3 Cleaning and Packaging of Returned Parts

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. (Please note: if a sensor is defective,

submit a trouble ticket and affix a red tag with the trouble ticket number on it.) Clean the Grape (also known as decontamination; *Reference RD [04])* by removing all biologics from the device prior to capping the connections and placing in ESD packaging. Reference Table 3 for the equipment, tools and consumables necessary for conducting the NEON HQ, CVAL Sensor Refresh procedures for the submersible PRT and Merlot Grapes.

Please remove all arachnids and/or insects from tower instruments prior to packing and shipping. Reference AD [04].

Warning*: Do not bang or bump the sensor or it voids its calibration!*

For the cleaning and packaging of the submersible PRTs post-removal, conduct the following steps:

1. Check mounting holes for spiders and spider webs. Remove biologics and clean connectors.
2. Coil and cap the cable connector with size 10 dust cap.
3. Reference Section 5.3.3 PRT Cleaning. A Clorox bleach mixture (nine parts water/1 part bleach) may also be used to decontaminate the PRT. Soak the sensor in bleach for 5 minutes, then rinse thoroughly with distilled water. (Residual bleach will break down sensor materials.) Do not forget to decontaminate the cable, too.
4. Dry the sensor using a lint-free/microfiber cloth.
5. Place a protective covering over the submersible PRT sensor rod. This comes with the sensor upon installation and/or swap/replacement in its original packaging from HQ.
6. Package the sensor in an ESD compliant package.
7. Update asset records via the NEON's project Asset Management and Logistic Tracking System (e.g., All devices in transit to HQ shall be moved to TRANSIT in 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.

8. 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.
9. Prepare a Bill of Lading.

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

10. Check mounting holes for spiders and spider webs. Remove biologics and clean connectors.
11. Cap all connectors.
12. Conduct decontamination and remove any additional biologics from the devices.
13. Place the device in an ESD bag and shipping container.
14. Update asset records via the NEON's project Asset Management and Logistic Tracking System (e.g., All devices in transit to HQ shall be moved to TRANSIT in 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.

15. 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.
16. Prepare a Bill of Lading.

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

For Sensor Refresh, package sensor items via packaging from CVAL HQ with packing list or per guidance 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

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/MAC Address, etc.
- Provide Diagnostic Information (from firmware, if applicable), such as error codes, values, etc. Provide screenshots.

Table 6. PRT 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 (1Hz)	☐	
Sensor – Clean	☐	
Sensor – Temperature Check (verify PRTs nearby show similar temperatures)	☐	
Environmental Information	☐	
Notes		

8 APPENDIX A – HOW TO POWER DOWN A TOWER MEASUREMENT LEVEL

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.

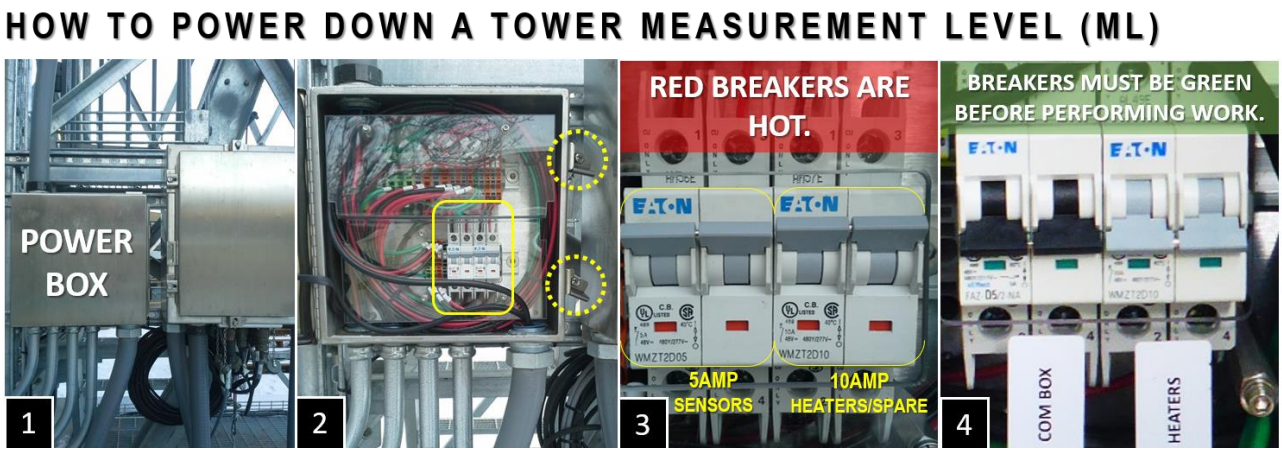

Figure 23. How to Power Down a Tower ML

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 23.

