NEON PREVENTIVE MAINTENANCE PROCEDURE:

AIS LAKE BUOY

PREPARED BY	ORGANIZATION	DATE
Geoff Simonds	SE	08/07/2017
Rachael Willingham	SE	08/07/2017
Madeline Cavileer	ENG	08/07/2017

APPROVALS	ORGANIZATION	APPROVAL DATE
Laura Leyba-Newton	ENG	10/03/2017
Angelo Reyes	PROD	10/13/2017

RELEASED BY	ORGANIZATION	RELEASE DATE
Judy Salazar	CM	10/17/2017

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	10/17/2017	ECO-04988	Initial release

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

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 **AIS Lake Buoy** to meet the objectives of the NEON project, and its respective stakeholders and end users.

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 procedures for the AIS Lake Buoy infrastructure for the following seven freshwater lake sites: CRAM, TOOK, SUGG, BARC, PRPO, LIRO, and PRLA. This procedure does not address the three AIS River Buoy sites, at this time (FLNT, TOMB and BLWA). This document does not address the specific sensor instrumentation on the AIS Lake Buoy.

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.004301	EHSS Environmental Protection Manual
AD [03]	NEON.DOC.004316	Operations Field Safety and Security Plan
AD [04]	NEON.DOC.001569	NEON Preventive Maintenance Procedure: AIS Surface Water Quality Multisonde
AD [05]	NEON.DOC.003808	NEON Sensor Command, Control and Configuration (C3) Document: Buoy Meteorological Station and Submerged Sensor Assembly
AD [06]	NEON.DOC.002716	NEON Preventive Maintenance Procedure: Nitrate Analyzer
AD [07]	NEON.DOC.000416	NEON Sensor Command, Control and Configuration (C3) Document: Photosynthetically Active Radiation (PAR)
AD [08]	NEON.DOC.004257	NEON Standard Operating Procedure (SOP): Decontamination of Sensors, Field Equipment and Field Vehicles
AD [09]	NEON.DOC.001166	NEON Sensor Command, Control and Configuration (C3) Document: MULTISONDE, STREAM
AD [10]	NEON.DOC.001063	NEON Sensor Command, Control and Configuration (C3) Document: UNDERWATER PHOTOSYNTHETICALLY ACTIVE RADIATION (UPAR)
AD [11]	NEON.DOC.001570	NEON Sensor Command, Control and Configuration (C3) Document: SUNA NITRATE ANALYZER, WADEABLE STREAMS
AD [12]	NEON.DOC.004608	Verification Procedure: AIS Buoy
AD [13]	NEON.DOC.001972	AIS Comm Interconnect Map

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.050005	Field Operations Job Instruction Training Plan
RD [04]	NEON.DOC.002767	AIS Subsystem Architecture, Site Configuration and Subsystem Demand by Site - SCMB Baseline
RD [05]	NEON.DOC.001104	Data Generating Device DGD List and Hierarchies
RD [06]	HB07530100	Assembly, Multisonde with Sensors, FDOM, Lake
RD [07]	NEON-8181	D18-TOOK Buoy Anchor Trip Lines
RD [08]	NEON-8540	YSI Buoy Retrieval and Storage
RD [09]	HB16100010	ASSEMBLY, MAST, RADIO, PORTAL BUOY

RD [10]	HB16100000	SUBSYSTEM, DAS, PORTAL, TELEMETRY, BUOY
RD [11]	HJ13300000	KIT, AQU PORTAL, POPULATION
RD [12]	TIS Training August 2015: Guide for Annual Sensor Refresh, Rev_C (8.13.15)	
RD [13]	NEON-8659	FOPS REVIEW: NEON.DOC.004613 NEON Preventive Maintenance Procedure: AIS Lake Buoy
RD [14]	NEON.DOC.000769	Electrostatic Discharge Prevention Procedure
RD [15]	NEON-9623	AIS Buoy guidance for removing buoy/instruments due to high winds and/or flooding
RD [16]	NEON-9273	Release of SUNA Preventive Maintenance - Doc now available!
RD [17]	NEON-6824	D03 AIS Buoy incompatible with bird excrement

2.3 External References

The external references (ER) listed below may contain supplementary information relevant to maintaining specific commercial products that make up the infrastructure of the AIS Lake Buoy. These documents are external to the NEON project and Battelle Ecology.

ER [01]	YSI, Incorporated. Vertical Profiler System (CR1000), Version 3. 19 December 2011. *https://www.ysi.com/systems*
ER [02]	Carmanah Technologies Corporation. M650H User Manual, Revision C. June 2014.
ER [03]	Campbell Scientific, Inc. Garmin GPS16X-HVS GPS Receiver, Revision 3/14. March 2014.
ER [04]	Precision Measurement Engineering (PME), Inc. RS232/RS485 T-Chain User's Manual. November 08, 2013.
ER [05]	Campbell Scientific, Inc. SDM-SIO1 Serial Input/output Module, Revision 7/13. July 2013.
ER [06]	Honeywell. HMR3200/HMR3300 Digital Compass Solutions User's Guide. *www.magneticsensors.com*
ER [07]	LI-COR. Underwater Radiation Sensors Instruction Manual LI-192 Underwater Quantum Sensor, Publication Number 984-08307. June 2006.
ER [08]	R.M. Young Company. Wind Monitor-HD Alpine Model 05108-45 Instructions, Rev. A030513 (PN: 05108-45-90), *www.youngusa.com*
ER [09]	YSI, Inc. Profile System Specifications. *https://www.ysi.com/File%20Library/Documents/Specification%20Sheets/e21-vertical-profilers-spec-sheet.pdf*
ER [10]	YSI, Inc. About the Vertical Profiler, Frequently Asked Questions… *https://www.ysi.com/File%20Library/Documents/Specification%20Sheets/e21-vertical-profilers-spec-sheet.pdf*
ER [11]	YSI, Inc. Field Survival Guide Checklist for Environmental Sondes. *https://www.ysi.com/File%20Library/Documents/Guides/Field-Survival-Guide.pdf*
ER [12]	YSI, Inc. Care, Maintenance, and Storage of YSI 6-Series Probes and Sondes. *https://www.ysi.com/File%20Library/Documents/Technical%20Notes/T601-Care-Maintenance-and-Storage-of-YSI-6-Series-Probes-and-Sondes.pdf*

2.4 Acronyms

2D	Two Dimensional	MSDS	Material Safety Data Sheet
A/R	As Required	LIRO	Little Rock Lake (D05RA1)

AIS	Aquatics Instrument System	LOGWAR	Logistics Warehouse
BARC	Barco Lake (D03CA2)	PAR	Photosynthetically Active Radiation
BLWA	Black Warrior River (D08RA1)	PDS	Power Distribution System
CFG	Configuration	PFD	Personal Floatation Device
CNC	Command and Control	PPE	Personal Protective Equipment
CRAM	Crampton Lake (D05CA1)	PRLA	Prairie Lake at Dakota Coteau Field School (D09RA1)
CVAL	Calibration, Validation, and Audit Laboratory	PRPO	Prairie Pothole (D09CA1)
DAS	Data Acquisition System	S-2	In-Stream Sensor Set, Downstream
DMM	Digital Multi-Meter	SUGG	Suggs Lake (D03CA1)
DO	Dissolved Oxygen	SUNA	Submersible Ultraviolet Nitrate Analyzer
ESD	Electrostatic Discharge	T-Chain	Temperature Chain
fDOM	Fluorescent Dissolved Organic Matter	TIS	Terrestrial Instrument Sites
FLNT	Flint River (D03RA1)	TOMB	Lower Tombigbee River (D08RA2)
GPS	Global Positioning System	TOOK	Toolik Lake
HMP	Humidity and Temperature Probe	uPAR	Underwater PAR
IR	Infrared	UTC	Universal Time Coordinated
JSA	Job Safety Analysis	UV	Ultraviolet
LC	Location Controller	YSI	Integrated Systems and Services
LED	Light-Emitting Diode		
MET	Meteorological		

2.5 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.

SYNONYMOUS COMMON NAME(S)	NEON TECHNICAL REFERENCE NAME
YSI Vertical Profiler System (CR1000), Buoy Meteorological Station and Submerged Sensor Assembly	**AIS Lake Buoy**
Level Winder, Axle Rod	**Axle**
Upwelling, Down facing, Outgoing PAR, Underwater PAR (uPAR)	**Lakebed PAR**
Down-welling, Up facing, Incoming PAR, uPAR	**Surface Water PAR**
Charge Regulator	**Charge Controller**
JIRA, ServiceNow	**NEON Issue Management and Reporting System**
MAXIMO	**NEON Asset Management and Logistic Tracking System**
Sonde, Water Quality	**Multisonde**

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 and conduct the appropriate Job Safety Analysis (JSA) before conducting any preventive maintenance.

Personal Protective Equipment (PPE) may be required in some decontamination procedures to maintain safe working conditions (e.g., use of equipment such as power washers, air compressors), and disinfectants. For this reason, personnel should be trained and familiar with the Material Safety Data Sheets (MSDS) for the cleaning solutions, tools and equipment necessary for decontamination of the sensor sets herein.

Technicians must not enter the water without water safety training and a personal floatation device (PFD), and must display basic competency in boat operation, regardless of whether or not boat operation is a main responsibility.

The AIS Lake Buoy winch system contains Mobil SHC 624 lubricant, which requires an MSDS. The gearbox using this lubricant does not contain any user-serviceable parts and not part of BEI's preventive maintenance procedure for the AIS Lake Buoy winch assembly. Do not open this compartment for any reason.

Please be aware, there is a risk of hurting hands/feet caught between the dual PAR SUNA mount and bracket. Maintain awareness of this risk when pulling the two Photosynthetically Active Radiations (PARs) and Submersible Ultraviolet Nitrate Analyzer (SUNA) out of the water. Figure 1 displays the bracket on the floating deck where hands/feet could encounter scissor/pinch injury when pulling the dual PAR SUNA mount of the water.

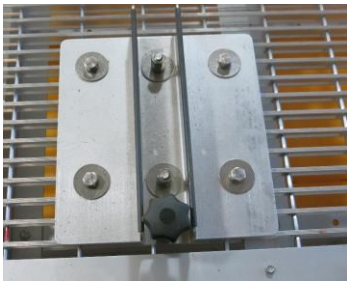


Figure 1. Dual PAR SUNA Mount Bracket - Scissor Risk Safety Note!

4 SENSOR OVERVIEW (SENSORS ONLY)

4.1 Description

The AIS Lake Buoy is a floating platform that includes an integrated meteorological (MET) station, a fixed underwater measurement set, and a profiling underwater measurement set (see Figure 2). The buoy instrumentation deploys to measure a suite of biogeochemical and atmospheric parameters to enable a greater understanding of how freshwater aquatic ecosystems respond to global and environmental change.

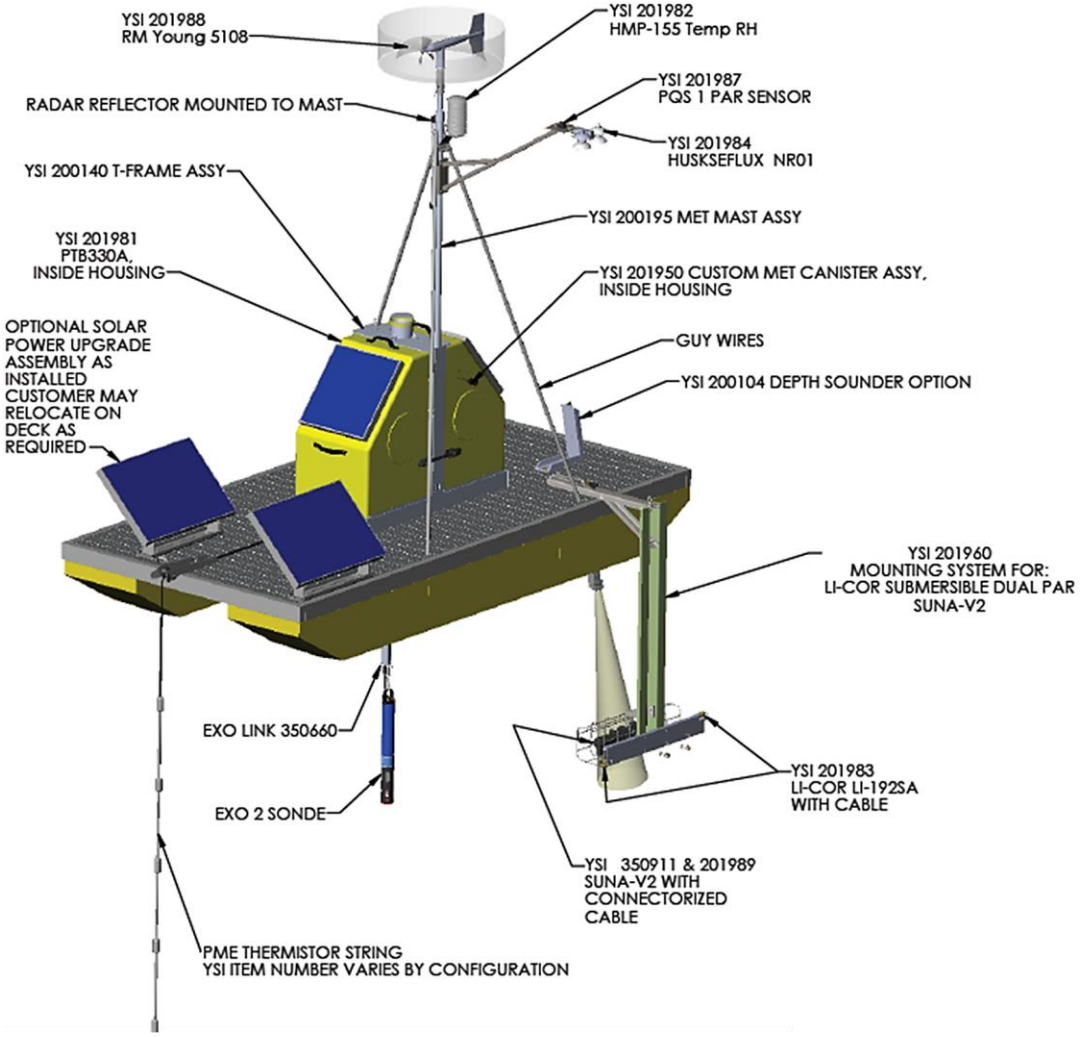


Figure 2. AIS Lake Buoy Sensor Components and Infrastructure

Standard Components:

- Floating Platform (Grated Deck on Pontoons)
- T-frame with Fiberglass T-Frame Cover
- Winch Assembly

- Antenna Assembly
- Beacon
- Depth Sounder
- Meteorological (MET) Mast: Wind Monitor Mount, Temp Humidity and Radar Reflector

Site-Specific Partially Custom Components:

- PSQ1 Mounting
- Power Upgrade Assembly: Solar Panels on Fiberglass T-Frame Cover & Auxiliary Solar Panels on Floating Platform
- Temperature Chain (T-Chain): Custom Chain with Standard Mount

NEON Custom Components:

- Dual Photosynthetically Active Radiation (PAR)/Submersible Ultraviolet Nitrate Analyzer (SUNA) Mount
- Barometer Mounting (Under T-Frame)
- Connectorized Pressure Case Assembly, MET- Global Positioning System (GPS)
- Met Mast: SUNA Radio Antenna (not pictured) and NR01 Mount

4.2 Sensor Specific Handling Precautions

Aquatic Technicians must employ special care to avoid dropping solutions, hardware, or tools into the water while working to prevent contaminating an aquatic environment. In addition, per NEON.AIS.4.1735, all vehicles, trailers, boats, tools, protective outerwear, and any other items that encounter an aquatic or riparian environment, require decontamination prior to site access.

