NEON PREVENTIVE MAINTENANCE PROCEDURE: 2D SONIC ANEMOMETER

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See configuration management system for approval history.

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Change Record

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
A	04/30/2018	ECO-05574	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 **2D Sonic Anemometer**.

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 **2D Sonic Anemometer** 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.003519	How-To: Turn on a Communication Box Relay
AD [12]	NEON.DOC.000780	NEON Algorithm Theoretical Basis Document (ATBD) - 2D Wind Speed and Direction
AD [13]	NEON.DOC.000387	NEON Sensor Command, Control and Configuration (C3) Document: 2D Wind
AD [14]	NEON.DOC.000525	NEON Installation Procedure: 2D Wind
AD [15]	NEON.DOC.004449	Site Maintenance Plan – Instrumented Systems
AD [16]	NEON.DOC.004420	2D Wind Formal Verification Procedure
AD [17]	NEON.DOC.004886	NEON Preventive Maintenance Procedure: Aquatic Portal & AIS Device Posts

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.000243	NEON Bolt Torque Specifications
RD [04]	NEON.DOC.000243	Electrostatic Discharge Prevention Procedure

RD [05]	NEON.DOC.000243	NEON Preventive Maintenance Procedure: Aquatic Meteorological (Met) Station
RD [06]	NEON.DOC.000243	Aquatic Met Station Installation Procedure
RD [07]	NEON.DOC.000243	AIS Verification Checklist
RD [08]	NEON.DOC.000243	TIS Verification Checklist
RD [09]	NEON.DOC.000243	Assembly Instruction, 2D Sonic Level 1 Non-Heated
RD [10]	NEON.DOC.000243	Instruction, Assembly, 2D Sonic Extreme 2" Clamp
RD [11]	NEON.DOC.000243	Instruction, Assembly, 2D Sonic Extreme Level 1
RD [12]	NEON.DOC.000243	Instruction Assembly, 2D Sonic, MET Station, Heated

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 2D Sonic Amemometer. External references contain information pertinent to this document, but are not NEON configuration-controlled. Examples include manuals, brochures, technical notes, and external websites. 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]	Gill Instruments WindObserver II User Manual http://gillinstruments.com/data/manuals/1390-PS-0004%20WindObserverII%20Manual%20Issue%2024.pdf?iss=24.20170306
ER [03]	Gill Instruments WindObserver II Datasheet http://gillinstruments.com/data/datasheets/1390-030%20Iss%204%20WindObserver%20II.pdf

2.4 Acronyms

Acronym	Description
2D	Two Dimensional
A/R	As Required
AIS	Aquatic Instrument Systems
CnC	Command and Control
Comm	Communications
CVAL	Calibration, Validation and Audit Laboratory
DI	Deionized
ESD	Electrostatic Discharge
FLNT	Flint River, Domain 03
FOPS	Field Operations
GRSM	Great Smoky Mountains National Park, Domain 07
HEAL	Healy, Domain 19

HQ	Headquarters
JSA	Job Safety Analysis
KING	Kings Creek, Domain 06
LC	Location Controller
LENO	Lenoir Landing, Domain 08
LOTO	Lock Out/Tag Out
MDP	Mobile Deployment Platform
ML	Measurement Level
ML*x*	Measurement Level where "*x*" is the level number
MLBS	Mountain Lake Biological Station, Domain 07
LOGWAR	Logistics Warehouse
OKSR	Oksrukuyik Creek, Domain 18
PoE	Power Over Ethernet
POSE	Posey Creek, Domain 02
PRPO	Prairie Pothole, Domain 09
QR	Quick Response
SDS	Safety Data Sheet
SERC	Smithsonian Environmental Research Center, Domain 02
SOAP	Soaproot Saddle, Domain 17
SRER	Santa Rita Experimental Range, Domain 14
TEP	Terminal Emulator Program
TIS	Terrestrial Instrument Systems
TOOK	Toolik Lake, Domain 18
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
2D Sonic, 2D Wind, Sonic Anemometer, Ultrasonic Anemometer	2D Sonic Anemometer
Transducer Arm(s), Sonic Arm(s), Transducer Spar(s), Arm(s), Prong(s)	Spar(s)
Red Dot/Line, Red Alignment Dot/Line, Alignment Dot/Line, Alignment Marker, North Alignment Mark	Red Alignment Dot/Line
Axis 1, North-South Axis, N-S Axis, Streamwise	U Axis
Axis 2, East-West Axis, E-W Axis, Crosswind	V Axis

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 External Components

- Gill Instruments WindObserver II Ultrasonic Anemometer
- Inclinometer
- Junction Box
- Grape

4.1.1 Internal Components

- De-icing Heaters (non-servicable)

4.2 Description

The Gill WindObserver II Ultrasonic Anemometer (hereafter referred to as 2D Sonic Anemometer) is a solid-state wind measurement sensor that has no moving parts, and utilizes sonic pulses of sound to determine the wind speed and direction in the two horizontal dimensions. The 2D Anemometer is comprised of a stainless steel cylindrical body, four equally spaced spars (arms) protruding up from the top of the instrument, and at the end of each of the spar is a bullet shaped ultrasonic transducer pointed in the direction of the opposing spar (see **Figure 1**). Specialized black rubber acoustic material covers the "face" (front) of each ultrasonic transducer. The spars are spaced 90° apart from one another so that the transducers oppose each other (see **Figure 2**).

One of the spars is designated as the "North" or Reference spar and is typically arranged so this points towards True North (or some other known reference direction[1]). The direction this spar is pointed towards is critical for accurate measurements of wind speed and direction, which is why it is emphasized here.

Non-Heated and Heated sites (see Appendix 8.1 and 8.2), the "North" or Reference spar can be identified two ways, by the alignment indicator notch (a Red Alignment Dot or Line) at the base of the instrument (see **Figure 3**), or by the dividing line between the silver and blue portions of the Gill Instruments Model and Serial No. label (see dashed line in **Figure 4**).

Extreme-Heated sites (see Appendix 8.1 and 8.2), the "North" or Reference spar is offset 45° from the alignment indicator. This spar can be identified three ways, by the alignment indicator line (a Red Alignment Line) at the base of the instrument (see **Figure 5**), an M8 grounding bolt (see **Figure 5**), or by

[1] The reference direction for NEON 2D Anemometers is aligned with the axis of the boom arm on which they are mounted. Boom arm directions are site-specific.

the dividing line between the silver and blue portions of the Gill Instruments Model and Serial No. label (see dashed line in **Figure 6**).

The 2D Sonic Anemometers at Heated and Extreme-Heated sites (see Appendix 8.1 and 8.2) have internal de-icing heaters. The heaters are non-serviceable and are located within the spars, and around each transducer. The heaters operate independently and automatically activated when the ambient temperature drops below 59 °F (15 °C) and automatically de-activates when each transducer reaches 77 °F (25 °C).

The 2D Sonic Anemometers are mounted at the end of each Measurement Level (ML) boom at TIS Tower Sites (except the tower top), and on AIS Met Stations.

NOTE: The 2D Sonic Anemometers at TIS Tower Sites are mounted "upside-down" (see e.g. **Figure 9** and **Figure 12**) while on AIS Met Stations, they are mounted "right-side up" (see **Figure 10** and **Figure 14**).

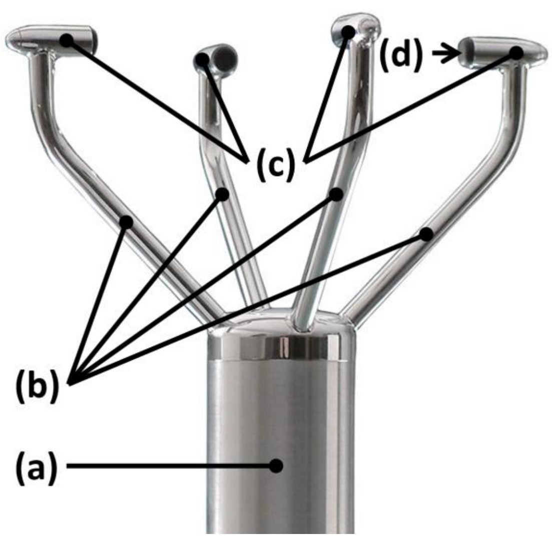


Figure 1. Picture and description of the 2D Anemometer components.

a) Stainless Steel Body
b) Spars
c) Transducers
d) Transducer Cap

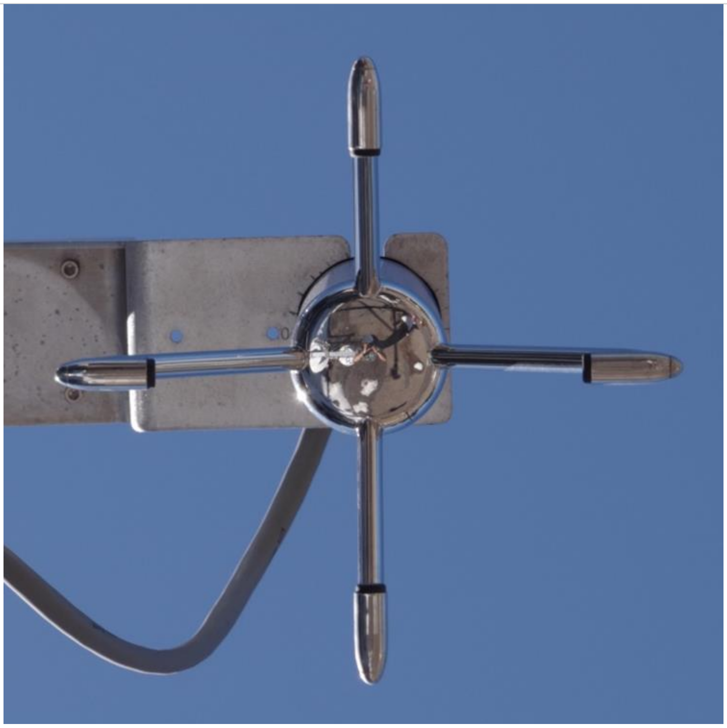


Figure 2. Picture of the 2D Anemometer showing the configuration of the opposing pairs of transducers.