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.***
2. Open the power box using a Phillips-head screwdriver on the two clasps on the right. Figure 23 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 – ***go ahead and proceed***</u>**.**
    b. Conduct LOTO procedures and proceed with the Preventive Maintenance, Sensor Refresh and/or Corrective Maintenance.

9 APPENDIX B – HOW TO POWER DOWN AN AIS DEVICE POST: POWER BOX FOR MET STATION

Powering down the site enables Technicians to perform work with less 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 site from the AIS Device Post power box. Use Figure 24 for this procedure.

    a. Power down the Device Post providing power to the Aquatic Met Station via the power box breakers.

    b. Open the Power Box using a Philips head screwdriver.

    c. Flip both breakers from RED to GREEN.

    d. Conduct LOTO procedures and proceed with the Preventive Maintenance, Sensor Refresh and/or Corrective Maintenance.

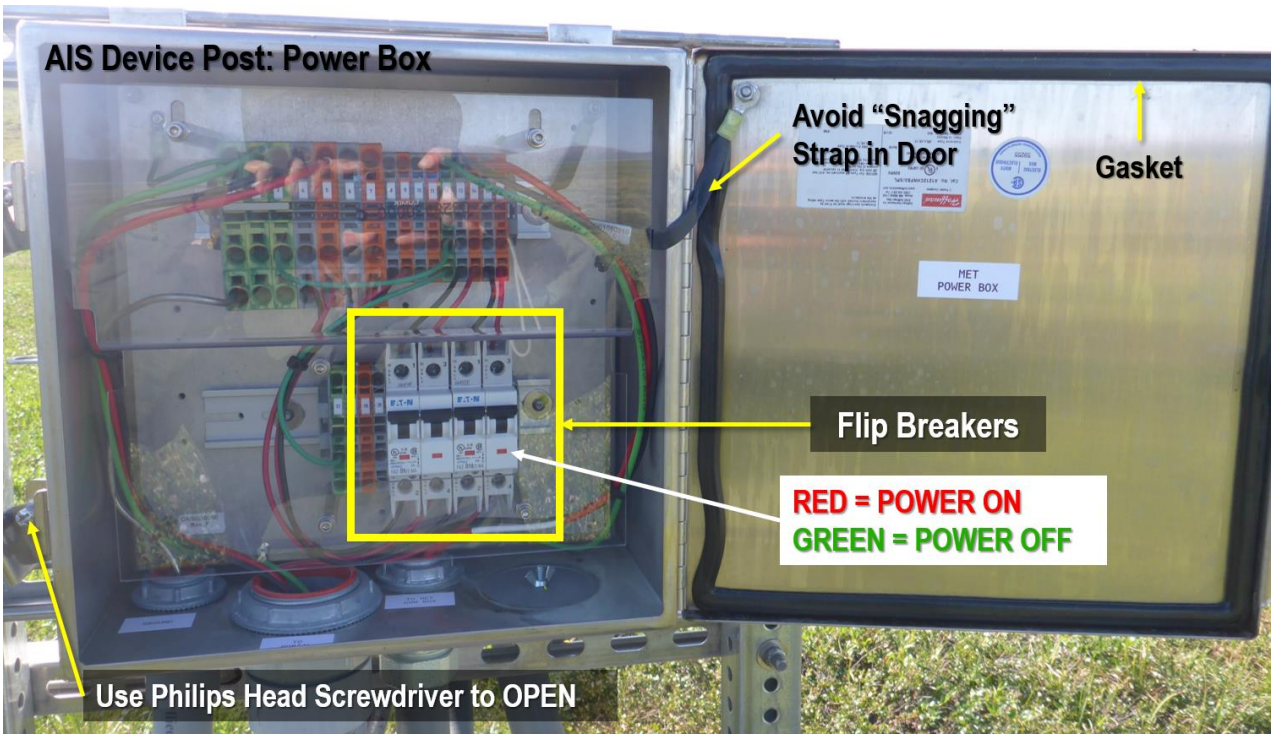

Figure 24. AIS Device Post: Power Box Components (Domain 18 OKSR AIS Aquatic Met Station)

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 or Concord Grape RJF/Eth-To-Comm connector before disconnecting or connecting sensor connections.

10 APPENDIX C – HOW TO POWER DOWN AN AIS DEVICE POST: COMBO BOX FOR STREAM SITES

Power down the Aquatic Site S-1/S-2 from their respective device post combo box (combo box means it contains both power (breakers) and communications (PoE) equipment). Use Figure 25 for this procedure.

1. Use a flathead screwdriver to open the combo box.
2. Flip the 5-Amp breaker(s) from RED to GREEN to de-energize the sensors.
3. Conduct LOTO procedures and proceed with the Preventive Maintenance, Sensor Refresh and/or Corrective Maintenance.