4.2.1 Multisonde Handling Precautions

When handling the probe sensors within the Multisonde, **do NOT touch the ends of the pH and Dissolved Oxygen (DO) probe.** When in storage or in transport, these sensors (pH and DO) must have caps on with a moist sponge touching the probe. Attach the calibration cup with a little water inside to keep sensors moist. Reference AD [04] for additional guidance specific to the Multisonde.

4.2.2 PAR Handling Precautions

The PARs contain sensitive optical components. Do not use a dry brush to remove biofouling from these sensors. Use care when positioning or adjusting the sensor; do not touch the sensor head. Dirt and oils on hands may cause biases in measurement collection.

4.2.3 Buoy Electronics

Employ electrostatic discharge (ESD) procedures when handling buoy electronics, such as the Profile and MET Canisters. This includes the Oz Grape that powers the radio in the Aquatics Portal that receives/transmits to the AIS Lake Buoy radio and receives data from the SUNA radio. Never “hot swap” any Grape sensor/subsystem connections; always remove the Ethernet Cable (Cat 5/RJF) before connecting/disconnecting other connections. Reference RD [14].

4.3 Operation

The AIS Lake Buoy features twelve distinct sensor types that provide 14 data products. Two Campbell Scientific data loggers capture the sensor sets data and transmits it via radio to the AIS Aquatics Portal on shore. The only exception is the data from the SUNA Nitrate Analyzer, which transmits directly via a radio dedicated specifically to that sensor (this is due to CR1000 usage limits). On-board solar panels and battery pack power the sensor sets during deployment. Figure 3 provides an operational overview of the data transmission, power system and sensor sets pertaining to the AIS Lake Buoy.

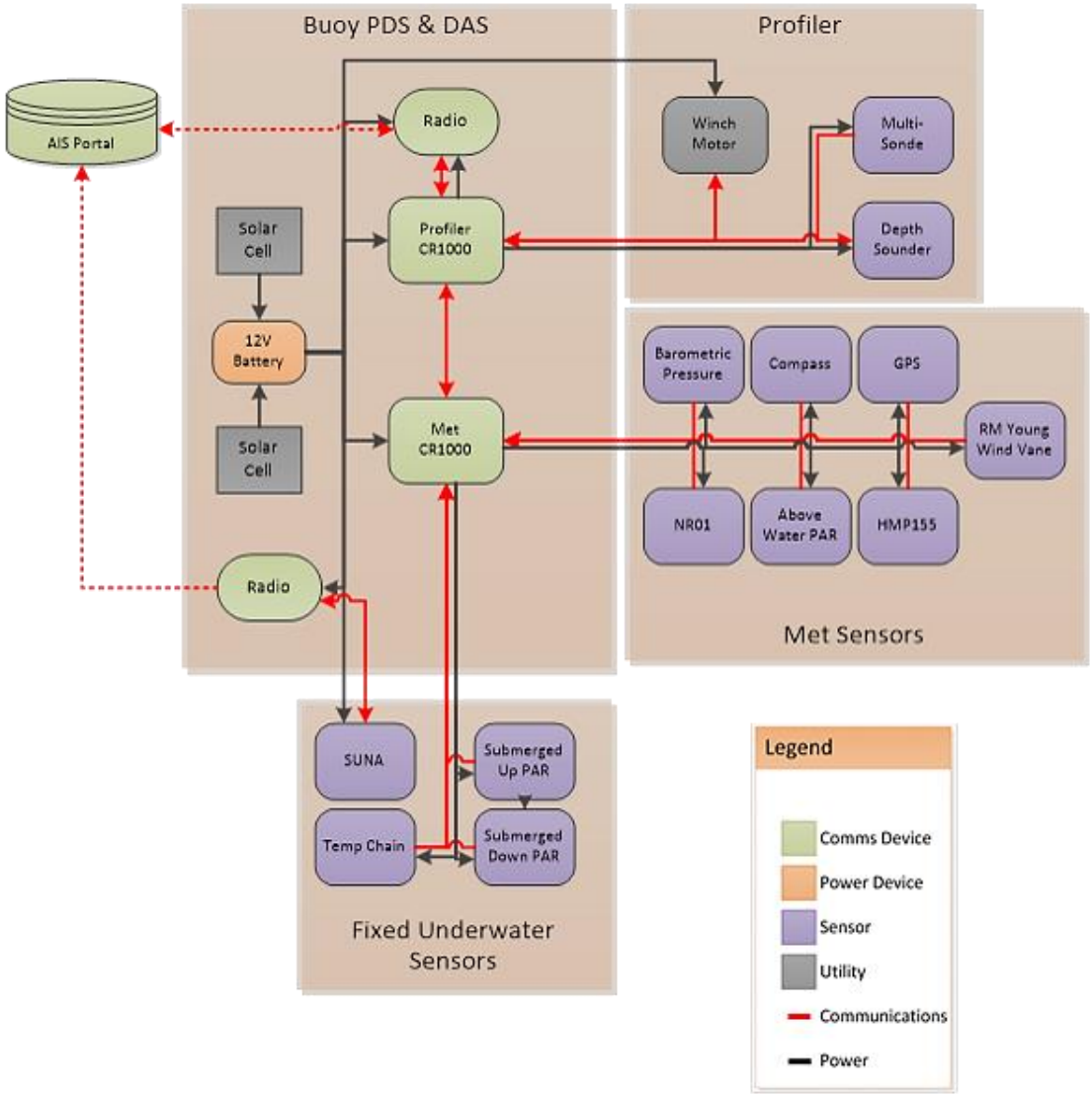


Figure 3. Buoy Operational Overview with Power Distribution System (PDS) and Data Acquisition System (DAS)

According to NEON.AIS.4.1596, AIS shall make the following underwater measurements on the buoy: chlorophyll a, dissolved oxygen, nitrate, pH, turbidity, upwelling and down-welling uPAR, water conductivity, water temperature and fluorescent dissolved organic matter (fDOM). According to NEON.AIS.4.1524, AIS shall make the following measurements at the aquatic land-based and buoy-based

meteorological stations: air temperature, down-welling above-water PAR, incident and reflected shortwave and longwave (net) radiation, horizontal wind speed and direction, barometric pressure and humidity.

5 INSPECTION AND PREVENTIVE MAINTENANCE

5.1 Equipment

Table 1 lists a summary of 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 1. AIS Lake Buoy Preventive Maintenance Equipment List

P/N	MX or NEON P/N	Description	Quantity
Tools			
NEON, IT		Rugged tablet / Laptop with USB-3.0 port	1
		Buoy Serial Cable (to connect to the buoy software)	1
NEON	HB09780000	SUNA-V2 Cable (to connect to the SUNA V-2)	
		USB to Serial Adapter (to connect to SUNA Radio)	A/R
		USB A to mini-B Cable	1
FLUKE-1AC-A1-11	MX102703	Digital Multi-Meter (DMM) (to measure 12V Battery Voltage)	1
Part# 69899		M650H Beacon Infrared Remote (IR) Programmer (to access beacon state of health on buoy)	1
		Measuring Tape	1
		Zip Tie Cutter (to remove cable dressings)	1
599810	0320170022	YSI Sensor Accessory - EXO Signal Output Adapter – USB (for field calibration)	1
	0337890000	EXO2 Calibration/Storage Cup (for field calibration)	1
		5-Gallon Bucket (for field calibration)	1
		EXO USB Adapter Driver (for field calibration)	1
		Multisonde Sensor/Probe Removal Tool (for field calibration)	1
		$^{9}/_{16}$” Combo wrench	1
		½” Combo wrench	1
		½” open-end wrench	1
		Crescent Wrench	1
		Flathead Screwdriver (to remove canisters and PARs)	1
		Dry Brush or equivalent (to clean off animal excrement)	1
		Knee Pads (to work on floating platform/deck)	1 Pair
		Mechanics Gloves or equivalent (to pull up the dual PAR SUNA Mount)	1 Pair
		Boat (to access the AIS Lake Buoy on water)	1
		Trailer (to tow the AIS Lake Buoy on land)	1
		Cable/Bike Lock (to temporary secure the buoy on land)	1
		Handheld Compass (to measure Digital Compass offset)	1
		Digital Level (to measure Pitch and Roll offsets)	1
		Channel Locks (for mooring shackles)	1
		Plyers (for cotter pins on mooring shackles)	1
		Pipe wrench (for seized mooring shackles)	A/R
Consumable Items			
Part # 57383		M650H Beacon Replacement Battery Pack Kit	1
10195K29		Krytox 205 (for Multisonde and Winch Assembly)	1

210-01958-1		LI-COR Dow Corning 111 (silicone grease for PAR sensors)	1
0719752		Fastenal 7” Zip Ties, Black, UV Stabilized Nylon	A/R
0719793		Fastenal 14” Zip Ties, Black, UV Stabilized Nylon	A/R
3824	0320170013	Calibration Solution - pH buffer for YSI EXO, Assorted Case of pH Values (for Multisonde Calibrations)	1 Case
		Deionized Water (for SUNA Calibrations)	2L
		Para film (for SUNA Calibrations)	A/R
		D-Cell Batteries (for Multisonde)	4
		Rope (to tow AIS Lake Buoy to land)	A/R
		Large Tarp (for temporary storage of the buoy)	1
	MX104219	Red Rejected Tag (for Defective Assets sending back to BEI HQ)	A/R
		Bird Deterrents – Plastic Stick-on Spikes, etc. (for solar panels)	A/R
Resources			
YSI_VPS_30.4 .dld	YSI Profile Wizard (Campbell Scientific LoggerNet™ Software) https://www.campbellsci.com/loggernet Download trial and use serial activation key from physical CD given to Domain by YSI.		1
	MetStation_6.9.CR1 (Campbell Scientific LoggerNet™ Software)		1
	PuTTy (to ping Grape at MET Station): http://www.putty.org/		A/R
1.0.12 or later	KOR-EXO Software (to conduct Multisonde Calibration/Validation) http://www.exowater.com/manuals-software.php Enter the serial number from your Multisonde to acquire download access.		1
	Multisonde Firmware Files		1
	SUNAcom/Seabird UCI (to conduct SUNA Calibration/Validation) http://www.seabird.com/software/uci		1
	XCTU Software (for SUNA Radio Configuration) https://www.digi.com/products/xbee-rf-solutions/xctu-software/xctu		A/R
	WinSitu: https://in-situ.com/support/documents/win-situ-5-software/		1
	Covered storage facility or environmentally-controlled storage facility		A/R

5.2 Subsystem Location and Access

AIS Lake Buoys reside on fresh water lakes within specific Domains. Figure 4 is an example of a successful AIS Lake Buoy deployed in Domain 09, Prairie Pothole (PRPO). Sensor subsystems reside on the AIS Lake Buoy and within the onshore Aquatics Portal.

Figure 4. AIS Lake Buoy for Domain 09 Prairie Pothole (PRPO)

5.3 Maintenance Procedure

Table 2 is an interval schedule of each infrastructure component requiring preventive maintenance.

Table 2. AIS Lake Buoy Preventive Maintenance Frequency Summary

	Maintenance	Bi-Weekly	Quarterly	Bi-Annual	Annual	As Needed	Type
	Buoy Infrastructure Inspection						
	Floating Deck & Pontoons			X		X	P
	Mooring System		X				
	T-Frame Cover & T-Frame		X				P
	GPS, Beacon, and Antenna Mounts to T-Frame		X				P
	T-Frame Cover & T-Frame		X				P
	Winch Assembly		X				P
	PVC Canister Connections & Instrumentation Cables/Cabling		X				P
	Batteries & Battery Enclosure			X			P
	Solar Panels and their Mounts		X				P
	Met Mast Mount & Guy-wires		X				P
	SUNA Radio Antenna and Mount		X				P
	Radar Reflector and Mount		X				P
	Dual PAR SUNA Bracket & Mount, Cage and Connections		X				P
	Depth Finder Mount & Cable		X				P
	T-Chain Mount, Rope and Zip ties		X				P
	Clean Buoy Infrastructure for Animal Excrement & Bio-fouling	X				X	P
AIS Lake Buoy Winch System							
	Visual Inspection		X				P
	Axle Lubrication				X		P
AIS Lake Buoy Mooring System							
	Mooring Line Adjustments		*X*	*X*	X	X	P
	Seasonal Storage						
	Beacon Batteries	X					P
	AIS Lake Buoy 12V Batteries	X				X	P
	AIS Lake Buoy Infrastructure/Instruments in Storage Visual Inspection	X				X	P
	Buoy Sensor Instrumentation						
	Visual Inspection	Reference Instrument-specific Preventive Maintenance Documents.					

Maintenance		Bi-Weekly	Quarterly	Bi-Annual	Annual	As Needed	Type
	Remote and Onsite Diagnostic Monitoring	X				X	P
	Clean Bio-fouling from Lakebed/Surface Water-facing uPARs	X					P
	Clean Bio-fouling from SUNA (Nitrate Analyzer) optics and body (Source: AD [06])	X					P
	Clean Multisonde Probes & Check Wiper/Cables for Bio-fouling (Source: AD[04])	X					P
NOTE: The biweekly and annual inspections should be carried out regardless of whether they coincide or not. P = Preventive, X = Indicates preventive maintenance task time interval may increase due to environmental (season/weather) or unforeseen/unanticipated site factors.							

5.3.1 Remote Monitoring

Two software programs control the buoy: YSI Profile wizard and MetStation_6.9.CR1. Reference AD [05] for information on the command, control and configuration of the AIS Lake Buoy.

5.3.2 AIS Lake Buoy Infrastructure Inspection

Conduct a visual inspection on the following components to verify structural integrity of the AIS Lake Buoy.

1. Inspect the Floating deck grates and pontoons.
   a. Each pontoon attaches to the floating deck in three sections. Inspect each attachment point to ensure each section is secure. Figure 5 is an example of an attachment point.
   b. Remove animal excrement and biofouling[1] using lake water and dry brush.

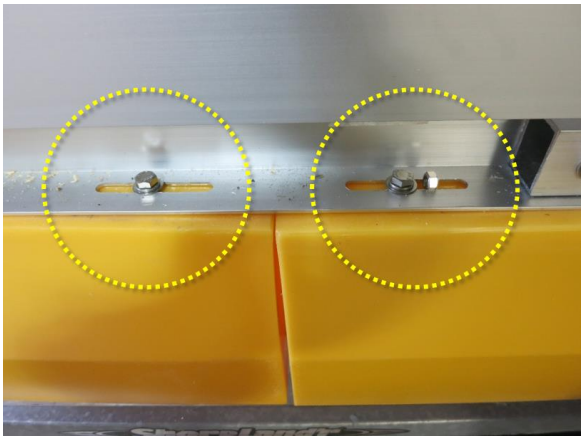


Figure 5. An Attachment Point for Floating Deck & Pontoon

PRO TIP: *Purchase plastic bird spikes (anti-*

[1] **Biofouling:** The accumulation of water borne organisms -- such as bacteria, protozoans, algae, and crustaceans -- on the surfaces of engineering structures (e.g., sensors and equipment) in water that leads to corrosion and inefficiency of moving parts. *Source: NEON.DOC.004257*

perching spike kit) at a local hardware store to add to the edge of the solar panels if birds are becoming a nuisance.