Figure 3. Close-up view of the Red Alignment Dot on Non-Heated and Heated 2D Sonic Anemometers.

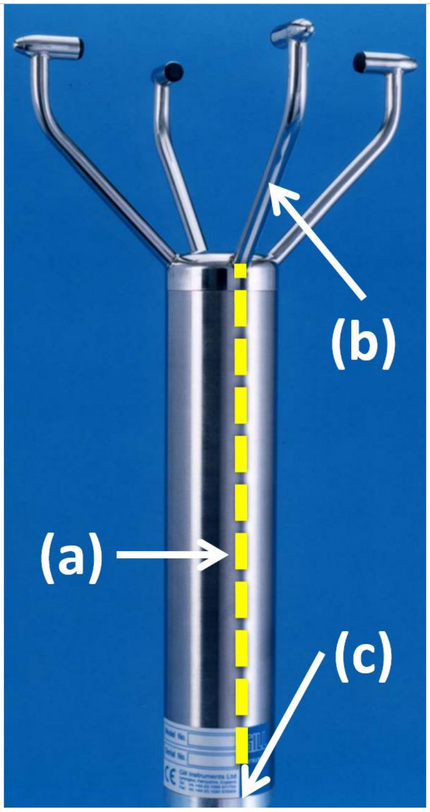


Figure 4. Identifying the "North" or Reference spar on Non-Heated and Heated 2D Sonic Anemometers.

a) Imaginary line showing which spar is the "North" or reference spar.
b) "North" (Reference) Spar.
c) Red Alignment Dot (see **Figure 3**).

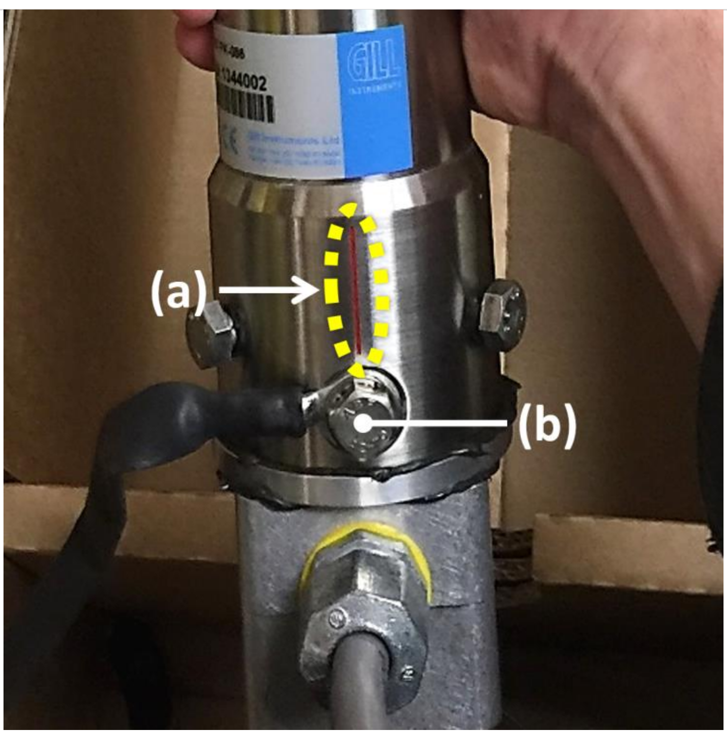


Figure 5. Close-up view of the Red Alignment Line and M8 Grounding Bolt on Extreme-Heated 2D Sonic Anemometers.

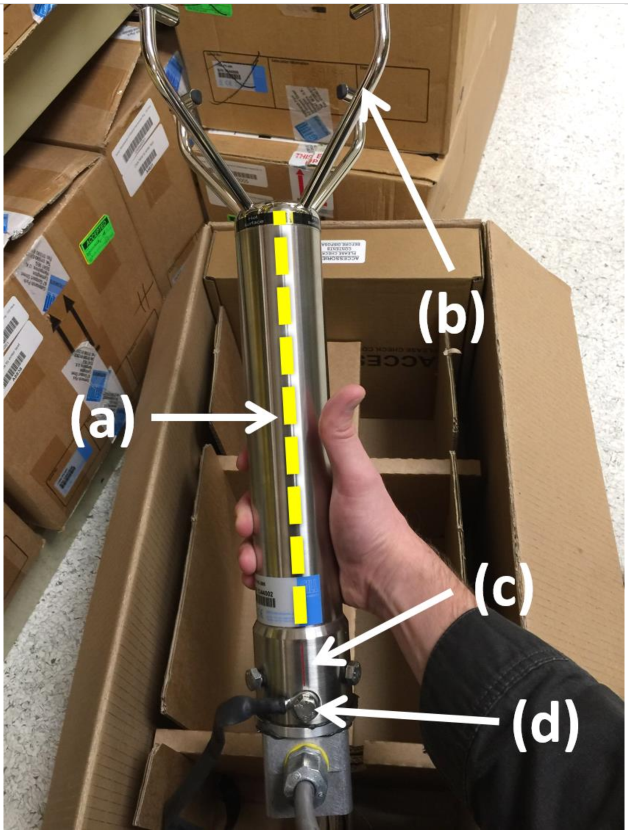


Figure 6. Identifying the "North" or Reference spar on Extreme-Heated 2D Sonic Anemometers.

The "North" or Reference spar is 45°offset from the (c) Red Alignment Line.

a) Imaginary line showing which spar will be designated the "North" or Reference spar.
b) "North" (Reference) Spar.
c) Red Alignment Line (see **Figure 5**).
d) M8 Grounding Bold (see also **Figure 5**).

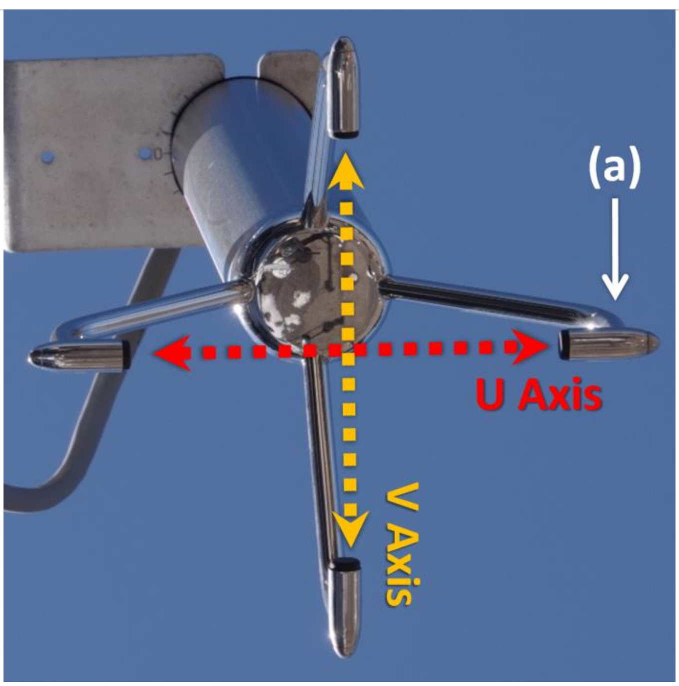


Figure 7. 2D Sonic Anemometer Axis

a) "North" or Reference spar.

Figure 8. TIS Tower mounted 2D Sonic Anemometer indicating the position of the Red Alignment Dot (arrow).

NEON location: D08 LENO

NOTE: At TIS Tower sites, 2D Sonic Anemometer is aligned with the Red Alignment Dot/Line facing away from the tower[2,3]*. At AIS Met Station sites, the 2D Anemometer is aligned with the Red Alignment Dot/Line facing away from the center mast.*

[2] NEON Science Requirement: NEON.TIS.5.2439 – The north transducer on heated and non-heated 2D sonic anemometers shall be oriented 180deg away from the reference point on the mounting plate.

[3] NEON Science Requirement: NEON.TIS.5.2440 – The grounding point and reference line on extreme-heated 2D sonic anemometers shall be oriented 180deg away from the reference point on the mounting plate.

Figure 9. TIS Tower mounted 2D Sonic Anemometer with associated Junction Box on ML1.

NEON location: D14 SOAP

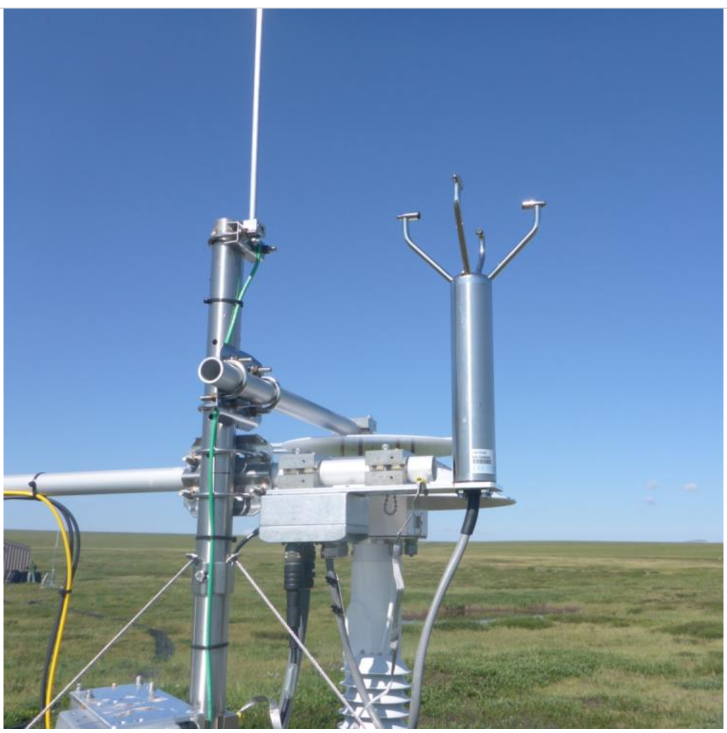


Figure 10. AIS Met Station mounted 2D Sonic Anemometer.