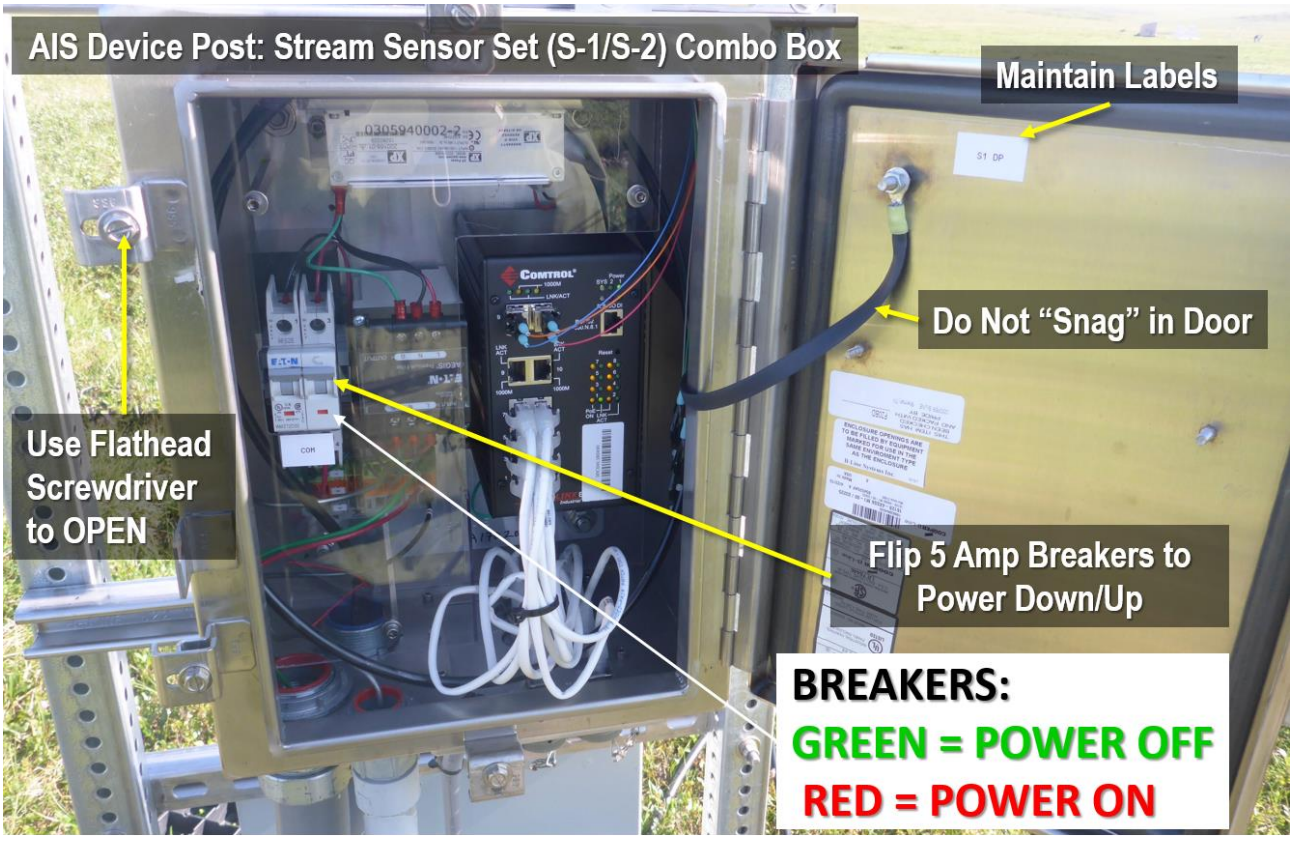

Figure 25. AIS Device Post: Combo Box Components (Domain 18 OKSR S-1)

11 SOURCES

Applegate, Nick. Technical content additions. November 30, 2017.

Cain, Gregory. Soil Plot Verification Checklist, V 1.0. May 22, 2017.

Faria, Genevieve. Technical content additions. December 1, 2017.

Simonds, Geoff. Verification Photos of TOOL AIS Secondary Precipitation. Accessed November 28, 2017. N:\Common\SYS\Install Docs Work in Progress 20170619\`AIS_Install_Docs\`Incoming_Drafts\D18-TOOK_Met

Simonds, Geoff and Andrew Keller. Verification Photos of OKSR AIS Stream Site. August 09, 2017. N:\Common\SYS\Install Docs Work in Progress 20170619\`AIS_Install_Docs\`Incoming_Drafts\Oks Creek

Hand Models: Andrew Keller, Geoff Simonds, Genevieve Faria

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[i] PRT Calculator Example: http://www.isotech.co.uk/prt-calculator

[ii] The Ethernet cable is an armored cable on the first ML of the TIS Tower.