2. Inspect the Mooring system components that are subject to the environment above water or under tension most frequently (e.g., subject to more ultraviolet rays/animal excrement or pull from wind/water currents). This includes the mooring eyebolts and bridles.
   a. Ensure the four mooring eyebolts are secure on the floating deck bow and stern.
   b. Ensure the mooring bridle is secure to eyebolts via the deck with shackles and the shackle cotter pins are bent (see Figure 6).
   c. Inspect the shackles of the bridle on the anchor end, too (see Figure 7). Use a boat to access this, if necessary, and pull on the rope to lift shackles. If you use the buoy to access, it may require some muscle to lift the anchor chain to enable these shackles to become visible for inspection.

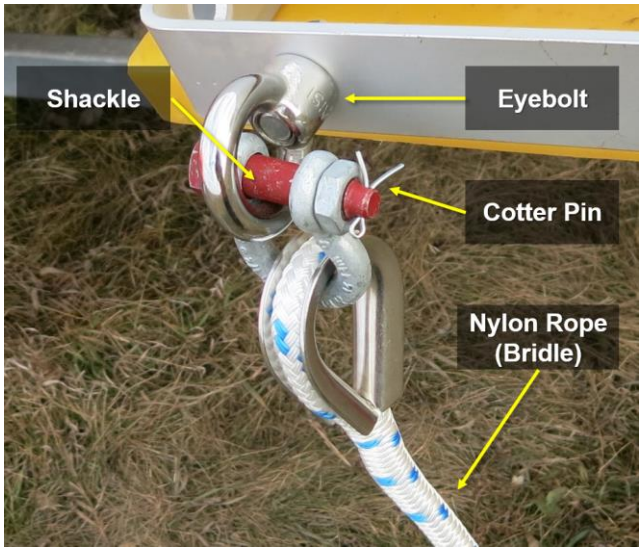


Figure 6. Mooring Bridle Attachment to AIS Lake Buoy

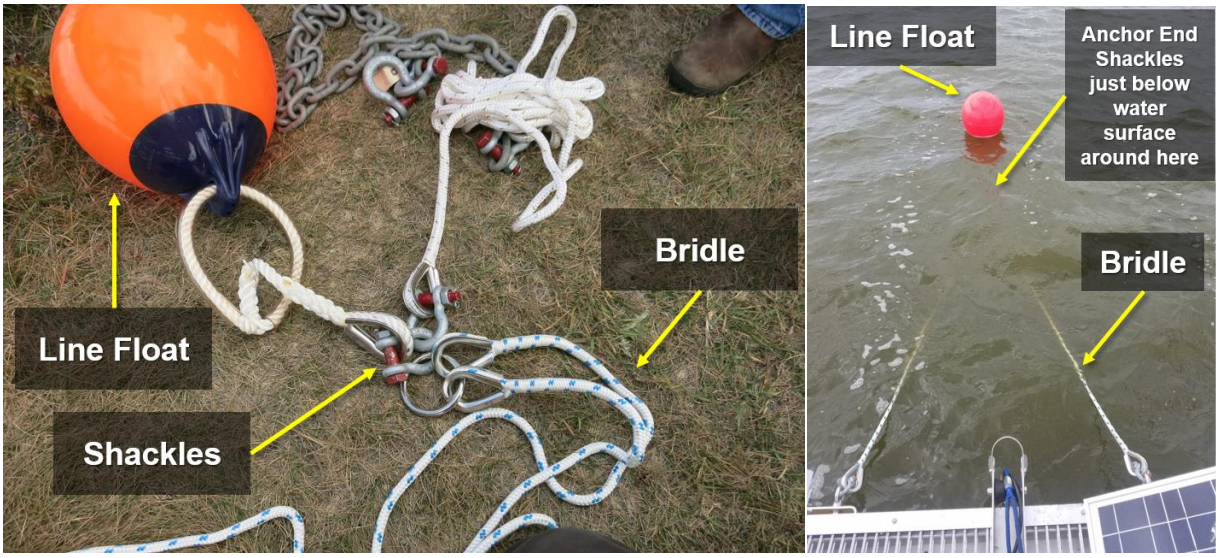


Figure 7. Shackles at the Anchor End of Bridle with Line Floats

   d. Inspect the bridle nylon rope for UV damage and the shackles and cotter pin for rust/corrosion (see Figure 8).

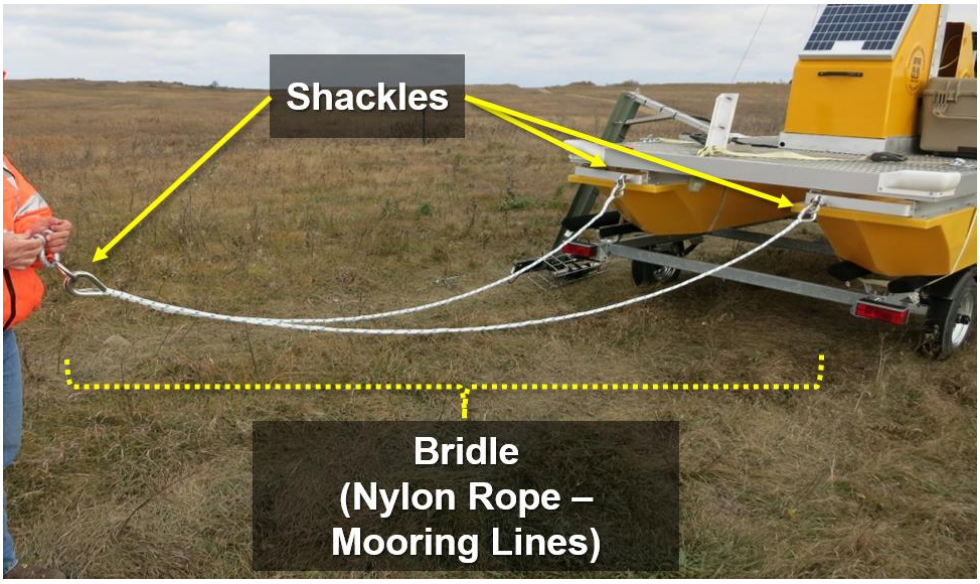


Figure 8. Bridle Attachment Points Example (What to Expect in the Water)

e. Inspect other mooring lines, trip lines, and orange/red circular line floats for wear/damage.
f. Ensure the mooring lines do not move ±45 degrees. See *Section 5.3.4 Adjusting the Mooring System* for more information on adjusting the mooring lines to accommodate water level changes.

3. Inspect the fiberglass T-frame cover and T-frame for structural integrity. ***The handles for the fiberglass T-Frame cover are not for lifting purposes; they guide the housing on and off the track.***
   a. Tighten or replace loose nuts, bolts, washers, as applicable.
   b. Ensure the GPS, Beacon, and Antenna securely mount to the T-frame (see Figure 9).

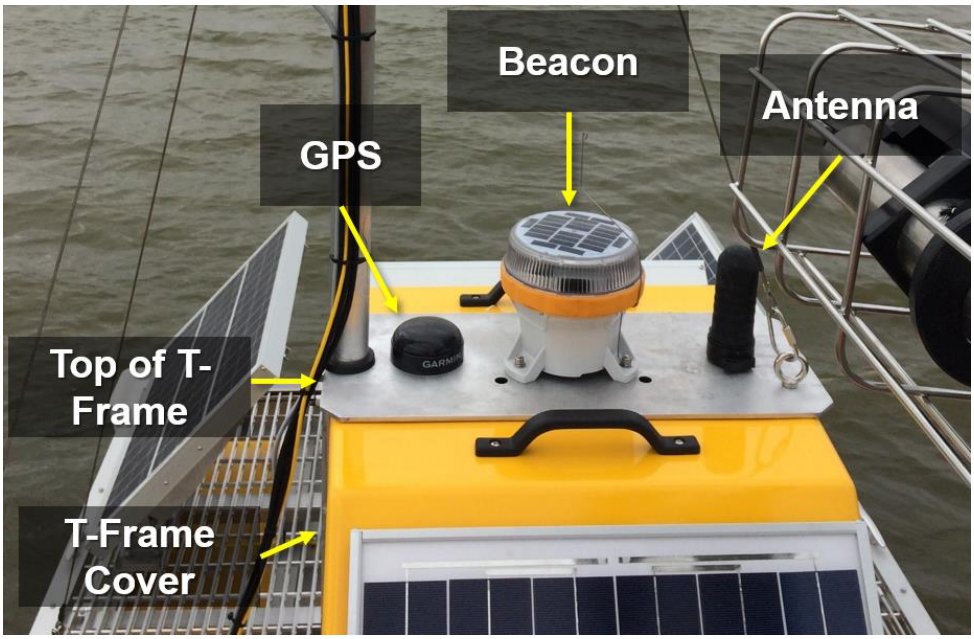


Figure 9. T-Frame: GPS, Beacon and Antenna

a. The GPS (GPS16X-HVS) receiver plugs directly into the Campbell Scientific CR1000 data logger. The GPS antenna should have a clear view of the sky. (Do not expect the GPS antenna to work indoors.) The GPS contains no user serviceable parts for preventive maintenance; reference ER [03] for configuration and wiring instructions, in the event corrective action is necessary.
b. Clean off any debris on the top of the Beacon (M650H), the solar panel, with water. The beacon contains no user serviceable parts with exception of charging the battery pack when the AIS Lake Buoy is in seasonal storage. See *Section 5.3.5.2 Seasonal Storage* for instructions on storing the beacon.
c. The antenna transmits data from the AIS Lake Buoy to the AIS Aquatics Portal (with exception of the SUNA, which has its own radio). Ensure the antenna is secure to the T-Frame and there is no visible damage/degradation.

4. Inspect the winch assembly that attaches to the AIS Lake Buoy T-frame. This includes the motor and motor gear, axle, drum, winch belt, and slip ring cover.
   a. Tighten or replace loose nuts, bolts, washers, as applicable.
   b. See *Section 5.3.3 Winch Assembly Maintenance* for details on the winch assembly preventive maintenance.
5. Inspect the PVC Canister port connections and cabling. Inspect seals and ensure connections are secure and accurate.
   a. A humidity sensor and a bag of desiccant reside inside the canisters. See *Section 8 APPENDIX A: Checking for Humidity in the Profile/MET Canisters* for the procedure to check the humidity inside the canisters to determine when/if the desiccant requires changing or leak(s) exist.
   b. Ensure cables dressed with zip-ties are not causing any strain on the sensor cables/connections. Replace zip-ties, as appropriate.
   c. See Figure 10 and Figure 11 for the AIS Lake Buoy port mapping.

Note: The SUNA is unique among the AIS Lake Buoy sensor sets since data transmission occurs via Radio. The Radio box connects directly to the battery power to power the SUNA.