NEON location: D18 0KSR

Figure 11. The 2D Sonic Anemometer mounted with other instruments on a TIS Tower mid-level boom.

Site Location: NEON HQ

Figure 12. The 2D Sonic Anemometer shield mounted along with other instruments on TIS Tower Measurement Level (ML) 1.

Site Location: D14 SRER

Figure 13. Close-up picture of an AIS Met Station mounted 2D Sonic Anemometer.

Site Location: D02 POSE

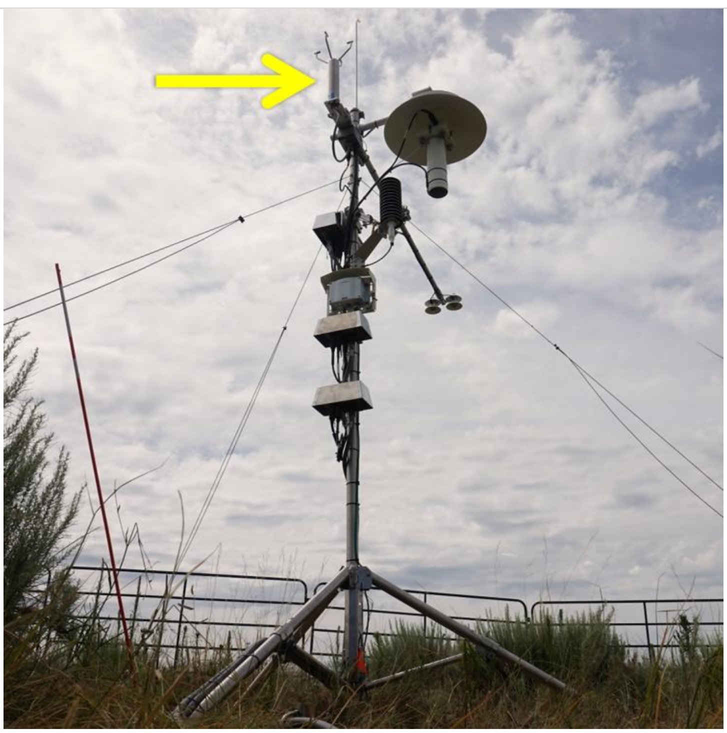


Figure 14. AIS Met Station Mounted 2D Sonic Anemometer.

NEON location: D10 ARIK

4.3 Sensor Specific Handling Precautions

The 2D Sonic Anemometer is a delicate sensor, and when not in use it should be kept inside its original packaging during storage or transport. The spacing and position of the transducers are absolutely critical and must be maintained for accurate wind velocity measurements.

Do **NOT** bump or knock the spars or transducers, or handle or carry the 2D Sonic Anemometer by the spars. Only handle the 2D Sonic Anemometer by the cylindrical body.

Do **NOT** remove the black "rubber" transducer caps

4.4 Operation

The 2D Anemometer measures wind speed and direction (wind velocity) by sending rapidly alternating ultrasonic pulses between each pair of transducers. The transit time of each ultrasonic pulse is measured and the difference calculated between each pair of transducers (see xxx) . Since the distance between each transducer pair is precisely known, the time of flight differences between each transducer pair can be used to calculate the wind speed (and speed of sound) along each axis. By combining the two horizontal axis measurements, the resultant wind speed and direction is calculated.

Example: During no-wind conditions, the transit time between each opposing transducer pair is the same. When wind is directly blowing over one transducer (e.g. Transducer A) to the other opposing transducer (e.g. Transducer B), the time of the ultrasonic pulse to travel from Transducer A to B (i.e. T_1) will be faster than from Transducer B to A (i.e. T_2). Wind speed and ultimately direction are calculated from the differences in the transit times between each transducer pair.

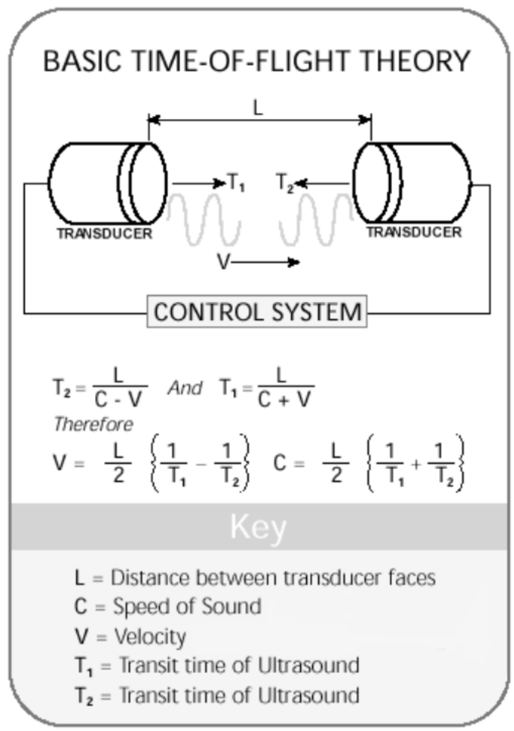


Figure 15. Basic Time-of-Flight Theory Diagram.

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. Monitor the 2D Sonic Anemometer Data Streams
2. Inspect Physical Condition of 2D Sonic Anemometer
3. Inspect and Remove Debris from Spars/Tranducers
4. Inspect the Transducers
5. Clean the Sensor Body, Spars, and Transducers
6. Level the Sensor (Boom)
7. Verify Proper Installation (Annually at Sensor Refresh)
8. Inspect cables and connectors.
9. Inspect mounting hardware.

5.2 Preventive Maintenance Schedule

Table 1. Preventive Maintenance Frequency and Schedule.

Maintenance		Bi-weekly	Quarterly	Annual	As Needed	Type
2D Sonic Anemometer						
	Remote Monitoring	X			X	P
	Visual Inspection of Sensor	X			X	P
	Clear Transducer Sonic Path				X	P/R
	Sensor Body Cleaning		*X*		X	P/R
	Sensor Leveling	*X*			X	P
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.

Item No.	Description	Quantity
Tools		
1	Hex or Allen Key Set (Imperial and Metric)	1
2	Soft-Bristle Brushes (Various Sizes)	A/R
Consumable items		
1	Formula 409, Multi-surface Cleaner (32 oz. spray bottle)	A/R
2	Distilled or Deionized (DI) Water (Squirt/Spray Bottle)	A/R
3	95% Ethanol (Squirt/Spray Bottle)	A/R
4	0.1M Acetic Acid	A/R
5	Can of Compressed Air (10 oz.)	1
6	Cotton Swabs (Short- and Long-Stem)	A/R
7	Lint-free Cloths or Microfiber Towels	A/R
8	Toothpicks	A/R
9	Powder-free Nitrile Gloves	A/R
10	Trash bag(s)	A/R
11	Small Plastic Bags	A/R
12	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)
Resources		
1	Technician	2

5.4 Subsystem Location and Access

The 2D Sonic Anemometers are located on TIS Towers and AIS Met Stations.

- **TIS Towers:** At the end of the booms at the various Measurement Levels (see for e.g. **Figure 11**).
- **AIS Met Station:** At the end of a small boom mounted to the central mast at approximately, 3m above the ground[4] (see for e.g. **Figure 14**).

5.5 Maintenance Procedure

The 2D Sonic Anemometer has no moving parts or user-serviceable parts that require routine maintenance, but routine inspections and cleaning is still required to maintain the accuracy of the sensor measurements.

5.5.1 Monitor the 2D Sonic Anemometer Data Streams

[4] NEON Science Requirement: NEON.AIS.4.1337 – Aquatic land-based meteorological station wind speed and wind direction measurements shall be taken at a height of 3 meters +/- 0.15 meters measured from the ground where ground level is measured directly below the station mast.

Monitor the data stream of each 2D Sonic Anemometer before visiting each site for maintenance. Doing so may provide information on potential problems and/or issues with the sensor.

Table 3. Status codes sent as part of the wind measurements.

Code	Status	Condition
00	OK	Sufficient samples in average period
60	OK and heating enabled	Sufficient samples in average period
A	OK	NMEA data Acceptable
01	Axis 1 failed	Insufficient samples in average period on U axis
02	Axis 2 failed	Insufficient samples in average period on V axis
04	Axis 1 and 2 failed	Insufficient samples in average period on both axes
08	NVM error	NVM checksum failed, data could be uncalibrated
09	ROM error	ROM checksum failed, data could be uncalibrated
10	System gain at max.	Inaccurate data likely
50	Marginal system gain	Data valid, but marginal operation
51	Measurement average building.	Data valid, but wars that average period not reached when averaging used (non-heat enabled unis only)
62	Heating current ripped or electronic failure	Valid data still output
63	Heater thermistor open circuit	Valid data still output
65	Heating element open circuit	Valid data still output, heater element of heater PSU has dropped out/failed
V	NMEA data Void	Invalid data output

5.5.2 Inspect Physical Condition of 2D Sonic Anemometer

The 2D Sonic Anemometer on either the TIS Tower or the AIS Met Station may be physically damaged while at the site. It may include (but is not limited to) tree limbs, animals, being struck by hard objects, vandalism, as well as mishandling during transport or shipping.

The physical condition of the 2D Sonic Anemometer, particularly the spars and the transducers, is critical for proper and accurate wind measurements. The physical condition of the mounts holding the 2D Sonic Anemometer is also important, as proper positioning and alignment are required for accurate wind measurements. A visual inspection should be done at each maintenance bout to ensure there are no obvious physical damages to the sensors or mounting assemblies.

Report any physical damages via the NEON Project's Issue Management and Reporting System (i.e., JIRA or ServiceNow).

Step 1. Visually inspect each 2D Sonic Anemometer for any obvious misalignments or sensor mount damages.

NOTE: Conditions that could bend the sensor mount may also have damaged the spars and transducers.

NEON Location: D07 GRSM[5]

Step 2. Do a closer inspection of each 2D Sonic Anemometer mount for more subtle misalignments, bent mounts, or damage.

NEON Location: D02 SERC[6]

[5] Photo from JIRA: NEON-6711
[6] Photo from JIRA: NEON-11656

Step 3. Visually inspect each 2D Sonic Anemometer for any obvious interactions with nature (e.g. trees, vegetation).

NEON Location: D07 MLBS[7]

Step 4. Visually inspect each 2D Sonic Anemometer for any potential interactions with nature (i.e. growing vegetation) that could directly interfere with the sonic paths. This may occur more often during the ecosystem's growing season.

Any misalignment of these spars should be reported, and a replacement obtained.

NEON Location: D05 STEI[8]

[7] Photo from JIRA: NEON-13187
[8] Photo from JIRA: NEON-8499

Step 5. Visually inspect each 2D Sonic Anemometer for any obvious damages to the spars (i.e. obvious misalignments).

Any misalignment of these spars should be reported, and a replacement obtained.

NEON Location: D02 POSE[9]

Step 6. Do a closer inspection of each spar of each 2D Sonic Anemometer for any more subtle misalignments of the spars.

Any misalignment of these spars should be reported, and a replacement obtained.

NEON Location: D02 SERC[10]

5.5.3 Inspect and Remove Debris or Vegetation from Spars/Tranducers

[9] Photo from JIRA: NEON-719
[10] Photo from JIRA: NEON-5814

Step 1. Visually inspect the spars and transducers and remove any debris blocking the sonic paths.

Step 2. Visually inspect for any vegetation that could be blocking the sonic paths.

Reference AD [15] for guidance on keeping vegetation clear of the 2D Sonic Anemometer sonic volume.

NEON Location: D19 HEAL[11]

5.5.4 Inspect the Transducers

Damages to the specialized black acoustic rubber caps covering the transducers can cause erroneous wind measurements. Routine visual inspection will ensure that damages to the transducer caps do not affect the wind measurements. Damages to the transducer caps can occur due to interactions with tree branches, animals (particularly for ML1), and mishandling.

The transducers are non-serviceable and any damage will result in the entire sensor needing to be replaced.

[11] Photo from JIRA NEON-9399

Do NOT remove the black acoustic rubber transducer caps.

Step 1. Visually inspect each face of the transducers for any damage to the black transducer caps.

Report any physical damages via the NEON Project's Issue Management and Reporting System (i.e., JIRA or ServiceNow).

If there is any accumulated dirt, follow the cleaning procedure in Section 5.5.5.

5.5.5 Clean the Sensor Body, Spars, and Transducers

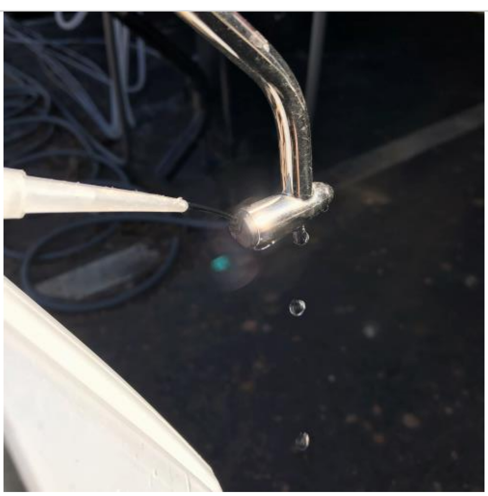
The stainless portions of the 2D Sonic Anemometer are extremely durable and resistant to the elements and minimal preventive maintenance is required, but routine cleaning is recommended to maintain the sensor over the long term. The transducer caps are sensitive and can be damaged easily; care should be taken when working around the transducer caps and only soft brushes should be used to clean them. Be careful not to hit the spars with any hard objects as this could cause the spars to misalign.

Dirt build up on the stainless steel surfaces are cleaned with a lint-free cloth or microfiber towel moistened with a multi-surface cleaner. The transducer caps should be cleaned with a soft-bristle brush and distilled or DI water. Solvents should not be used.

	**Step 1.** Moisten a lint-free cloth or microfiber towel with a multi-surface cleaner.
	**Step 2.** Wipe down and clean the cylindrical sensor body.
	**Step 3.** Gently wipe down and clean the stainless steel portions of the spars and transducers. Avoid applying pressure to the spars that may cause a misalignment.

Step 4. If there is accumulated dirt on the transducer cap, gently spray some distilled or DI water on to the transducer cap and let it drain off.

Step 5. If necessary, use a soft bristle brush and gently brush away any remaining dirt.



Step 6. Rinse once more with distilled or DI water and allow to air dry

5.5.6 Level the Sensor (Boom)

The 2D Sonic Anemometer should be horizontally level[12]. Since the 2D Sonic Anemometer has fixed mounts, leveling of the sensor requires leveling of the boom with the assistance of the associated inclinometer.

5.5.7 Specific Conditions Cleaning Procedures (SCCP)

5.5.7.1 SCCP – Winterization

The 2D Sonic Anemometers will operate throughout the winter and only the sensors on ML1 will require removal. Reference AD [15] for sites, removal dates, and sensors.

Heated and Extreme-Heated sites (see Appendix 8.1 and 8.2) have automatically activated internal heaters and should allow normal operation throughout the winter.

5.5.7.2 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, or AIS Met Stations, remove the 2D Sonic Anemometer. Reference AD [15] for sites, removal dates, and sensors.

5.5.7.3 SCCP – Rain

The 2D Sonic Anemometer will operate normally under this condition.

1. If it is actively raining, perform visual inspections (see Sections 5.5.2, 5.5.3, and 5.5.45.5.1).

5.5.7.4 SCCP – Dew, Fog, Mist

The 2D Sonic Anemometer will operate normally under this condition.

1. Perform routine preventive maintenance (see Section 5.5).

5.5.7.5 SCCP - Frost

The 2D Sonic Anemometer will operate normally under this condition if the transducers or sonic paths or transducer caps are not blocked by frost.

The unit must be allowed to defrost naturally after being exposed to snow or icy conditions, do NOT attempt to remove ice or snow with a tool[13].

---

[12] NEON Science Requirement: NEON.TIS.4.1976 – 2D sonic anemometers shall be mounted to remain level within ± 1° in the horizontal axes measured at the transducer configuration.

[13] Direct reference from ER [02]

5.5.7.6 SCCP – Snow

The 2D Sonic Anemometer will operate normally under this condition. Heated and Extreme-Heated sites (see Appendix 8.1 and 8.2) have automatically activated internal heaters and should allow normal operation throughout the winter.

The unit must be allowed to defrost naturally after being exposed to snow or icy conditions, do NOT attempt to remove ice or snow with a tool[14].

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 within 10 cm of the sonic paths.
2. Follow procedure outlined in Section 5.5.7.5, SCCP - Frost.

5.5.7.7 SCCP – Ice

The 2D Sonic Anemometer will operate normally under this condition if the transducers or sonic paths or transducer caps are not blocked by frost.

1. Follow procedure outlined in Section 5.5.7.5, SCCP - Frost.

The unit must be allowed to defrost naturally after being exposed to snow or icy conditions, do NOT attempt to remove ice or snow with a tool[15].

5.5.7.8 SCCP - Salt Deposits

The 2D Sonic Anemometer will operate normally under this condition.

Salt deposits can accumulate on the sensor body, spars, transducers, and transducer caps. These deposits can be seen as a thin white film or white spots or accumulations. The cleaning procedure in Section 5.5.5 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 5.5.5.
2. If the salt deposits remain, or are caked-on, use of 0.1 M acetic acid may be required.

---

[14] Direct reference from

[15] Direct reference from

a. Place a catch basin, or towel underneath the 2D Sonic Anemometer 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. For stainless steel portions of the 2D Sonic Anemometer - Gentle scrubbing motion with a lint-free cloth, microfiber towel, or cotton swab may be used to help facilitate salt deposit removal.

ii. For the transducer caps – Use a soft-bristle brush to gently brush and facilitate salt deposit removal.

c. Repeat as necessary until salt deposits are removed.

3. Follow the cleaning procedure in Section 5.5.5.

5.5.7.9 SCCP - Insect Nests

The 2D Sonic Anemometer will operate normally under this condition. However, spiders or other insects may form nests on, in, or around spars and tranducers of the sensor, potentially affecting operation.

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 2D Sonic Anemometer.

2. Follow the cleaning procedure in Section 5.5.5.

5.5.7.10 SCCP - Bird and Other Droppings

The 2D Sonic Anemometer 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,

   - Stainless steel portions of the 2D Sonic Anemometer – Use a cotton swab or microfiber towel to aid in loosening and removing the debris. Use only gentle pressure and continue spraying with water.

- Transducer caps – Use a soft-bristle brush 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 5.5.5.

5.5.7.11 SCCP – Wildlife

The 2D Sonic Anemometer will operate normally under this condition. However, the ends of the booms where the sensor is located may attract wildlife, particularly birds and lizards, and sometimes even snakes.

1. Use common sense to determine whether it would be safe, easy, and/or appropriate to try to ward off any wildlife on the booms or 2D Sonic Anemometer.
2. Consult with local agencies and authorities regarding nesting birds.

5.5.8 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.

5.5.9 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.
        ii. Apply cold-galvanizing compound to the cleaned areas.
    b. If heavy corrosion is present,
        i. Clean with a small wire brush
        ii. Remove the corroded nut or bolt.

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

iv. Apply cold galvanizing compound to the cleaned areas of fasteners or structure that is not being replaced.