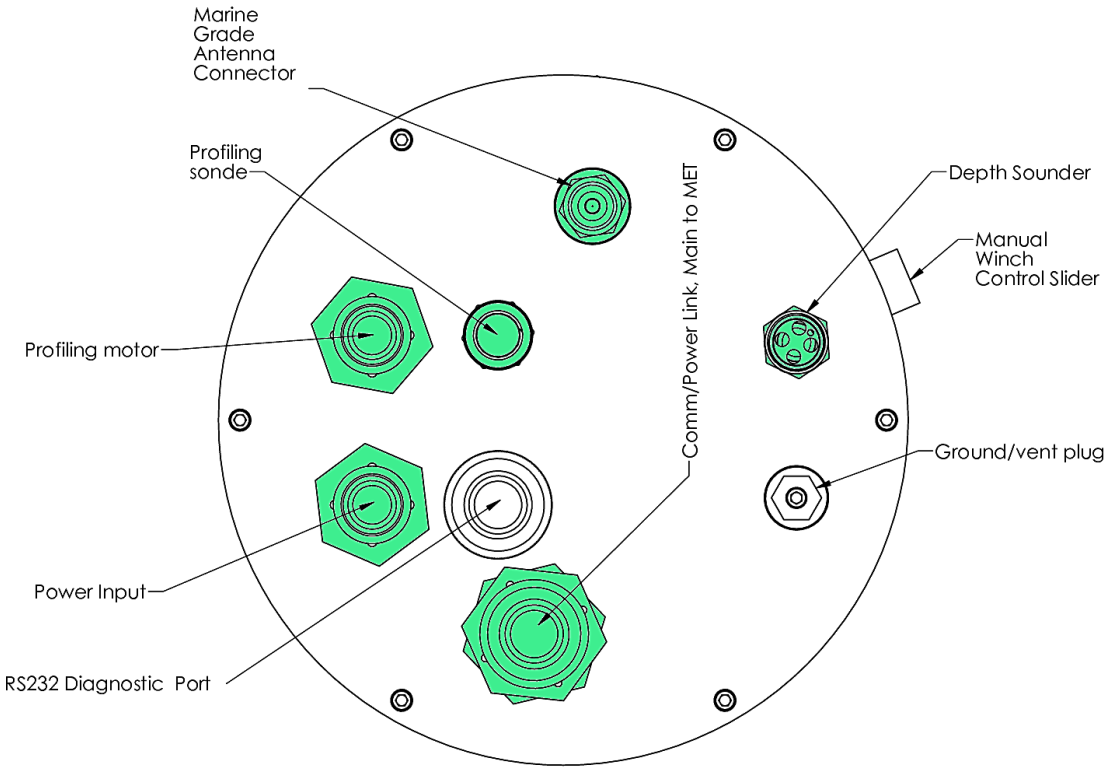


Figure 10. Profile Canister Port Mapping

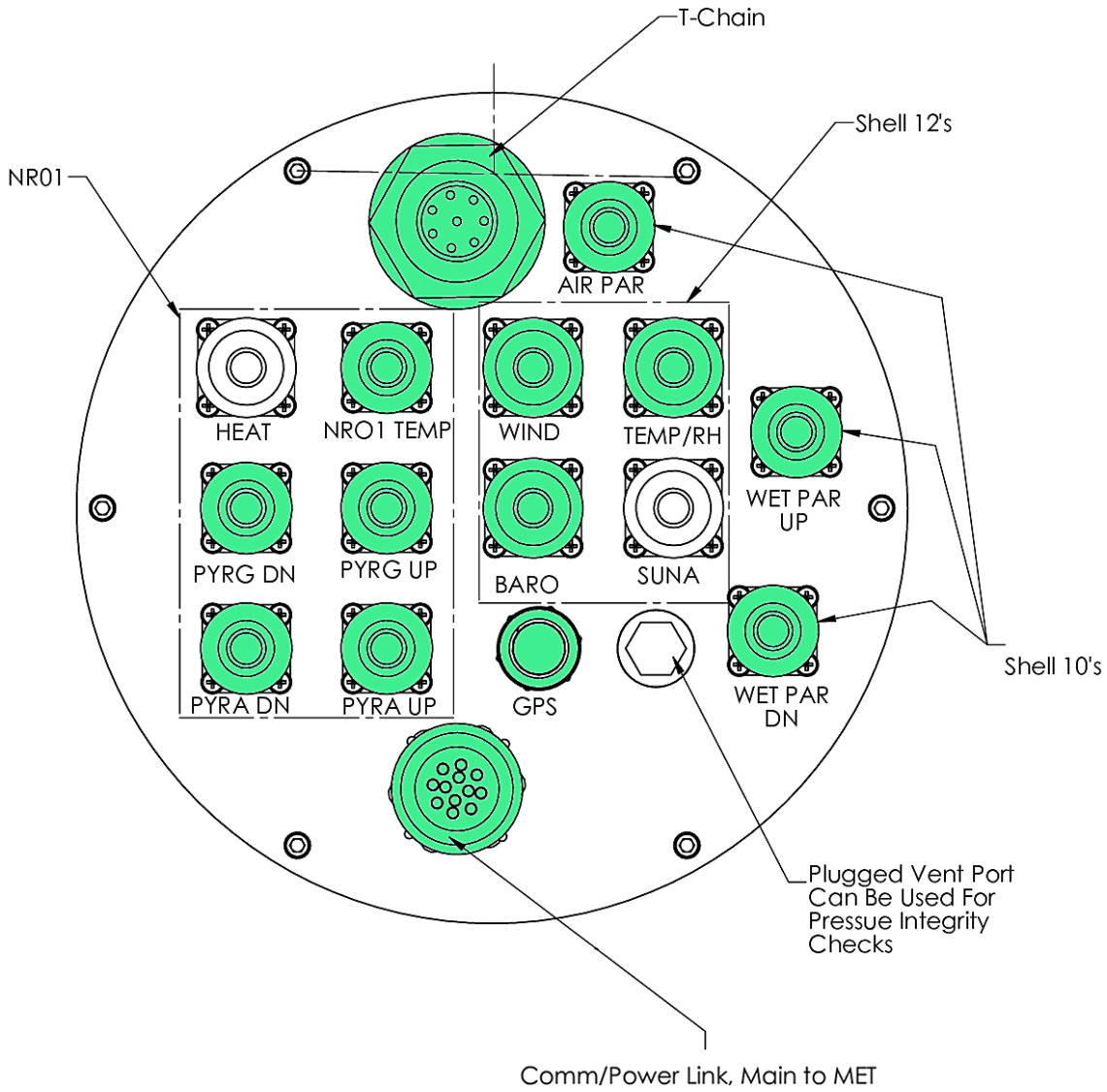


Figure 11. MET Canister Port Mapping

6. Inspect the two Battery Enclosures within the T-frame. Ensure posts are corrosion-free and that connections are secure. Verify voltage capacity (more than 12 volts; less than 11 volts and system shuts down).
   a. Use a Digital Multi-Meter (DMM) to check voltage (see Figure 12). Set the DMM for DC (direct current).
      i. Red goes to positive +
      ii. Black goes to negative -
   b. The charging light on the charge controller(s) illuminates at least some of the time (it will turn off when the battery is fully charged). Figure 12 displays the charging light lit up, which means the battery is charging.

c. The Activated light is off (A lit up Activated light means the battery is low and the buoy electronics are off). Figure 12 displays the location of the Activated light.

7. Inspect solar panels. Ensure all mounts are secure: mounting to the deck and the T-Frame cover. Wipe away dirt and debris. Ensure connections are secure to their respective charge controllers.

Note: The solar panels must receive direct sunlight. If the panels are no longer receiving direct sunlight due to the orientation of the buoy or panels, please submit a ticket to the NEON Issue Management/Reporting System for headquarters to evaluate and remediate.

a. The solar panels on T-Frame cover are facing west and east.
b. The auxiliary solar panels on the deck face south.

8. Inspect Met Mast. Ensure it securely attaches to the T-frame via three U-bolts. Tighten or replace loose nuts, bolts, washers, as applicable.
   a. Ensure it securely attaches to the floating deck via three Guy-wires.
   b. Replace zip-ties, as appropriate.
   c. Note: the three Guy-wires are tight, but low in tension. This is more for stabilization than for tensioning. Using a crescent wrench, loosen the jam nut and retighten turnbuckle to tighten enough to stabilize the Met Mast evenly across each wire. If you tighten it to the point of pulling the mast out of level, then it is too tight.

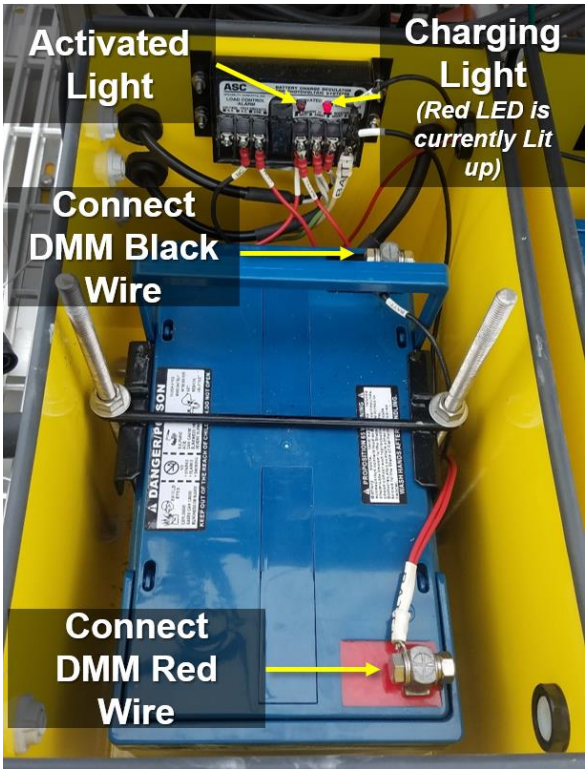


Figure 12. AIS Lake Buoy Battery Box/Enclosure and Battery (Where to Connect DMM)

*Note: **DO NOT** remove the U-bolts that attach the mast to the T-Frame. The mast can easily tip. When removing the mast for servicing instrumentation, undress the cables and disconnect them from the sensors, remove applicable sensor instrumentation, release the guy-wires, loosen the U-bolts, and slide the mast up. Do not remove the Met Mast while on water.*

   d. Inspect the radiation sensor mounts securely to the mast via two U-bolts, flat washers, lock washers, and ½" nuts. Use the battery box as step up to reach the Radiation boom arm mount. Loosen the two U-bolts (never remove) to swing the radiation boom arm in/lower for servicing.
   e. Cut and replace zip ties, as appropriate.
   f. Use a Boomtron to reach the radiation sensor for cleaning.

Note: The radiation boom arm must orient south ±45° and be perpendicular (90°) to the buoy.

g. Check hose clamp attached to the mast (see Figure 13). This works as a bump stop above the boom. A bump stop enables reinstallation to a fixed height. This may or may not exist at all AIS Lake Buoy sites. AIS Lake Buoy sites are welcome to install one of their own to know where the fixture must stop on the Met Mast.

Figure 13. Bump Stop on Met Mast

Note: The Met Mast points perpendicular to the buoy centerline, on the port side.

h. Inspect SUNA radio antenna and radar reflector, which also mounts to the Mast (see Figure 14). The SUNA radio antenna should point towards the AIS Aquatics Portal.

i. The RM Young Wind Monitor (2D Wind) is a mechanical wind sensor (comprises of mechanical components, such as bearings) as opposed to a sonic wind sensor (electronic data collection) at our Terrestrial Instrument Sites (TIS). Inspect the ceramic bearings for this instrument (ceramic bearings are resistant to corrosion; comprises of Teflon seals with low torque wide-temperature range grease).

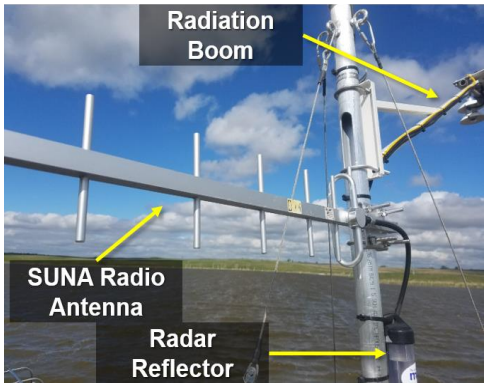


Figure 14. SUNA Radio Antenna and Radar Reflector on Met Mast

i. Two items to monitor for the RM Young Wind Monitor when conducting maintenance activities on the AIS Lake Buoy:

1. If anemometer bearings become noisy or wind speed threshold increases above an acceptable level, bearings may require replacement. a rough check can be performed by adding an ordinary paper clip (0.5 gm) to the tip of a propeller blade. Turn the blade with the paper clip to the "three o'clock" or "nine o'clock" position and gently release it. Failure to rotate due to the weight of the paper clip indicates anemometer bearings need replacement. Repeat this test at different positions to check full bearing rotation.
2. The potentiometer in the RM Young Wind Monitor has a life expectancy of fifty million revolutions. As it becomes worn, the element may begin to produce noisy signals or become nonlinear. When signal noise or non-linearity becomes unacceptable, replace the potentiometer.

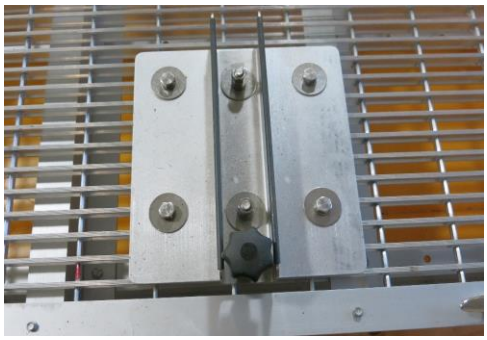


Figure 15. Bracket on Floating Deck for Dual PAR SUNA Mount

9. Inspect dual PAR SUNA bracket (see Figure 15) and mount. Remove biofouling in the cage using water and a dry brush. Replace zip-ties, as appropriate. See Section

6.2.2 PAR and SUNA Removal and Replacement for instructions on moving the mount.

a. In the mount, ensure the SUNA brush does not hit the cage. The slot should be facing toward the bracket in order to allow maximum room for brush movement. The brush operates every 15 minutes to mitigate biofouling.
b. For select sites using the assist for this mount, please ensure it is not degrading the integrity of the bracket.
c. Ensure the guy-wire jam nuts are tight after resetting the dual PAR SUNA mount in the water (see Figure 16). The jam nut enables the turnbuckle to be secure post-tightening.

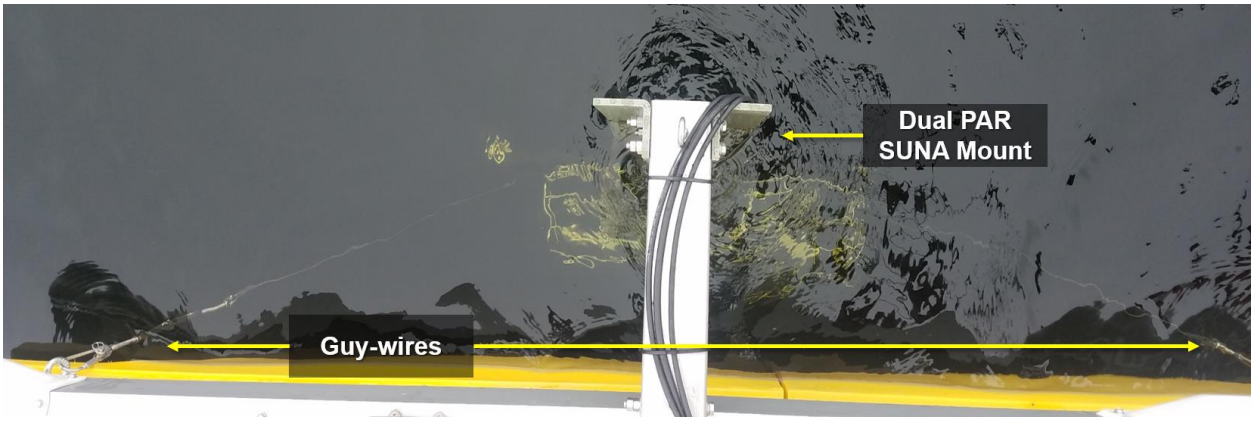


Figure 16. Looking Down on the Dual PAR SUNA Mount and Guy-wires

Note: The water may cause these jam nuts to loosen and/or fall off in the water, allowing the turnbuckle to fall off in the water. Figure 17 displays these components for reference.

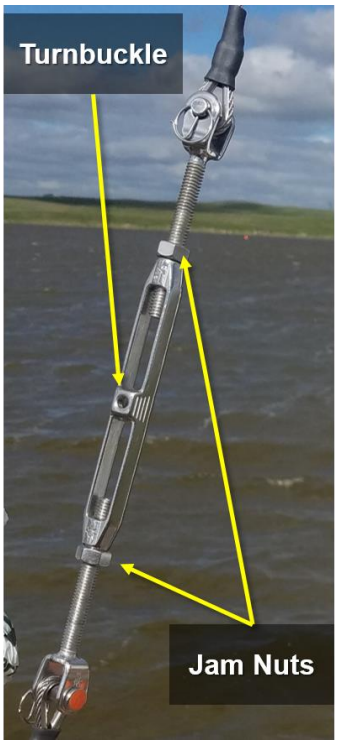


Figure 17. Guy-wire Components

a. Tighten or replace loose nuts, bolts, washers, as applicable.

10. Inspect Depth Finder bracket (see Figure 18), pole and cable.

Figure 18. Depth Sounder Bracket on Floating Deck

11. Inspect the Temperature Chain (T-Chain) attachment to the floating deck (see Figure 19) on the bow. The T-Chain is a single-cable string consisting of sensors that measure water temperature at specific depths in Celsius. The T-Chain varies in length per AIS Lake Buoy site.
    a. Ensure the attachment is secure and not tangled in the mooring lines. The T-Chain should never be under tension (e.g., not caught in the mooring lines or debris underwater).
    b. Inspect the T-Chain rope for UV damage.
    c. Replace zip-ties, as appropriate.

See AD [05] for list of site-specific T-Chain depths from water surface.

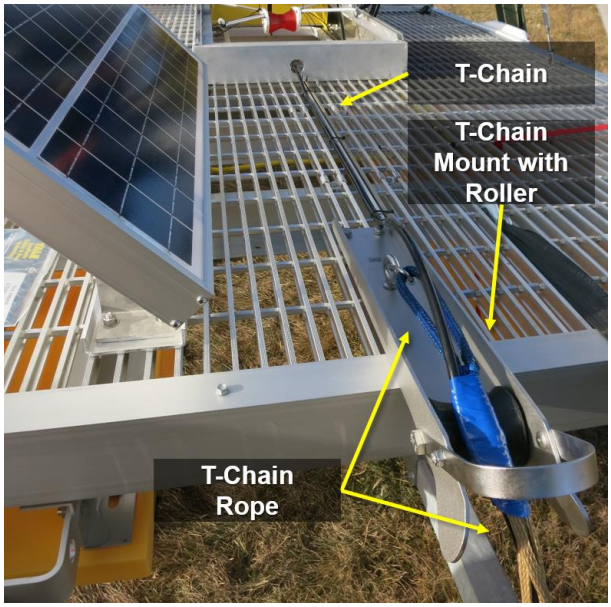


Figure 19. T-Chain and T-Chain Mount on Floating Deck

5.3.3 Winch Assembly Maintenance

As stated above in *Section 5.3.2,* inspect the winch assembly that attaches to the AIS Lake Buoy T-frame. (The winch assembly faces the bow.) This primarily includes the motor and motor gear, axle, drum, and winch belt (see Figure 20). This section aims to provide additional guidance for these tasks.

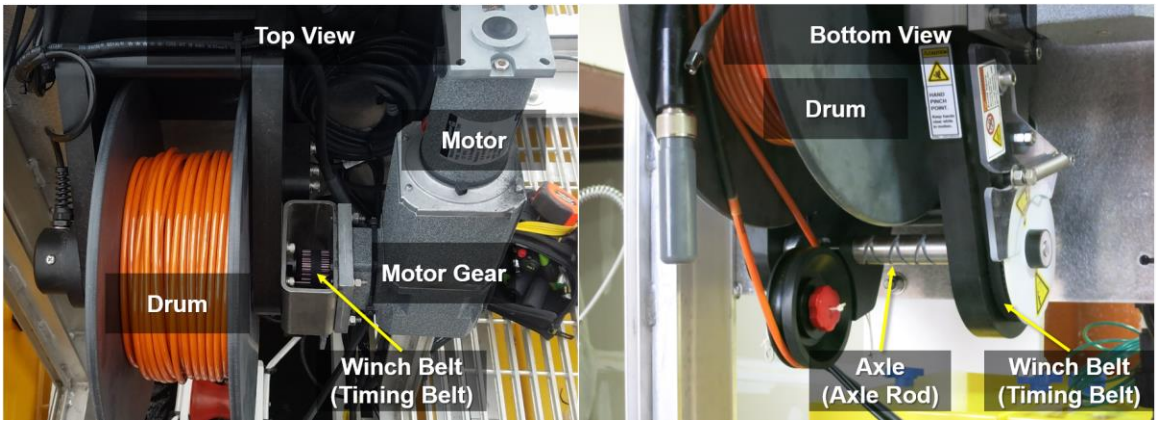


Figure 20. Winch Assembly Components

1. Tighten or replace loose nuts, bolts, washers, as applicable.
2. The winch axle (axle rod) requires lubrication with Krytox 205 annually. Figure 21 is an example of a properly greased axle. Maintaining lubrication on this component ensures the equipment lifespan.

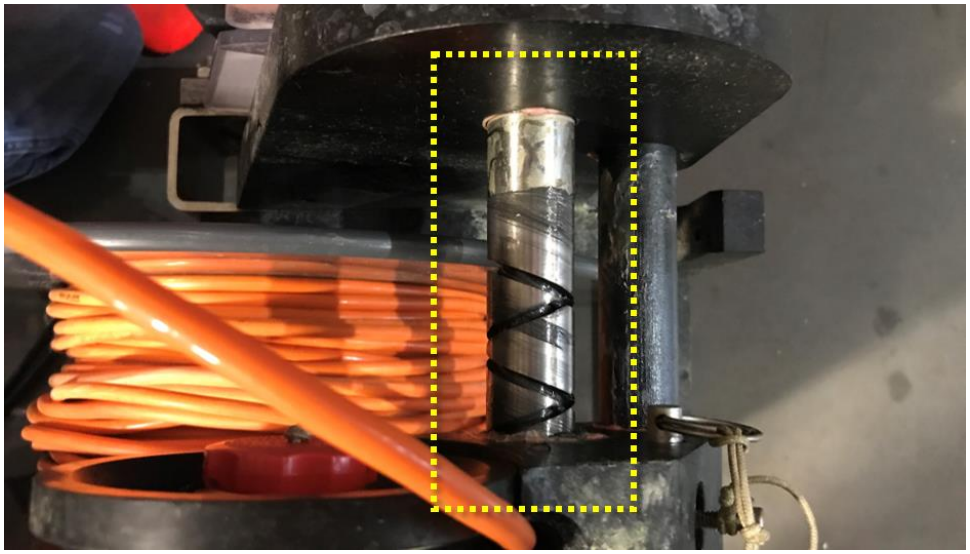


Figure 21. Properly Greased Winch Axle (Axle Rod)

The winch encompasses two safety thresholds. A mechanical safety mechanism and an electrical safety mechanism. For mechanical, the couplet break point has the lowest threshold and YSI provides spares with each AIS Lake Buoy. For electrical, 4.2 amps shuts off the motor.

5.3.4 Adjusting the Mooring System

Fresh water lakes naturally adjust over time. Water levels dropping/rising may strain the mooring system of the AIS Lake Buoy. To ensure the lifespan of the mooring system, and prevent unnecessary strain on the buoy and mooring lines, use the following procedure to adjust the mooring lines to accommodate water level changes at your site.

12. Ensure the mooring lines do not move ±45 degrees. If water level drops, the lines are loose and FOPS needs to remove slack in the line. If water rises, the lines get tight and FOPs need to add slack.
    a. **To add slack**: While standing on buoy, pull in one anchor line to find the sheepshank containing excess line. Remove enough extra line to allow for water depth increase. Retie sheepshank and secure with cord/twine.
    b. **To remove slack**: While standing on the buoy, pull in one anchor rope until line is as tight as desired. Tie excess line into a sheepshank and secure with cord/twine. Then do the same to the other anchor rope. Ideally, the buoy will sit equidistant between the two line floats, but some adjustment may occur to move closer to the site-specific GPS location (this resides in the site as-built document).

Note: YSI expects the mooring system to last up to five years, depending on fresh water lake variables (e.g., fetch, wind, UV, and if any existing objects interfere with the mooring system). If an anchor fails, it is likely to display remotely from rotating GPS coordinates (the AIS Lake Buoy would rotate like a clock if a two-point mooring system). If there are any concerns regarding your mooring system underwater (chains/anchors and other components not visible for maintenance inspections), please submit a ticket to NEON HQ via the Issue Management and Reporting system. NEON HQ will

evaluate the ticket and determine if a diver must deploy to inspect and/or conduct corrective action on the system.

5.3.5 Seasonal Removal/Towing, Storage and Redeployment

5.3.5.1 Winter Removal/Towing

Per NEON.AIS.4.1314, aquatic-based sensor infrastructure shall be removed from select lake and wadeable stream sites prior to ice formation that could result in structural damage. Remove the AIS Lake Buoy when the weather projections are calling for any ice accumulation or severe weather conditions.[2] The buoy is able to handle a light snowfall; heavy snowfall increases the risk of the buoy tipping over. Conduct the following procedure to prepare the AIS Lake Buoy for removal from the lake to tow to your site-specific storage location. ***All submerged sensors must be out of the water before removing the buoy from its mooring.***

1. Decontaminate Trailer prior to site access. Use the procedure in AD [08] for field vehicles. Ensure it meets the height and width requirements of the buoy without the Met Mast. YSI pontoons are narrower than the standard pontoon. To meet buoy specifications, modify the trailer, as follows:
   a. Relocate the mounting brackets to match the width of the pontoon. Leave the rear and center mounting brackets as-is. Move the front bracket forward to meet the trailer frame (see Figure 22). Adjust the ladder/ buoy bumper backwards towards the pontoon float rack by loosening and sliding the U-bolts. Lower the winch to match the buoy height.
   b. "Buoy dimensions are just shy of 7 x 13 ft." (Scott, 2017).

Figure 22. Mounting the AIS Lake Buoy on the Trailer

2. Deploy a boat and to tow the AIS Lake Buoy to land.

[2] *YSI, Inc. About the Vertical Profiler Frequently Asked Questions (FAQs). "Can I leave my system out year round? Unless you have ice or extremely severe storms and weather conditions, your system can be continuously deployed and maintained.* https://www.ysi.com/File%20Library/Documents/FAQs/Vertical-Profiler-FAQs.pdf

3. Place the buoy in setup mode. Turn Flag 2 on (high). Flags are a default term in the profiler software; you are making a request for the system to start or stop an action by turning a Flag on (high) or off (low).
4. Bring all underwater sensors above water. This includes the Multisonde with EXO Link, PAR, SUNA, T-Chain, Depth Sounder and pole. For the Multisonde, see *Section 6.2.1 Multisonde Removal and Replacement.*
5. Pull up the Dual PAR SUNA Mount. Disconnect the two locking carabineers from the eyebolts on the side of the buoy stabilizing the mount underwater and the reference *Section 6.2.2 PAR and SUNA Removal and Replacement* to pull up the mount.

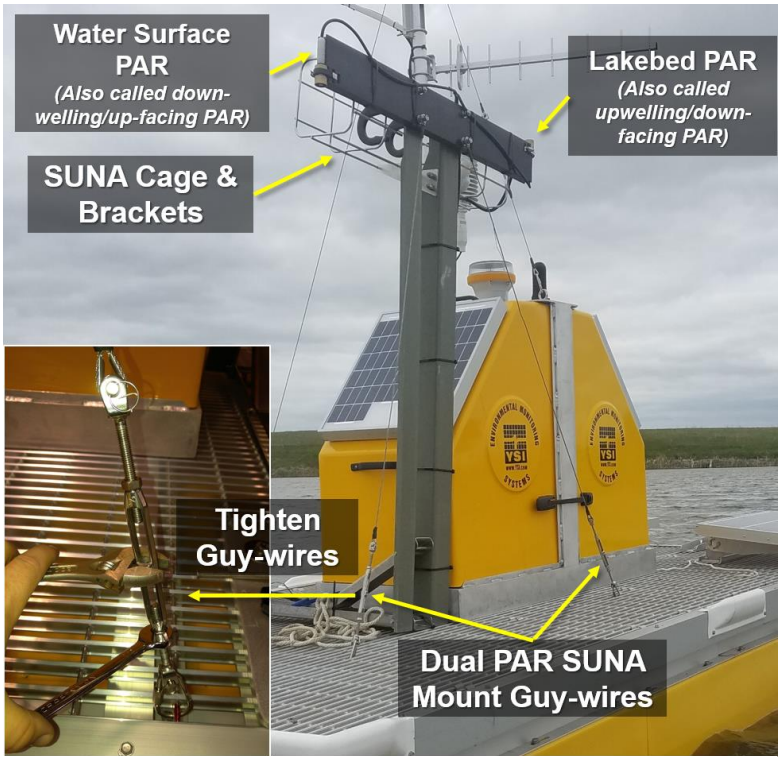


Figure 23. Dual PAR SUNA Mount in an Upright Position with Guy-wires for Transport

PRO TIP: *One PAR faces the water surface and the other PAR faces the lakebed. They sit at each end of the Dual PAR SUNA Mount. Use electrical tape to differentiate between the two to aid reinstallation. Ensure the yellow dot aligns with the raised nub when reattaching cables to the water surface and lakebed PARs.*

6. Secure the Dual PAR SUNA Mount for towing by tightening the two guy-wires when the mount is upright on the floating deck (see Figure 23). Tighten guy-wires for stability: tight, but low in tension.
   a. Using a combo wrench, tighten the tension of the guy-wires.
   b. Loosen jam nuts and tighten the turnbuckle.
   c. Retighten jam nuts after tightening turnbuckles (see Figure 23).
7. Remove the shackles connecting to the bridles to the anchor. To do this, pull the anchor end/line float shackles into the boat.
   a. Use plyers to remove the cotter pin.
   b. Use channel locks and/or a pipe wrench to remove the shackle connecting the bridle to the anchor/line floats (see Figure 24). Leave the bridles attached to the buoy for towing.

Figure 24. Remove Cotter Pin and Shackle Connecting Bridles to Line Float/Anchor Line

8. Secure the buoy mooring system that remains in the lake. Employ Option 1 or Option 2 below, as applicable to site characteristics. A combination of both options is OK, too. This prevents having to search the lake for floats or dig the mooring system lines out of a mucky lake bottom.
   a. **Option 1:** After removing the buoy from the mooring, attach weighted line to each anchor shackle. Remove the line float from the anchor shackle and run the weighted line to shore. Be careful not to entangle the two anchor lines.
   b. **Option 2:** Remove the surface water line floats. Leave the mid-water line floats in place.
   c. **For sites with trip lines:** Attach a weighted line to each trip line and stake the line to shore.
      i. Remove the line float and replace with weighted line, and run the line to shore. Again, be cognizant of the lines to prevent snares.
      ii. Secure all shorelines to shore by leveraging a nearby sturdy object (e.g., tree) or pound in a post to secure the lines.
      iii. If adding any infrastructure, the Domain Manager/NEON Permitting office must coordinate this action with the site host to ensure this is OK. If issues arise, submit a ticket for HQ evaluation.
   d. **For temporary removal**: leave the line floats in place with the anchor lines.
   e. <u>For TOOK:</u> Use the shallow area to the west of the buoy location to secure the shorelines (sturdy object underwater).
   f. <u>For PRLA, PRPO, CRAM, and LIRO:</u> Employ option 1 or option 2 or a combination of both, as applicable, at the discretion of the Domain Manager. If the lake level drops during the winter or freezes to the point of the mid-line floats, causing the mid-ling float to catch in the surface freeze, then employ Option 2. *Ice can move the buoy mooring system in the lake and marine growth/biofouling can disguise the mid-line floats in the spring when attempting to relocate them.*
   g. <u>For SUGG and BARC:</u> Seasonal winter removal/spring deployment requirements do not apply to these two buoy sites. Employ temporary removal requirements, as applicable.
9. Tow the AIS Lake Buoy to land and stage offshore or on dry ground to continue the remainder of the procedure. ***Only tow the buoy by the bridle or the bridle eyebolts on the floating deck.***
   a. Figure 26 provides an example for towing the AIS Lake Buoy to maintain the most control over it on the water. Other methods have proven

Figure 25. DO NOT USE CLEATS

tedious due to the weight of the buoy compared to our boats. **Do NOT tow the buoy by the deck cleats (**Figure 25 **shows a deck cleat).**

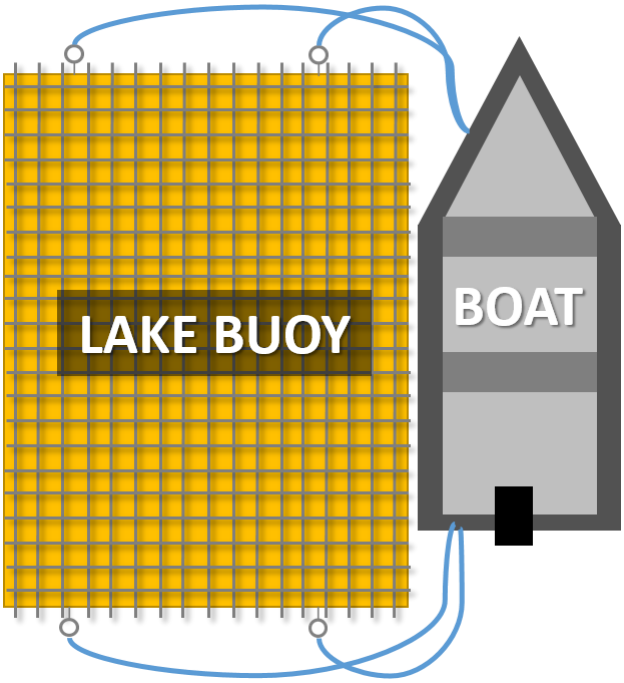


Figure 26. Recommended Towing Technique

10. Power down the buoy by disconnecting the bolts from the battery or unplug the Power Input cord from the profiler canister.
11. Remove the Multisonde. See *Section 6.2.1 Multisonde Removal and Replacement.*
12. Remove the T-Chain.
    a. Cut the zip-ties securing it to the floating deck and unlock the small locking carabineer that connects the Yale Grip rope to the eyebolt just behind the roller.
13. Disconnect the cables connecting to the instruments on the Dual PAR SUNA Mount.
14. Remove the SUNA and the two PARs from their respective brackets.
    a. The SUNA pops out of three black clamps within the cage with some force applied. The SUNA has its own radio provided by NEON, not YSI. It attaches to the deck, below the winch in T-Frame. The power cable connects to the yellow battery box/enclosure.
    b. Remove the two PARs from their rubber protected pipe clamp (see Figure 27). Place black plastic caps at the optical end of the sensor.