6 REMOVAL AND REPLACEMENT (SUBSYSTEM ONLY)

6.1 Equipment

Table 4 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 4. 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 Aquatics Portal)	1
GENERIC		Ethernet Cable (for AIS only to connect to Aquatics Portal)	1
GENERIC		3/16" & 5/32" Allen Wrenches (to remove Grapes Mounts and Sensors)	1
GENERIC		Digital Level (to level sensor post-installation)	1
GENERIC		Hex Wrench Set (to remove/reinstall sensors)	1
GENERIC		11-in-1 (to remove/reinstall sensors)	1
GENERIC		Phillips-Head Screwdriver (to access Power Box Breakers)	1
GENERIC		Flathead Screwdriver (to access Power Box Breakers)	1
Safety		Site-Specific PPE for TIS and AIS sites	A/R
Safety		LOTO Equipment (required over 50 Volts)	A/R
GENERIC		Flush cutters/Scissors (to cut zip ties/remove zip ties)	1
		Consumable Items	
	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
3M	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) *Temp 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	
NEON Data Monitor, Inclinometer & SSH/TEP Software Resources: N:\Common\SYS\LabVIEW Programs			
TEP Programs - PuTTy: http://www.putty.org/ *or MobaXterm:* https://mobaxterm.mobatek.net/			

P/N	MX/NEON	Description	Quantity
The SAS Report: http://sas.ci.neoninternal.org/			
Site Configuration Static IP Device List: N:\Common\SYS\Site Network Configurations			
FTDI Drivers: http://www.ftdichip.com/FTDrivers.htm *(use with Inclinometer if hardware requires this driver to function)*			
NEON Document Warehouse: https://neoninc.sharepoint.com/sites/warehouse/Documents/Forms/AllItems.aspx			
NEON Drawing Warehouse: https://neoninc.sharepoint.com/sites/warehouse/Drawings/Forms/AllItems.aspx			

A/R = As Required – Amount varies per site. Ordering amount is at the discretion of the Domain or FOPS Leadership.

Note: When working on power systems, use tools with insulated handles. Always shut down the power prior to removing or replacing any components.

Note: Maintain legible labels on sensor and subsystem cables.

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 5** for sensor refresh requirements for the sensor and subsystem infrastructure for the 2D Wind Sensors at both TIS and AIS sites. **Table 9** in *Section 6.6 Cleaning & Packaging of Returned Sensor* compliments the information in **Table 5**.

Table 5. 2D Wind Sensor Refresh Requirements.

	LOCATION		TIMEFRAME			
INSTRUMENT	***CVAL***	***FIELD***	***BIWEEKLY***	***ANNUAL***	***NA***	**COMMENTS**
Concord (24V) Grape	**X**			**X**		Employ ESD Protocols. Cap all ports.
2D Wind Sensor	**X**			**X**		Return to CVAL per Domain/Site Sensor Refresh Schedule. Employ ESD Protocols; cap both connections on sensor junction box. See Figure 30 and Figure 31.

<u>Note for AIS:</u> Maintain the AIS sensor sets asset tags in the AIS Buoy battery box or closest onshore AIS device post (e.g., the Aquatics Portal or AIS Device Post Combo Box). Use option one or option two, do not split up tags between the two options. ***Do not send a sensor to CVAL without its asset tag.***

6.3 TIS 2D Wind Sensor Removal and Replacement Procedures

6.3.1 Tower Profile Measurement Level

The TIS profile MLs booms (and ML1 arbors for specific sites) contains a 2D Wind Sensor on the Temperature Split Profile Boom (**Figure 16**) or Combined Temp/Rad Profile Boom. Reference **Table 4** for equipment and materials.

Figure 16. 2D Wind Profile Measurement Level (TIS Tower) Overview (D07 MLBS).

Table 6. Tower Profile ML 2D Wind Sensor Removal and Replacement Procedure | TIS Tower

STEP 1 | Power down the profile ML or for short towers, the combined ML. *Reference Appendix 8.3 – How to Power Down a Tower Measurement Level (ML).* Disconnect the communication box heater (12-3) ports before servicing or replacing sensors for sensor refresh.	
 **Figure 17.** ML1 Profile Temperature Sensor Boom (D07 MLBS).	**STEP 2** | Wear the appropriate PPE to access the sensors on the ML. If Technicians are unable to access ML1 arbor/boom (**Figure 17** displays a ML1 boom) or ML2 temperature sensors from the ground or with a ladder, climb the tower and bring in the profile boom arm via its winch to reach the 2D Wind sensor for removal and replacement (Sensor Refresh). ***Disconnect the 240V AC heater power cables from the Comm box before retracting the boom.***

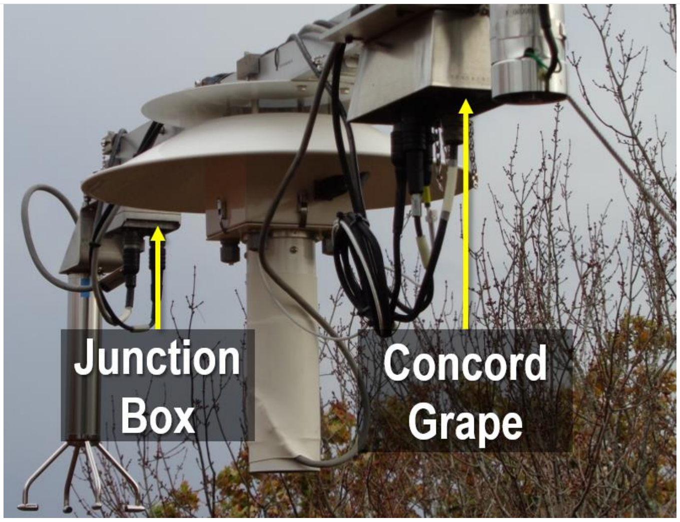


Figure 18. Junction Box & Concord Grape on Boom (D07 MLBS).

STEP 3 | The 2D wind sensor shares a Concord Grape (24V) with the AATs sensor (**Figure 18**). Disconnect Eth-to-Comm (RJF) and sensor connections from the Concord Grape (24V) per AD [09].

Cut zip ties to undress cables, as appropriate.

STEP 4 | Disconnect the connections on the 2D Wind Junction Box (**Figure 18**). These are the connections to the Concord Grape and the heater, not the connection to the sensor. (Warmer sites do not have a heater connection in use.) Cut zip ties to undress cables, as appropriate.

Figure 19. Remove 2D Wind Sensor (NEON HQ).

STEP 5 | Remove the 2D Wind sensor with a 5/32 allen wrench (**Figure 19** and **Figure 20**). The mount may remain on the boom with the sensor hardware.

Figure 20. 5/32 Allen Wrench.

Figure 21. Remove Junction Box from Boom (NEON HQ).

STEP 6 | Remove 2D Wind Junction Box with a 5/32 Hex Wrench (**Figure 21**).

Note: Figure 19 and Figure 21 are on a Mobile Deployment Platform (MDP) Rohn Tower mount, which is similar to the mount at TIS sites for the 2D Wind. The nuts/screws and their placement are the same. The MDP is part of the NEON project's Assignable Assets program, which may involve FOPs personnel depending on location and private investigator requirements per deployment.

STEP 7 | Use the reverse order to reinstall the "refreshed" sensor. *In addition, reference AD [14] for the NEON Installation Procedure: 2D Wind.*

PRO TIP: Apply anti-seize compound in Table 4 to threads of all mounting fasteners to ensure an easier future removal/replacement.

Figure 22. Orient Red Dot or Red Line Away from Tower (D06 KING).

STEP 7.1 | Orient the 2D Wind sensor where the red dot (or red line) on the sensor body faces away from the tower (**Figure 22**).

Reference AD [16] for the 2D Wind Formal Verification Procedure to verify orientation and position.

STEP 8 | Level the 2D Wind sensor relative to the boom post-sensor reinstallation. Verify that the 2D Wind sensor is level to ±1^{o} in both directions. Use a digital level on the sensor body. *Reference AD [16] for the 2D Wind Formal Verification Procedure.*

STEP 9 | Level the boom using the Inclinometer.

Note: Leveling the boom post-installation of the 2D Wind sensor is necessary to maintain data quality. A non-level boom arm compromises data quality.

STEP 10 | Reconnect the sensor and Ethernet Comm box connection on the Junction Box (reference Figure 9).

STEP 11 | Connect Eth-to-Comm (RJF) and sensor connections from Grape per AD [09]. Redress cables with zip ties, as appropriate. Create slack in the cables to make drip-loops at the sensor and the GRAPE, with no stress on any connection. Adjust slack to make all cables agree. Do not "reverse loops" or "change direction" if possible. Never twist cables. Remove Grape for Sensor Refresh; *reference Section 6.5 Grape Removal and Replacement Procedure on page 42.* Reconnect the ATS 240V heater power cable to the Comm box after extending the boom.

STEP 12 | Restore power to the sensor/ML.

STEP 13 | Verify the sensors show up in the SAS Report the next day.

6.4 AIS 2D Wind Sensor Removal and Replacement Procedures

6.4.1 Aquatic Met Station

The Aquatic Met Station contains the 2D Wind sensor on the short end of the Radiation Boom arm from the Met Station mast. Reference **Table 4** for equipment and materials.