Figure 27. Remove the Two PARs from the Mount

15. Remove the Radiation Boom from the Met Mast.
    a. Disconnect the cables to the sensor and cut the zip ties.
    b. Remove via the two U-bolts securing the boom arm to the Met Mast. Reference Figure 28.

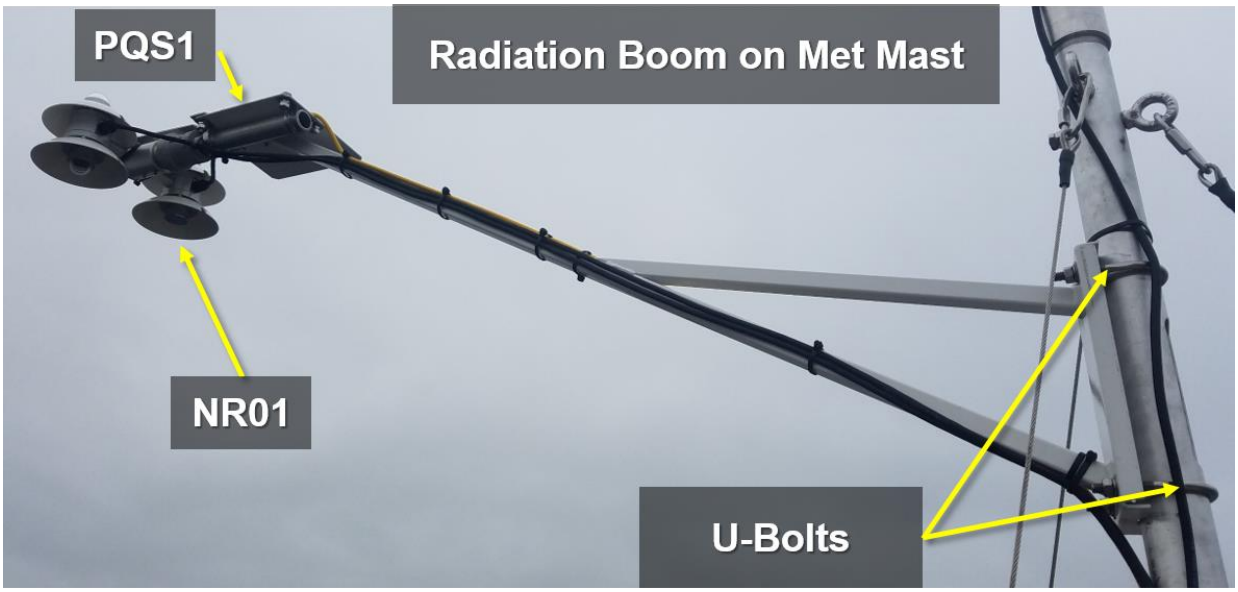


Figure 28. Radiation Boom Mount U-bolt Location

16. Remove the Humidity sensor (HMP155), Radio Antenna, and Radar Reflector. Reference Figure 29.
    a. Disconnect cables and cut zip ties.
    b. Remove U-bolts mounting each component.
17. Remove the Met Mast from the T-Frame. **Do not transport the buoy with the Mast installed**.
    c. Undress the cables and release the guy-wires via their locking carabineers from the floating deck.
    d. Loosen the U-bolts using a 9/16" wrench and slide the Met Mast up and over the U-bolts.

Note: <u>DO NOT remove the U-bolts</u> that attach the Met Mast to the T-Frame. The Met Mast easily tips over.

18. Remove the RM Young Wind Monitor (2D Wind), last, after removing the Met Mast from the AIS Lake Buoy.
    a. Remove only the upper stainless steel band clamp.
    b. Leave the lower location collar (lower stainless steel band clamp). The lower collar maintains the orientation for redeploying the RM Young on the MET Mast (similar to the bump stop) without loss of wind direction reference. See Figure 30 for upper and lower collar location on Met Mast.

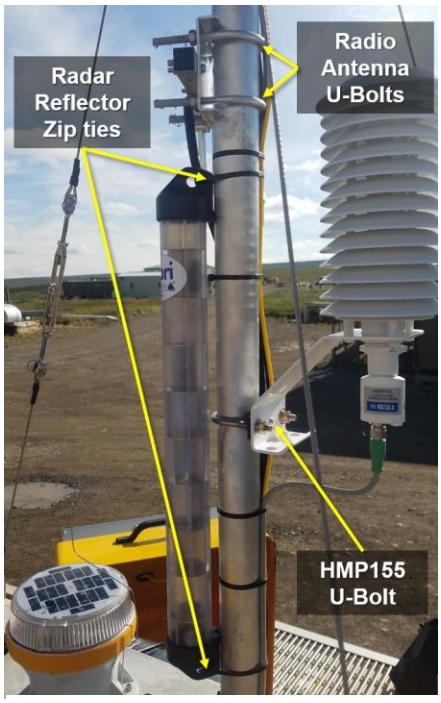


Figure 29. Remove Instruments from Met Mast

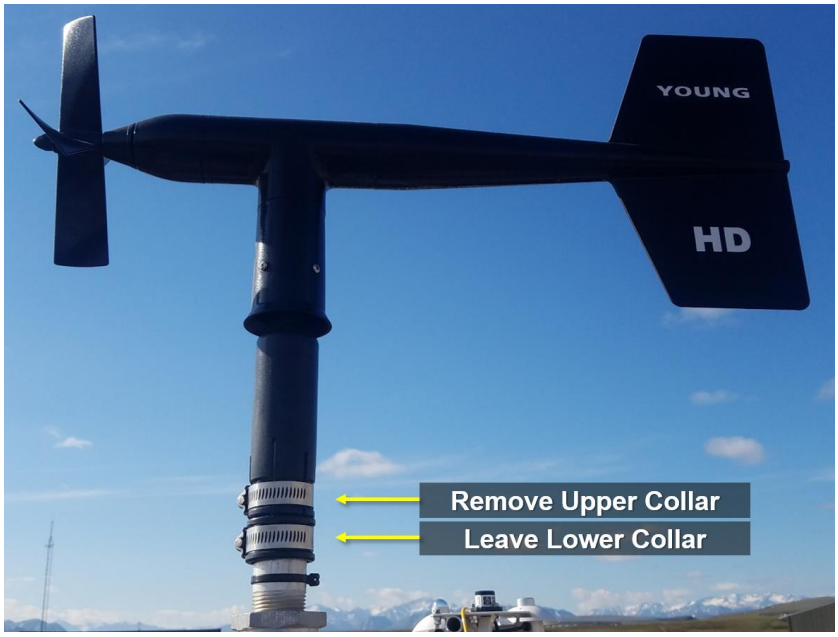


Figure 30. RM Young Wind Monitor (2D Wind) Upper and Lower Collar on Met Mast

19. Remove the Met and Profiler Canisters.
    a. Disconnect all the connections on the canisters.
    b. Each canister secures to the T-Frame via two large hose clamps. Use a flathead screwdriver to disconnect each hose clamp and maneuver the canister free from their grip. See *Section 6.2.3 Profiler and MET Canister Removal and Replacement* for the location of these hose clamps.
20. Remove the Beacon from the buoy by removing the three hex bolts with 7/16" nuts that secure it to the T-frame.
21. Leave the Garmin GPS system on the buoy if storage conditions are above -40°C.
22. Leave the Antenna on the buoy on the buoy if storage conditions are above -40°C.
23. Disconnect the battery directly in the battery enclosure (see Figure 31).
    a. Disconnect the negative lead (black wire) first then disconnect the positive lead (red wire).
    b. Remove the bolt using a ½" open-end wrench to detach the batteries from the solar regulators. Do this for each battery (some sites use more than one).
    c. Two protective yellow 8-amp fuses prevents the battery from receiving an overabundance of electrical current for each battery.
24. Use a forklift with long, narrow tines, if available, to lift the buoy between the pontoon floats and to arrange the buoy on the trailer in and out of the lake/storage location, unless it never leaves the trailer. **NEVER LIFT FROM THE CLEATS.** The deck

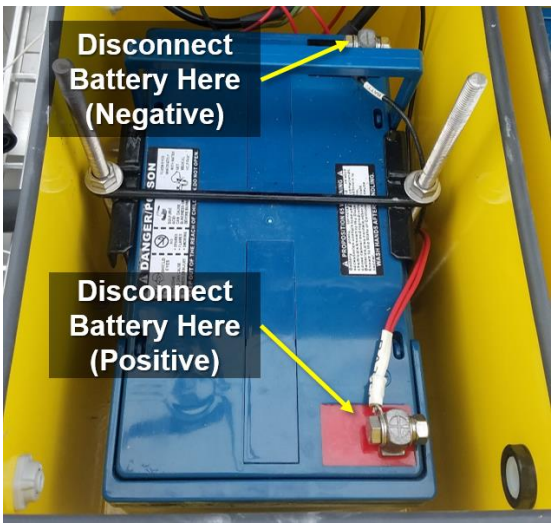


Figure 31. Disconnect the Batteries to Remove from the Battery Enclosure

frame bends and bolts may dislodge, if lifting from cleats. *Address site-specific issues and additional guidance pertaining to this step using the NEON Issue Management/Reporting system.*

a. Secure the buoy to the trailer using ratchet straps. See Figure 32 for examples of ratchet straps securing the AIS Lake Buoy on the trailer.

Figure 32. Ratchet Straps secure the AIS Lake Buoy to the Trailer

25. For transportation purposes, the solar panels on the floating deck may lie flat (for sites that have the two auxiliary solar panels mounting to the floating deck). The solar panels on floating deck attach to a bracket via four hex bolts, eight flat washers, four split lock washers, and four 1/2" nuts.
26. Ensure all connections have caps and are secure for storage.

Note: If pulling the buoy from the lake for temporary removal, do not remove the electronics.

5.3.5.2 Seasonal Storage

Each AIS Lake Buoy requires a seasonal storage unit to protect the infrastructure from winter or temporary seasonal weather (e.g., prevent serious ice accumulation on floating deck for northern sites and destructive tropical depressions/storms and/or Hurricanes at our Florida AIS Lake Buoy sites).

Remove the following instrumentation from the AIS Lake Buoy and store at the Domain Office for temporary storage or send back to CVAL until redeployment in the spring:

1. Multisonde with EXO Link (Send the appropriate probes to CVAL and keep the Body & EXO Link at the Domain Office). No matter which sensors are installed in the instrument, it is important to keep them moist without actually immersing them in liquid, which could cause some of them to drift or result in a shorter lifetime. For example, the reference junction of a pH sensor must be kept moist to minimize its response time during usage, but continued immersion in pure water may compromise the function of the glass sensor and/or result in long-term leaching of the reference junction.
   a. For short-term storage (up to four weeks) of the Multisonde: YSI recommends placing approximately 0.5 inch of water in the calibration cup that was supplied with the instrument, and by placing the Multisonde with all of the probes in place into the cup. The use of a moist sponge instead of a half-inch of water is also acceptable as long as its presence does not compromise the attachment of the calibration cup to the Multisonde. The calibration cup seals prevent evaporation unless the sponge interferes with the seal. Do not use tap water.

b. For interim storage (longer than four weeks): use a minimal amount of water so that the air in the chamber remains at 100% humidity. The water level has to be low enough to prevent immersing the sensors. Any type of water is OK to use in this protocol: distilled, deionized, or tap water. If the storage water is inadvertently lost during field sampling studies, environmental water is OK to use to provide the humidity. Remove the 4 D-Cell batteries to prevent batteries that were in use for a portion of time from exploding in the instrument battery housing.

PRO TIP: *Interim storage of the Multisonde is easy. Simply remember the following key points:*

- *Use enough water to provide humidity for the ph probe, but not enough to cover the probe surfaces.*
- *Make sure the storage vessel seal is in good condition and secure to minimize evaporation.*
- *Check the vessel periodically to make certain that water is still present.*

2. PARs, PSQ1, and NR01 (Send to CVAL)
3. SUNA (Send to CVAL)
4. Beacon (Store at Domain)
   a. Use the IR remote to turn the Beacon OFF to prevent the Beacon from lighting up the LED/using its battery power, while charging. Use the following code via the IR remote:
      i. Off = "**000**"
      ii. Press **Enter**.

*Note: If the Flash Code update was successful, the main LED flashes three times quickly. If the Flash Code update was unsuccessful, the main LED flashes twice slowly. If you were unsuccessful, it means the Flash Code was entered incorrectly. Repeat this process using the Flash Code "**000**".*

   b. Place the AIS Lake Buoy Beacon in the window of the domain office that receives the most direct sunlight. For sites such as Alaska, place the Beacon in a window likely to receive any sunlight. If the Beacon fails to charge due to lack of sunlight, then replace the Beacon batteries prior to deploying the buoy next year. The Beacon uses lead acid batteries. See Table 1 for the replacement battery pack part number.
   c. At the bottom of the beacon (post-removal), its software provides a read out for battery state of health. Scroll through the options to see battery state of health.
      i. Good: A Battery Pack is healthy, and charged (>4.2V).
      ii. A battery voltage between 3.9V and 4.2V means the battery pack requires charging.
      iii. A low voltage (<3.9V) means the beacon will not light up at dusk.
5. Garmin GPS (Leave on the Buoy if storage conditions are above -40°C, otherwise store at Domain)
6. Antenna (Leave on the Buoy if storage conditions are above -40°C, otherwise store at Domain)
7. Depth Sounder and pole (Store at Domain)
8. T-Chain (Store at Domain)
9. One or two 100-amp hour batteries sit within the AIS Lake Buoy T-frame battery housing (Store at Domain)
   a. Place these two batteries in a trickle-charger at the Domain Office to maintain the batteries lifespan when they are not in use.
   b. If a battery is unable to deliver 11 volts, the system shut downs.
10. Profiler and MET Canisters (Send to CVAL)
11. Store the remaining components, namely the pontoon, profiler hardware and solar panels, outside under a tarp/covered roofing or storage unit (garage). Ensure the tarp/cover affixes to the buoy to

prevent unnecessary exposure to the environment and/or mitigate theft/vandalism (e.g., employ some kind of cable/bike lock).

a. While in storage, periodically check on the buoy. It is important to prevent freezing and/or thawing of water in the seams and crevices of the buoy and prevent bird/rodent excrement from accumulating on the buoy.

Note: If pulling the buoy from the lake for temporary removal, do not remove the electronics.

5.3.5.3 Redeployment

Redeployment is at the discretion of the Domain Manager; evaluate site characteristics while monitoring for weather events that call for ice, snow or severe wind. Submit a ticket in the NEON Issue Management and Reporting system to coordinate with HQ on unique events/site characteristics.

For re-installation and maintenance, the AIS Lake Buoy must meet NEON.AIS.5.1349 science requirement "The depth of the submerged sensors on buoys shall be measured and recorded with an accuracy of +/- 5 cm during installation and maintenance." Reference AD [13] and AD [12] for the installation and verification instructions of the AIS Lake Buoy. ***Ensure all underwater sensors are out of the water until the buoy connects to the mooring system.***

A primary concern for instruments during storage are draining the batteries/reducing battery lifespan for specific instruments and the AIS Lake Buoy itself. For redeployment, it may prove beneficial to have smaller battery replacements on hand for the Multisonde (four D-cell internal batteries) and Beacon (replacement battery pack). For the two large batteries that power the AIS Lake Buoy system, maintain cognizance on the battery charger to determine when replacements are necessary.

1. Prior to launch, ensure connectors not in use have caps, the fiberglass T-frame covers are secure and all underwater sensors are above water/secure on the floating platform.
2. See *Section 5.3.5.1* for trailer/towing procedures.
3. For reconnecting the AIS Lake Buoy to its mooring, ensure the following:
   a. The cotter pins are bent in such a way to allow room for plyers for easy removal (do not bend the cotter pins to form around the shackle, just bend them enough to secure the shackle)
   b. The mooring rope allows for at least one meter of vertical travel to account for water level changes.
   c. See *Section 5.3.4* to adjust the mooring system.
4. See *Section 6.2.3* to reconnect the Profiler and the MET canister, and conduct the necessary offsets for the data collection. ***This action requires a compass and level and must occur whenever the MET canister incurs a placement adjustment or undergoes Sensor Refresh for your site.***
   a. See *Section 5.3.2* to reference the port connections on each canister.
5. Per YSI, maintain all submerged sensors at one meter to prevent wear and tear on the cables, unless otherwise directed per AIS science requirements. The dual PAR SUNA mount sits at one meter.
   a. See *Section 6.2.1* to reconnect the Multisonde.

PRO TIP: *The Multisonde comes with a custom YSI tool to remove the sensor probes. This tool is in a hidden compartment inside the Multisonde manufacturer's box. Technicians may have to conduct a minor scavenger hunt to find the tool within the Multisonde original packaging, if one was not originally*

provided with the Multisonde integration/verification or if a replacement Multisonde is sent to a Domain.

b. See *Section 6.2.2* to reconnect the PAR and SUNA sensors on the dual PAR SUNA mount.

Note: For reconnecting the cables on the underwater LI-COR PAR sensor, the yellow dot on the sensor connector must align with the raised nub on the sensor cable before pushing them together in order to obtain the proper pin connection (see Figure 33*). If the dots do not align, this can result in a negative reading on the readout device due to the change in polarity of the conductors. The sensor connector may need periodic lubrication with a silicone grease (e.g. Dow Corning 111, available from LI-COR under product number 210-01958-1) before installing it in the mating connector of the underwater cable.*

6. See *Section 5.3.5.1* to use the reverse order mount the Met Mast Instruments, Beacon, auxiliary Solar Panels, reconnect Batteries, and other remaining components.
7. To check Battery state of health when the Beacon is installed on the AIS Lake Buoy, use the IR Remote to check Battery Health: **810**.
   a. Good: A Battery Pack is healthy, and charged (>4.2V).
   b. A battery voltage between 3.9V and 4.2V means the battery pack requires charging.
   c. A low voltage (<3.9V) means the beacon will not light up at dusk.
   d. Use the IR remote to check Battery Health: **810**.
      i. 4 Flashes = Bad Battery Pack
      ii. 5 Flashes = Low Voltage
      iii. 7 Flashes = Requires Charging
      iv. 10 Flashes = Good Battery Pack (fully charged)

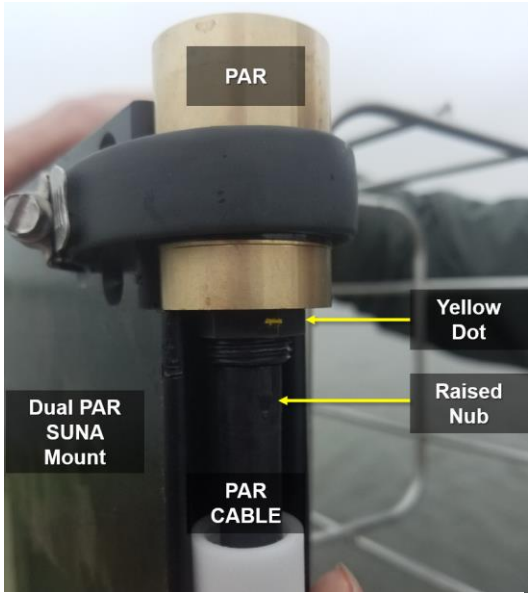


Figure 33. Align the PAR Yellow Dot with Cable Nub for Reinstallation

6 REMOVAL AND REPLACEMENT (SUBSYSTEM ONLY)

6.1 Equipment

Reference Table 1 for the equipment and materials to conduct the procedures in this section.

Note: Maintain original product packaging, if possible, for use in future sensor swaps (calibration and validation), temporary storage, or to return faulty equipment.

Note: Save the any connection port caps for later use. Reinstall the caps to connections for storage, moving and/or shipping.

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 3 for sensor refresh requirements applicable to the AIS Lake Buoy sensor sets.

Table 3. AIS Lake Buoy Instrumentation Calibration and Validation Requirements Summary

	LOCATION		TIMEFRAME			
INSTRUMENT	***CVAL***	***FIELD***	***BIWEEKLY***	***ANNUAL***	***NA***	**COMMENTS**
Multisonde with EXO Link (Suspends under T-Frame)		**X**	**See Comment**			Reference AD [04]. ***Field Validation (Second Reference CVAL Sensor) occurs quarterly.***
SUNA (In Cage on Dual PAR SUNA Mount)	**X**	**X**	**X**			Reference AD [06]. Only send the SUNA to CVAL when the lamp requires replacement. This may occur annually or over a longer duration depending on how long the buoy is operational at your site***. Field baseline spectrum calibrations occur biweekly.***
Water Surface PAR & Lakebed PAR (On each end of Dual PAR SUNA Mount Cage)	**X**			**X**		Return to CVAL per Domain/Site Sensor Refresh Schedule.
Barometer (Under Canisters within T-Frame)	**X**			**X**		Return to CVAL per Domain/Site Sensor Refresh Schedule.
T-Chain (Off Bow of Buoy)	**X**			**X**		Return to CVAL per Domain/Site Sensor Refresh Schedule.
Depth Sounder					**X**	The depth sounder may reach or misread a depth that is considerably thick with lakebed muck. This instrument is power hungry when in use.
PSQ1 (On Radiation Boom, MET Mast)	**X**			**X**		Return to CVAL per Domain/Site Sensor Refresh Schedule.

	LOCATION		TIMEFRAME			
INSTRUMENT	CVAL	FIELD	BIWEEKLY	ANNUAL	NA	COMMENTS
NR01 (On Radiation Boom, MET Mast)	X			X		Return to CVAL per Domain/Site Sensor Refresh Schedule.
RM Young Wind (On Met Mast)	X			X		Return to CVAL per Domain/Site Sensor Refresh Schedule.
HMP155 (on MET Mast)	X			X		Return to CVAL per Domain/Site Sensor Refresh Schedule.
CR1000 Data Logger (In Profile and MET Canister)	X			X		Return to CVAL per Domain/Site Sensor Refresh Schedule.

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

6.2.1 Multisonde Removal and Replacement

This procedure provides guidance on removing and replacing the Multisonde for field calibrations/validations. Conduct the following procedures to remove and replace the Multisonde from the Lake Buoy profiling winch assembly.

1. Unlatch and slide off the T-Frame cover where the Profiler Canister resides. ***The handles for the fiberglass T-Frame cover are not for lifting purposes; they guide the housing on and off the track.***
   a. Note: If the system is currently using the Multisonde to conduct profile measurements, wait for it to complete the sequence and place the system in PARK.
2. Connect a laptop to the Controller Assembly using the diagnostic cable. Attach the buoy serial cable to the RS-232 diagnostic port on the profiler (lower) canister to a laptop using a USB to serial adapter. Figure 34 displays the RS-232 diagnostic port in green.

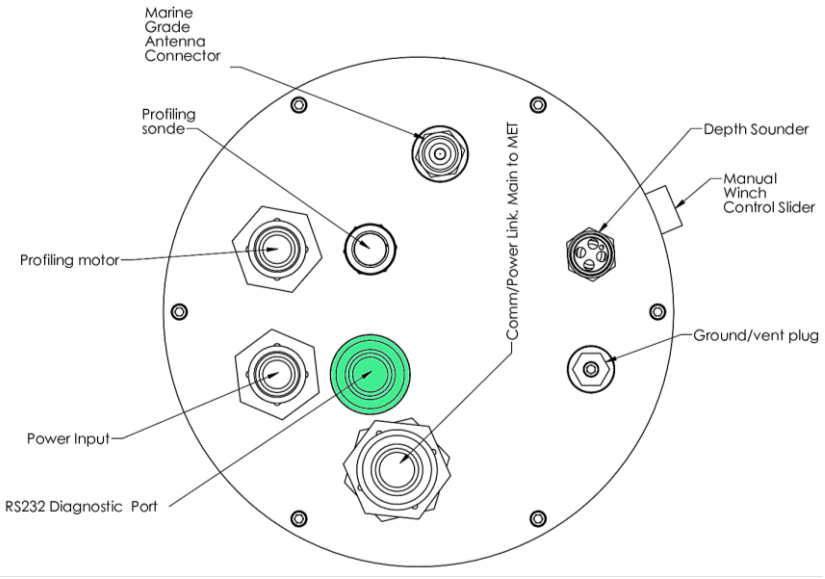


Figure 34. RS-232 Diagnostic Port on Profile Canister (Lower Canister) in Green

3. Start LoggerNet™ and connect to the canister.
4. From the **Connect Screen**, use the "**Ports and Flags**" function to track activity. Note: At this point, Flag 2 should be OFF (low).
5. Turn **Flag [1]** on (high) then **Flag [2]** on (high) by clicking on the green dot/light icon. This stops the AIS Lake Buoy from profiling and places the Profiler system into Setup Mode, keeping it in idle (PARK) mode for the duration of the procedure. Figure 35 is an example of when **Flag [2]** is on (high) (this may take a minute to display).
    a. If the AIS Lake Buoy is not profiling, skip **Flag [1]** and click **Flag [2]** on (high) directly; however, there is no harm in clicking **Flag [1]**, then **Flag [2]** every time. (If it is not profiling, clicking Flag [1] will not result in anything.)

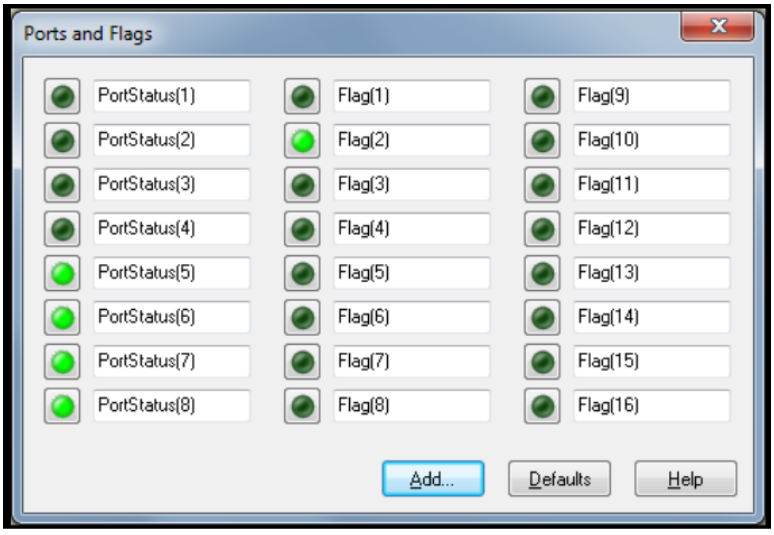


Figure 35. Flag 2 (High)

6. Use the magnetic switch to initiate manual function of the winch in PARK mode to add two feet of slack on the winch cable to enable lifting the Multisonde onto the AIS Lake Buoy floating deck. This prevents dropping the Multisonde and EXO Link into the lake.
   a. A magnetic wand attaches to a string inside the T-Frame next to the battery enclosures, hanging off the profiler canister (lower canister). On the left side of the profiler is a small oblong slot. Waving the magnetic wand across the window activates the winch (see Figure 36).
      i. To lower the winch, slide the magnetic wand to the left along the slot.
      ii. To raise the winch, slide the magnetic wand along the window to the right.

Figure 36. Magnetic Switch to Activate the Winch

Note: The magnet automatically puts the profiler into setup mode. Do not use it after setting up a profiling sequence.

   b. If the magnetic switch fails, manually adjust the winch – grab the winch spool and turn it.
7. Disconnect the Multisonde with EXO Link from the winch by disconnecting the carabineer connecting to the winch and EXO link (see Figure 37).

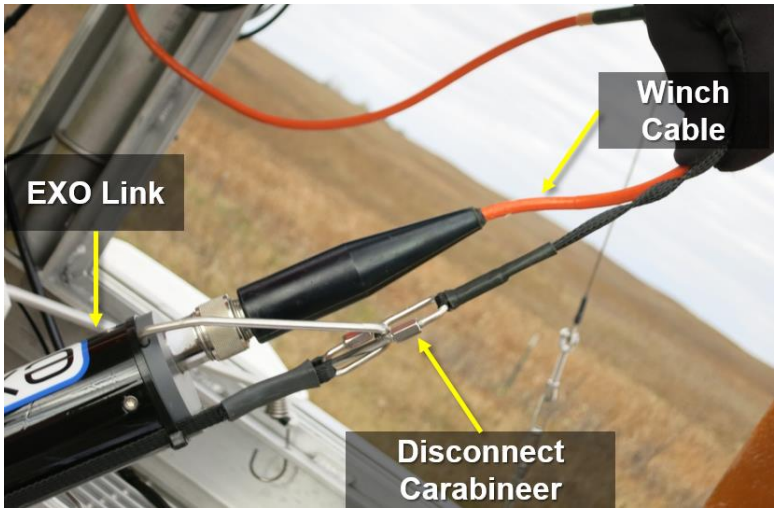


Figure 37. Disconnect Multisonde from the Lake Buoy Winch

Note: In the event the Multisonde with EXO Link requires manual retrieval using the AIS Lake Buoy winch system, avoid pulling the EXO-Link too far into the winch. The winch controller includes a current limiter, which should shut it off in the case of binding. The coupler between the motor and the transmission is also a weak link in the system and will break first to prevent damage to the winch system.

8. Reference AD [04] to conduct the appropriate field calibration and validation procedures.
9. After servicing the Multisonde, reconnect the Multisonde with the EXO Link to the winch via the same carabineer that was disconnected in Step 7.
10. Lower the instrument into the water connected to the winch cable. No need to make any manual adjustments to the winch.

Note: The cable connection must thread through the steel bar and red (or orange) spool (see Figure 38*, called a V-roller suspension assembly to protect the cable from snagging while profiling). Never return the Multisonde into the water under the Winch Assembly without ensuring the winch cable threads properly.*

11. Exit set up mode by setting **Flag [2]** off (low). Click on the bright green dot to turn it dark green (off).
12. To start profiling immediately, set **Flag [5]** on (high).
13. Click "Disconnect" and disconnect the cable from the RS-232 diagnostic port.
14. Cap the diagnostic port.
15. Guide the T-frame cover over the tracks to close it and secure it via its latches.

IMPORTANT: A note on set up, the Multisonde requires its fourth parameter set to **Vertical Position** (meters) instead of Depth (meters) for Stream 4. This is only a requirement for Multisondes measuring the vertical profile of a fresh water lake from an AIS Lake Buoy.

Figure 38. Thread the Winch Cable Properly to Return Multisonde to Water

6.2.2 PAR and SUNA Removal and Replacement

This procedure provides guidance on removing and replacing the SUNA for field calibrations/validations and/or general maintenance. Conduct the following procedures to remove and replace the SUNA from the AIS Lake Buoy dual PAR SUNA Mount.