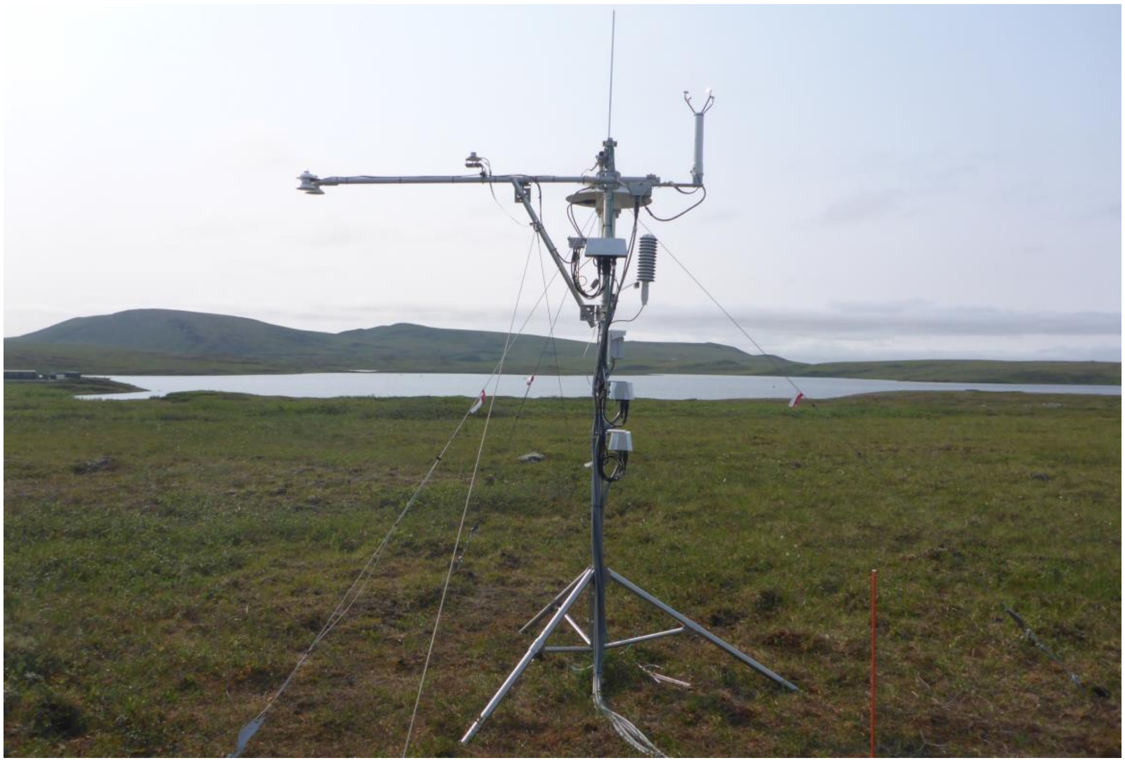


Figure 23. AIS Aquatic Met Station Radiation Boom Arm - Short End with the 2D Sonic Anemometer (D18 TOOK).

Table 7. 2D Sonic Anemometer Removal and Replacement Procedure | Aquatic Met Station.

STEP 1 | Power down the Aquatic Met Station. *Reference Appendix 8.4 – How to Power Down an AIS Device Post*: *Aquatic Met Station.* Disconnect the communication box heater (12-3) ports before servicing or replacing sensors for sensor refresh.	

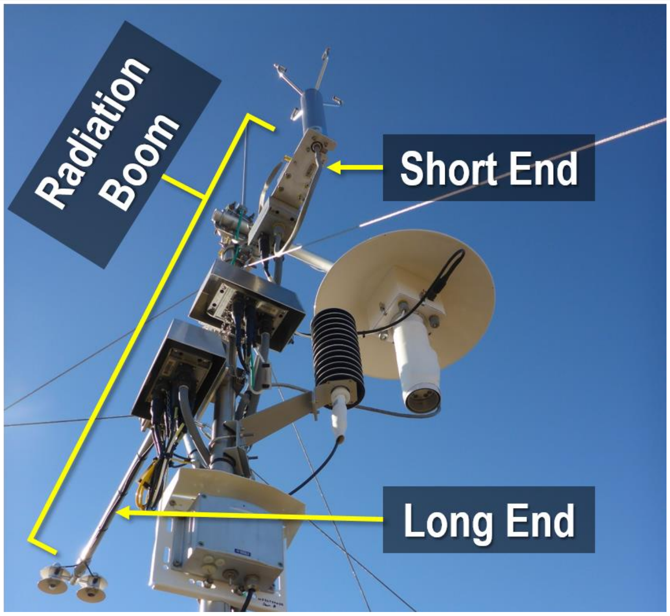


Figure 24. Aquatic Met Station Radiation Boom (D09 PRPO).

STEP 2 | Access the Radiation Boom Arm (**Figure 24**) via a ladder. Consult with the NEON Safety Office to determine the safest method to conduct Sensor Refresh procedures herein.

PRO TIP: In the event the Radiation Boom requires removal, use a bump stop on the mast to aid reinstallation (see AIS Buoy procedure for examples with its Radiation Boom).

Figure 25. 2D Wind Concord Grape (24V) (D03 FLNT).

STEP 3 | The 2D Wind sensor shares a Concord Grape (24V) with the AAT Fan and PRT (**Figure 25**). Disconnect Eth-to-Comm (RJF) and sensor connections from the Concord Graper (12V) per AD [10].

Cut zip ties to undress cables, as appropriate.

Figure 26. Disconnect Grape and Heater Cables (D18 OKSR).

STEP 4 | Disconnect the Comm box connection on the 2D Wind Junction Box (**Figure 26**).

Note: Colder sites tend to have two port connections, in addition to the sensor connection, on the 2D Wind Junction Box. One port for the Concord Grape and one for the heater. The heater port connects to the Comm Box on the AIS Device Post. Sites in warmer climates have only one port available, which connects to the Concord Grape (e.g., D03 FLNT in Figure 27 below).

Figure 27. Remove 2D Wind from Aquatic Met Station (D03 FLNT).

STEP 5 | Remove the 2D Wind sensor with a 5/32 hex wrench (**Figure 27**). The mount with the hardware may remain on the Aquatic Met Station for Sensor Refresh.

Figure 28. Remove Junction Box (D03 FLNT).

STEP 6 | Remove the 2D Wind Junction Box (**Figure 28**) with a 5/32 hex wrench. The mount with the hardware may remain on the Aquatic Met Station for Sensor Refresh.

STEP 7 | Use the reverse order to reinstall the "refreshed" sensor. *In addition, reference AD [14] for the NEON Installation Procedure: 2D Wind.*

*PRO TIP: Apply anti-seize compound in **Table 4** to threads of all mounting fasteners to ensure an easier future removal/replacement.*

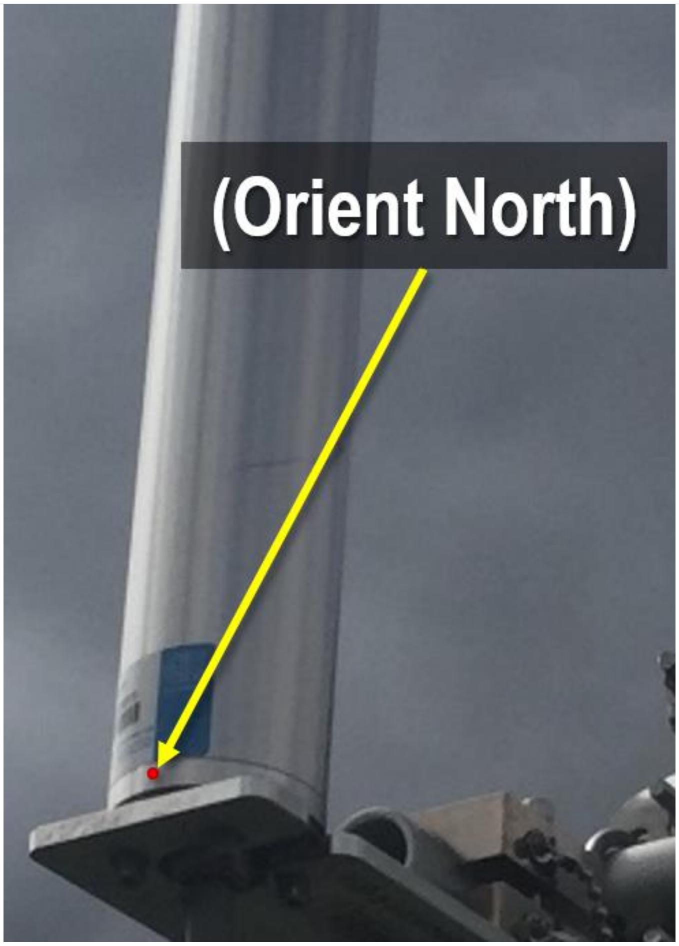


Figure 29. Orient Red Dot or Line North (D09 PRPO).

STEP 7.1 | Orient the 2D Wind sensor red dot/line North. This is where the red dot (or red line) on the sensor body faces away from the Mast (**Figure 29**).

PRO TIP: The 6ft. Radiation Boom points to the south, so face the 2D Wind away from the Radiation Sensors.

Reference AD [16] for the 2D Wind Formal Verification Procedure to verify orientation and position.

STEP 8 | Level the 2D Wind sensor relative to the Radiation Boom post-sensor reinstallation. Verify that the 2D Wind sensor is level to ±1° in both directions. Use a digital level on the sensor body. *Reference AD [16] for the 2D Wind Formal Verification Procedure.*

STEP 9 | Reconnect cable (or cables for heated sites) to the 2D Wind Junction Box (reference **Figure 26**). The heater cable connects to the 3-pin connector per AD [14].

STEP 10 | Connect the sensor and Eth-to-Comm (RJF) connections to the Grape per AD [10]. Redress zip ties, as appropriate. Create slack in the cables to make drip-loops at the sensor and the Grape, with no stress on any connection. Adjust slack to make all cables agree. Do not "reverse loops" or "change direction" if possible. Never twist cables**.** Remove Grape for Sensor Refresh; *reference Section 6.5 Grape Removal and Replacement Procedure.*

STEP 11 | Restore power to the Aquatic Met Station.

STEP 12 | Verify sensors show up in the SAS Report the next day.

6.5 Grape Removal and 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 Location Controller (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 or AIS Device Post.
   a. *Reference Appendix 8.3 – How to Power Down a Tower Measurement Level (ML)*
   b. *Reference Appendix 8.4 – How to Power Down an AIS Device Post*: *Aquatic Met Station*
   c. Disconnect the communication box heater (12-3) ports before servicing or replacing sensors for sensor swap. (Comm box is next to the power boxes on Tower MLs or opposite side of an AIS Device Post. Disregard this step for S-1/S-2 combo boxes; these assemblies do not use heater ports.)

Note: These heater ports are NOT interchangeable; FOPS must label each port to ensure they plug back into the correct port post-sensor swap.

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 the Grape Shield.
   a. Remove the four screws that affix the Grape to the Grape Shield using a hex wrench.
   b. If there is a need to remove the Grape Shield(s) from the Tower or Aquatic Met Station, remove the Grape Shield Unistrut or pipe mount/clamp using a 3/16" hex wrench. Otherwise, the hardware may remain on the tower/Aquatic Met Station.

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 a new Grape into a 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 PoE (Power over Ethernet) 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 8**.

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

Table 8. Grape Verification TEP Commands (e.g., 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.

6.6 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 are listed in **Table 5**. Reference **Table 4** for the equipment, tools and consumables necessary for conducting the NEON HQ, CVAL Sensor Refresh procedures. Asset tags must accompany each sensor returning to CVAL and reflect CFGLOC changes in NEON's project Asset Management and Logistic Tracking System. Use **Table 9** to reference sensor packing requirements.

Table 9. 2D Wind Sensor Packaging Requirements.

STEP 1 | Conduct decontamination on each sensor in accordance with AD [05].

STEP 2 | Package dry sensors post-decontamination. Ship sensors in containers (e.g., pelican cases or similar) with pertinent protective hardware (e.g., caps/ESD bags/bubble wrap). Secure any moving parts and loose cables that may incur damage or damage contents. If Domains are missing shipping containers or protective hardware, submit an issue ticket to request additional supplies from CVAL (e.g., NEON-11712). Below is a visual summary for the 2D Wind sensor.

Figure 30. 2D Wind in Cardboard Packaging (CVAL).

2D Wind Sensor | **Figure 30**

Employ ESD Protocols. Cap Junction Box plugs and package to protect sensor and sensor transducers (sensor claws/fingers) during shipping/handling.

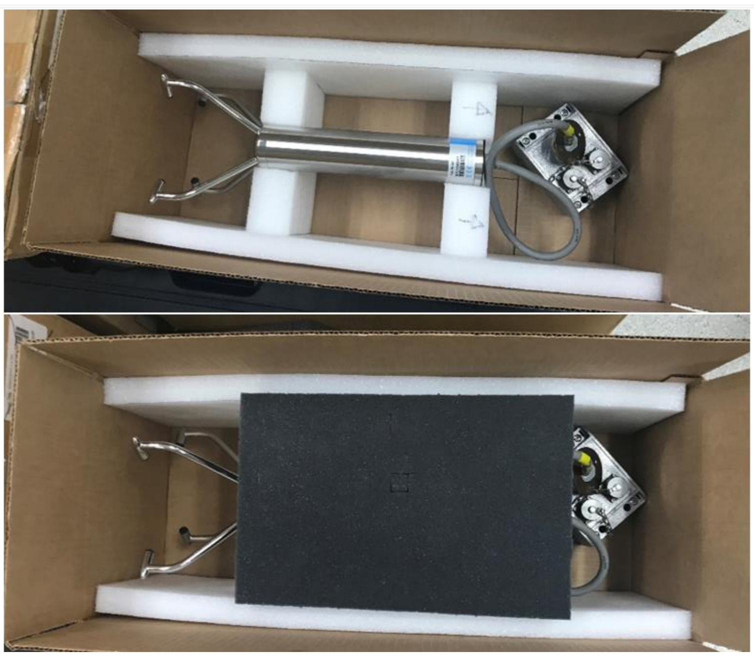


Figure 31. 2D Wind in Foam Packaging (CVAL).

2D Wind Sensor | **Figure 31**

Employ ESD Protocols. Cap Junction Box plugs and package to protect sensor and sensor transducers (sensor claws/fingers) during shipping/handling.

Note: If any of the 2D Wind Sensors are 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 the Grape in an ESD bag and shipping container. Follow packing requirements per **Table 9** for the 2D Wind sensor.
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 and Sensors 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

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

6.7 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.

6.7.1 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 2D Sonic Anemometer 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[16].

2. Ship all defective equipment/assets with a red “Rejected” tag. **Figure 32** displays the minimum information requirements for each tag.

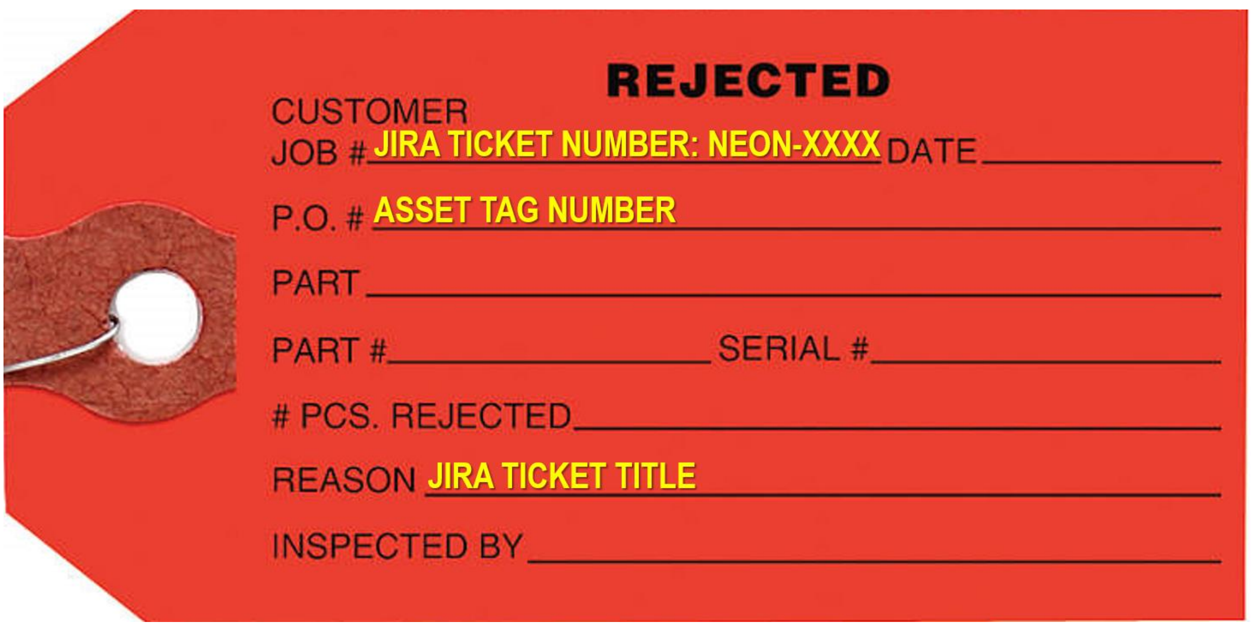


Figure 32. Red Rejected Tag for Defective Assets (MX104219).

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

8 APPENDIX

8.1 TIS Heated and Extreme-Heated Sites

Table 11. List of TIS Heated and Extreme-Heated Sites.

Domain	Site ID	Site Name	Core/Relocatable	Heated/Extreme
1	HARV	Harvard Forest	Core	Heated
1	BART	Bartlett Experimental Forest	Relocatable	Heated
2	SCBI	Smithsonian Conservation Biology Institute	Core	Heated
2	SERC	Smithsonian Environmental Research Center	Relocatable	Heated
2	BLAN	Blandy Experimental Farm	Relocatable	Heated
5	UNDE	UNDERC	Core	Heated
5	STEI	Steigerwaldt Land Services	Relocatable	Heated
5	TREE	Treehaven	Relocatable	Heated
6	KONZ	Konza Prairie Biological Station	Core	Heated
6	UKFS	The University of Kansas Field Station	Relocatable	Heated
6	KONA	Konza Prairie Biological Station	Relocatable	Heated
7	ORNL	Oak Ridge	Core	Heated
7	MLBS	Mountain Lake Biological Station	Relocatable	Heated
7	GRSM	Great Smoky Mountains National Park, Twin Creeks	Relocatable	Heated
9	WOOD	Woodworth	Core	Heated
9	DCFS	Dakota Coteau Field School	Relocatable	Heated
9	NOGP	Northern Great Plains Research Laboratory	Relocatable	Heated
10	CPER	Central Plains Experimental Range	Core	Heated
10	STER	North Sterling, CO	Relocatable	Heated
10	RMNP	Rocky Mountain National Park, CASTNET	Relocatable	Heated
11	CLBJ	LBJ National Grassland	Core	Heated
11	OAES	Klemme Range Research Station	Relocatable	Heated
12	YELL	Yellowstone Northern Range (Frog Rock)	Core	Heated
13	NIWO	Niwot Ridge Mountain Research Station	Core	Extreme
13	MOAB	Moab	Relocatable	Heated
15	ONAQ	Onaqui-Ault	Core	Heated
16	WREF	Wind River Experimental Forest	Core	Heated
16	ABBY	Abby Road	Relocatable	Heated
17	SJER	San Joaquin	Core	Heated
17	SOAP	Soaproot Saddle	Relocatable	Heated
17	TEAK	Lower Teakettle	Relocatable	Heated
18	TOOL	Toolik Lake	Core	Extreme
18	BARR	Barrow Environmental Observatory	Relocatable	Extreme
19	BONA	Caribou Creek - Poker Flats Watershed	Core	Extreme
19	DEJU	Delta Junction	Relocatable	Extreme
19	HEAL	Healy (Eight Mile)	Relocatable	Extreme

8.2 AIS Heated and Extreme-Heated Sites

Table 12. List of AIS Heated and Extreme-Heated Sites.

Domain	Site ID	Site Name	Heated/Extreme
1	HOPB	Hop Brook	Heated
2	LEWI	Lewis Run	Heated
2	POSE	Posey Creek	Heated
5	CRAM	Crampton Lake	Heated
5	LIRO	Little Rock Lake	Heated
6	KING	Kings Creek	Heated
6	MCDI	McDiffett Creek	Heated
7	LECO	LeConte Creek	Heated
7	WALK	Walker Branch	Heated
9	PRLA	Prairie Lake	Heated
9	PRPO	Pairie Pothole	Heated
10	ARIK	Arikaree River	Heated
11	BLUE	Blue River	Heated
11	PRIN	Pringle Creek	Heated
12	BLDE	Blacktail Deer Creek	Heated
13	COMO	Como Creek	Heated
13	WLOU	West Saint Louis Creek	Heated
15	REDB	Red Butte Creek	Heated
16	MART	Martha Creek	Heated
16	MCRA	McRae Creek	Heated
17	BIGC	Upper Big Creek	Heated
17	TECR	Teakettle 2 Creek	Heated
18	OKSR	Oksrukuyik Creek	Heated
18	TOOK	Toolik Lake	Extreme
19	CARI	Caribou Creek	Extreme

8.3 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.

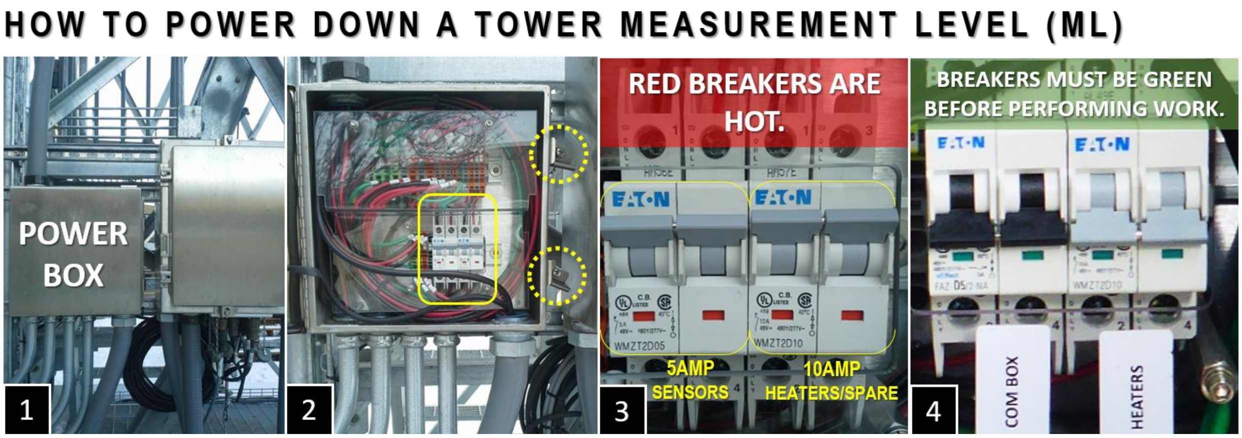


Figure 33. How to Power Down a Tower ML.

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 33**.

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 33** 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>**.**

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

5. **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 [09] to verify heater ports onsite where Comm Boxes are combined.* Heater ports are the 12-3 connectors on the Comm box.

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

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

8.4 How to Power Down an AIS Device Post: 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 AD [17] for additional information.*

1. Power down the site from the AIS Device Post power box via the breakers. Use **Figure 34** 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).

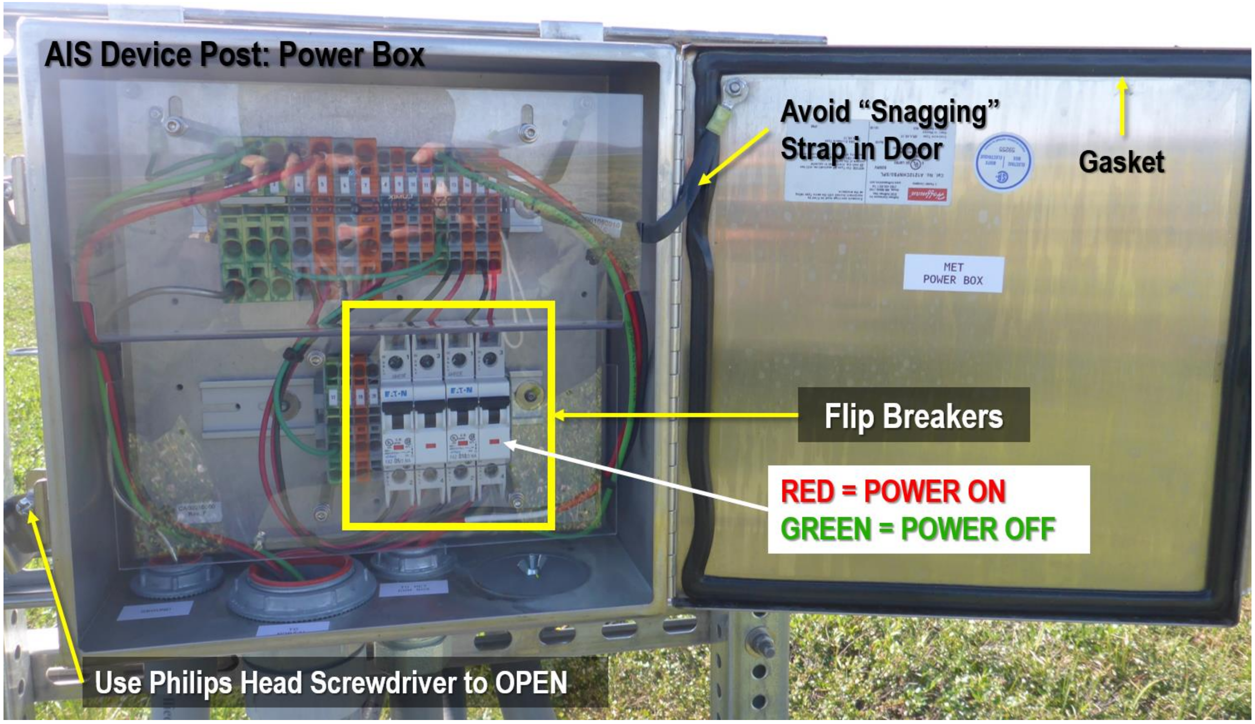


Figure 34. AIS Device Post: Power Box Components (Domain 18 OKSR AIS Aquatic Met Station).

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 Temperature Shield (ATS) and 2D Wind heaters. The 2D wind heater port is in front of the ATS heater port in **Figure 35** per AD [10]. (*PRO TIP: The ATS 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!

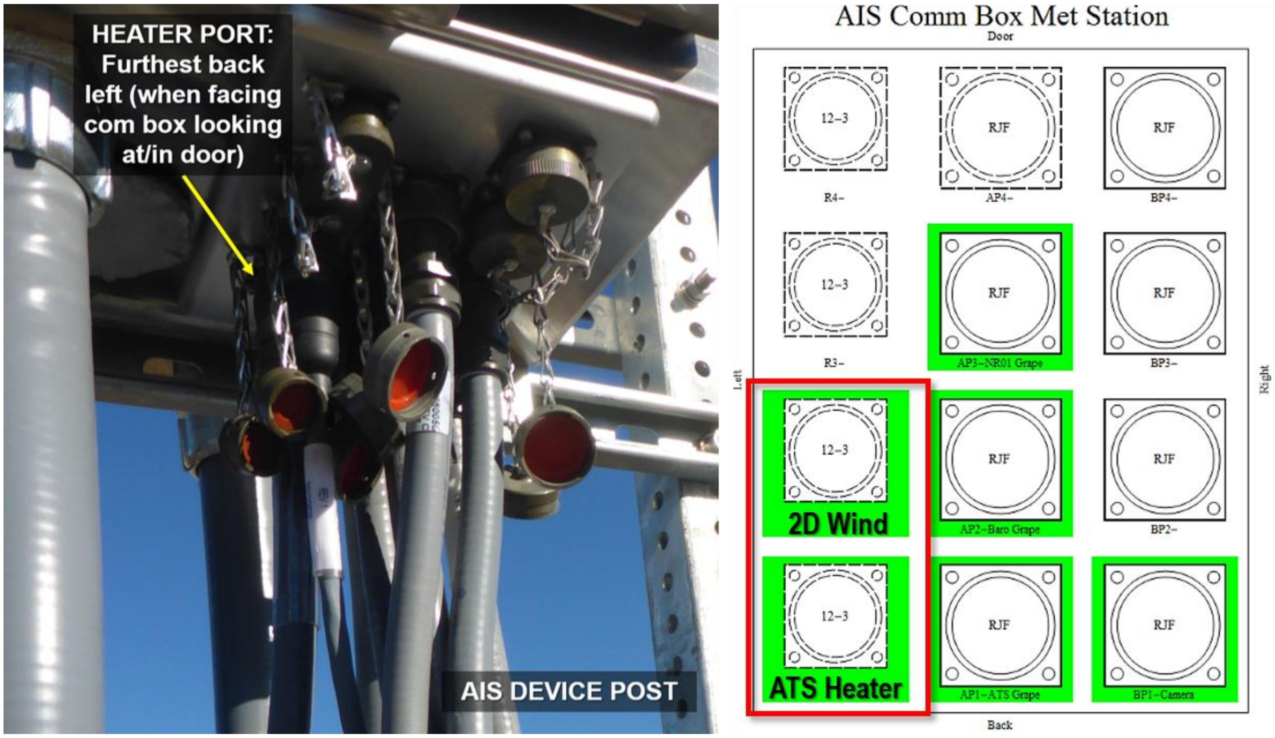


Figure 35. AIS Device Post: Comm Box Heater Ports for Aspirated Temperature Shield (ATS) and 2D Wind (Source: AD [10]).

*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 35***). 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 single 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].

9 SOURCES

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