1. Wear a life vest and gloves, and a have second Technician with you to act as a spotter.
2. Disconnect the two guy-wires from the eyebolts. These guy-wires stabilize the mount to the AIS Lake Buoy when submerged (see Figure 16 in *Section 5.3.2*) locking carabineers.
3. The SUNA and underwater PARs mount to a bracket that must manually lift from the water. This bracket requires a lifting technique to lift out of the water.

Dual PAR SUNA Mount Lifting Techniques:

Technique #1: Squat down and grasp the metal part of the arm right where it joins to the composite arm that sticks into the water. See Figure 39 for start point reference. Apply a pulling force parallel to the composite arm –at first, pull straight up, but as the mount rises out of the water, pull more horizontal. Once the SUNA clears the water surface, have a spotter stand to the side to lend a hand when the mount becomes its heaviest. ***It is important, especially once the sensors are out of the water, to sink down and use your legs; making sure you engage core/leg muscles, instead of your back/arm muscles is key.*** (Source: Torey Ploeger)

Technique #2: Straddle the metal arm (feet close to the edge of the buoy) and grab the bracket with both hands to lift the mount up. See Figure 39 for start point reference. Lean back using your weight to lift the mount above water. As the SUNA breaches the water, the mount reaches its heaviest weight. It gradually becomes lighter the higher the mount lifts. (Source: Geoff Simonds)

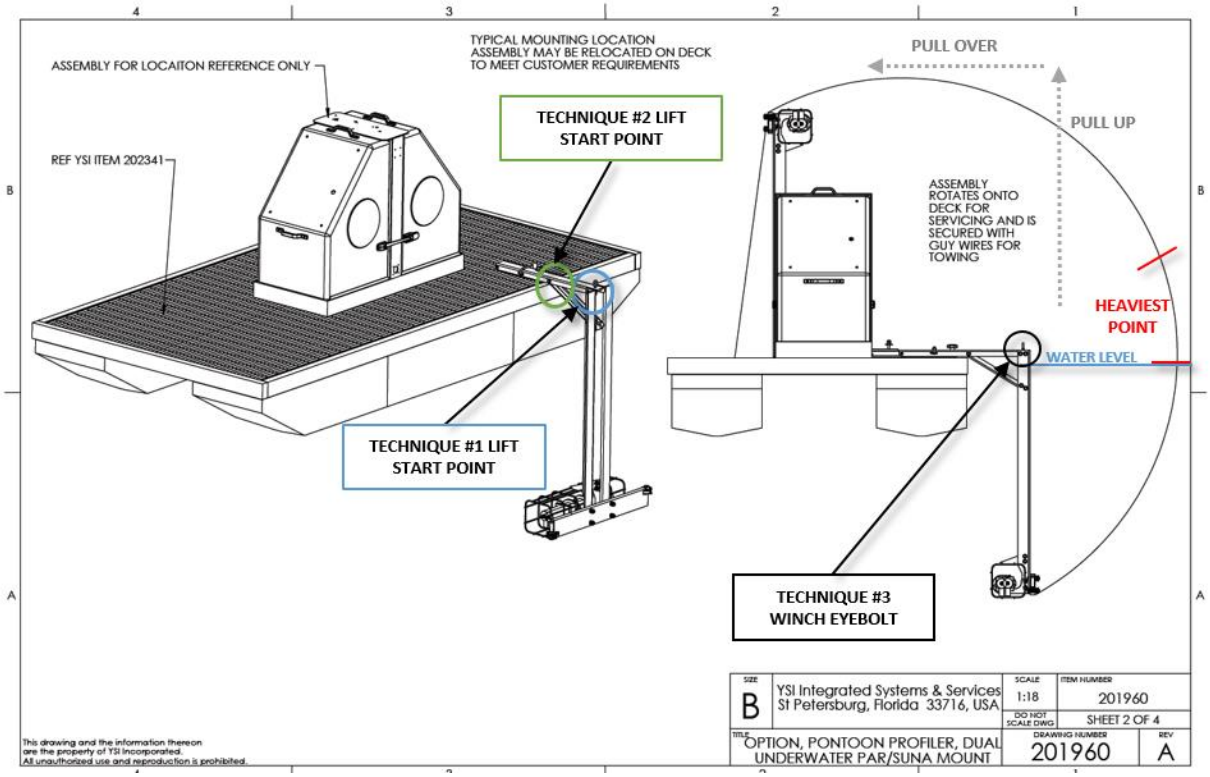


Figure 39. Dual PAR SUNA Mount Lifting Guidance

Technique #3: This technique employs a NEON custom component to assist in raising the mount over the heaviest point. This technique employs a portable winch, which connects to the winch bracket between the winch bracket and the eyebolt near the 90-degree joint of the arm. The winch pulls the mount out of the water to over the center of the buoy where a Technician must guide it down to the bracket in the floating deck.

4. Re-attach the guy-wires to the deck when the mount is sits in its bracket in the up position (reference Figure 23 to see the upright position and guy-wire attachment points on the floating deck of the AIS Lake Buoy).

5. Disconnect power cables from the sensors.
6. Loosen the hose clamp holding each PAR using a flathead screwdriver.
7. Pop the SUNA out of the cage from the three clamps using a small amount of force.
8. Reference AD [06] to conduct calibration and validations for the SUNA.
9. The underwater optical sensors are sensitive and require a special cleaning procedure to remove biofouling from the circular light diffuser (see Figure 40). As a rule, handle the PAR sensors with care; as a rule, do not use a dry brush on any of the optical sensors on the buoy (the two PARs, PSQ1 and NR01).

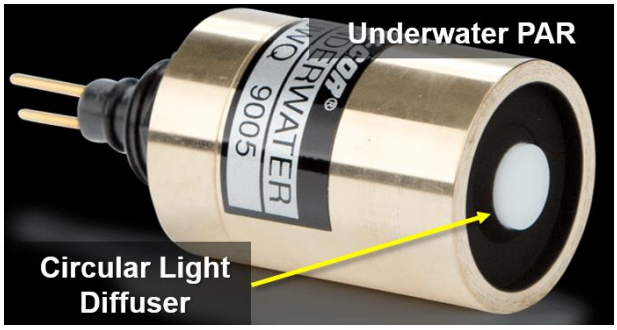


Figure 40. Underwater PAR Circular Light Diffuser

   a. If sending the PARs to CVAL for annual calibration, conduct decontamination per AD [08].
   b. For preventive maintenance, use a lint-free lens cleaning wipe or DI/tap water with lint-free cotton cloth to remove biofouling on the top surface and vertical sides of the circular light diffuser. Use a cotton swab to clean the vertical sides of the diffuser; do not use a cotton swab on the top surface of the diffuser.
10. Reverse this process to return the sensors to the mount and return the dual PAR SUNA mount to the water. Push the SUNA back into the three black clamps.
11. Install each PAR into the hose clamps, and tighten.
12. Reconnect power cables to the sensors.
    a. Ensure the yellow dot on the PAR aligns with the raised nub on the cable for the underwater PAR sensors.
13. Disconnect the guy-wires from the floating deck via their locking carabineers.
14. Slowly lower the mount towards the water with the help of a spotter. ***As soon as the mount hits the water, it significantly reduces in weight and requires a lot less effort to lower.*** However, before reaching that point, the mount reaches its heaviest point, which may feel like it is going to pull you into the water. The mount, at its heaviest, is not far from the water (it should not be too far above the water, see Figure 39 above), so it is OK to let go of the mount if you feel you are losing control or if it is actually pulling you overboard.
15. Re-attach the guy-wires via the locking carabineers to each eyebolt underwater.

PRO TIP: See *Section 10 APPENDIX C: Connecting to the SUNA on the Buoy on page 54* to connect to the SUNA on the AIS Lake Buoy to check configuration and reset the SUNA clock. This process is a more effective and easier means of connecting to the SUNA than through the Grape, and recommended for use at both SUNA In-Stream (S-2) and AIS Lake Buoy locations. However, in the event it is not safe to

connect to the SUNA on the buoy, connect to the SUNA via the Merlot Grape at the MET Station onshore.

6.2.3 Profiler and MET Canister Removal and Replacement

The CR1000 data loggers in the Profiler and MET PVC canister enclosures require annual calibration via CVAL. Employ ESD protocols as a precaution. To Remove/replace the Met and Profiler Canisters, conduct the following procedure.

1. Unlatch and slide off the T-Frame cover where the PVC canisters reside (the canisters face the stern of the AIS Lake Buoy).
2. Power down the AIS Lake Buoy by disconnecting the Power Input cable from the battery box.
3. Disconnect all the connections on the canisters.
4. Each canister secures to the T-Frame via two large clamps. Figure 41 displays the location of each canister and their hose clamps.

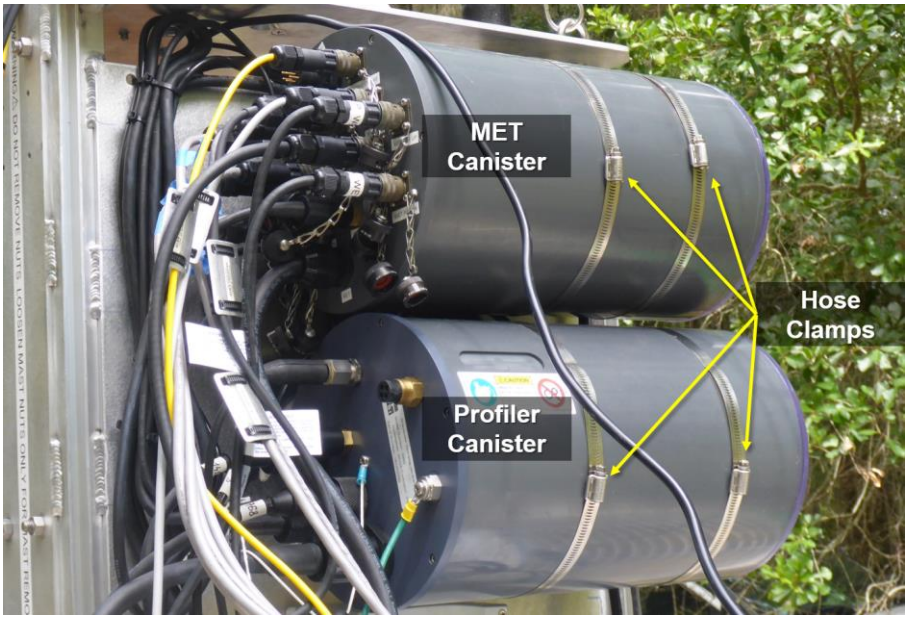


Figure 41. PVC Canister Enclosures for MET and Profiler Electronics

5. Use a flathead screwdriver to disconnect the four hose clamps and maneuver the canisters free from their grip.
6. Package the canisters in a pelican case(s) provided by CVAL as part of your Domain/Sites annual sensor refresh. If you do not have a pelican case(s), please contact CVAL two weeks prior to removing the AIS Lake Buoy for seasonal storage or canisters sensor refresh to request shipping materials.
7. Use bubble wrap to fill the gaps/pack the canisters into the container tight.
8. Use the reverse order of the removal instructions for replacement procedures with exception of the next step. Complete this next step every time the canisters undergo adjustments in their placement, Sensor Refresh, or replacement/installation after corrective action or winter storage.

9. When replacing/moving the canisters when the AIS Lake Buoy is operational, always capture the physical and logical offset[3] for the digital compass in the MET canister. The offset is to correct the data since the orientation of the digital compass is not visible (it sits in a sealed canister).
   a. Use a digital compass to measure the **Heading**. Use the MET software to logically capture this value (instructions below).
      i. Take the compass and set it on the edge of the starboard side of the floating deck centerline. Capture this measurement in the boat next to the AIS Lake Buoy. (Note: The side with the winch may throw off the compass measurements.)
   b. Use a digital level and digital compass to physically capture the **Pitch** and **Roll**. Use the MET software to logically capture these values (instructions below).
      i. Take a digital level and measure the PITCH by placing it on the top of the floating deck along the centerline (at the bow, to measure from bow to stern). Positive PITCH is bow above stern. Capture this measurement in the boat next to the AIS Lake Buoy (your movement can influence the measurement). See Figure 42 for reference.
      ii. Take a digital compass and measure the ROLL from port to starboard. Positive ROLL is port above starboard. See Figure 42 for reference.

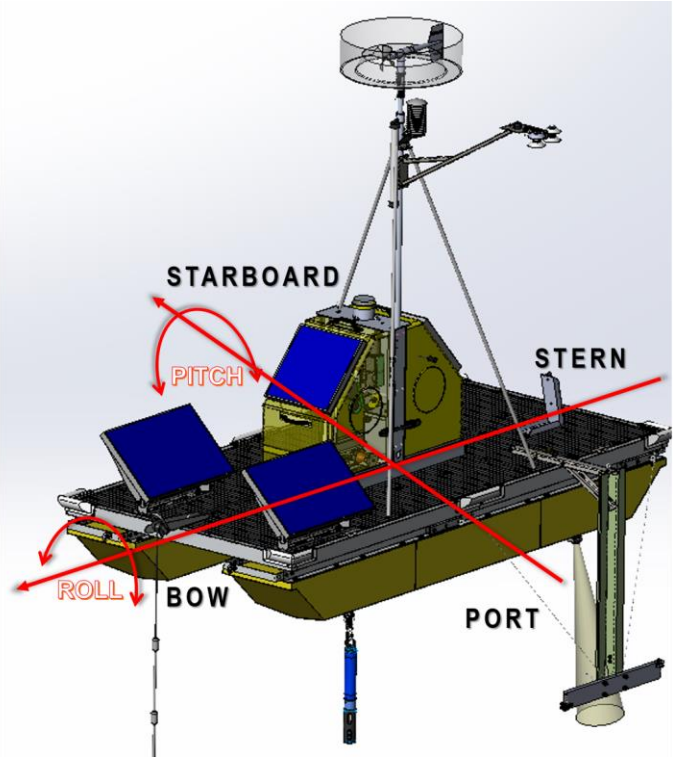


Figure 42. AIS Lake Buoy Pitch and Roll Diagram

[3] *NEON.AIS.4.1742 The buoy shall include a digital compass for horizontal wind direction data correction relative to true north. NEON.AIS.4.1745 The buoy shall include an accelerometer to flag radiation data when the buoy is off-level.*

c. To capture these measurements logically, connect a laptop to the Controller Assembly using the diagnostic cable. Attach the buoy serial cable to the RS-232 diagnostic port on the profiler (lower) canister to a laptop using a USB to serial adapter.
d. Start LoggerNet™ and connect to the canister.
e. Click "**Connect**".
f. Click "**Num Display**" (see Figure 43) to open the Data View.

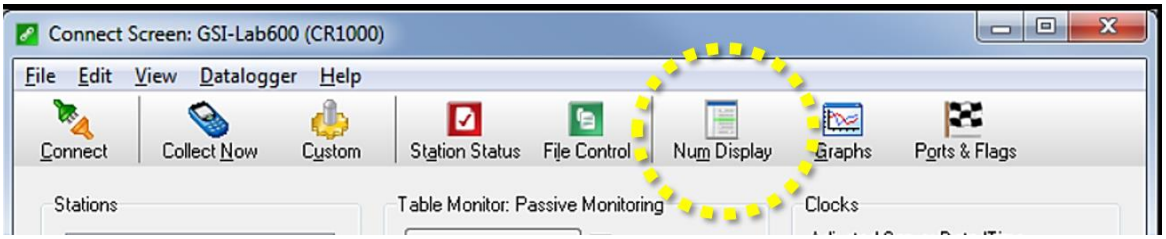


Figure 43. Click "Num Display" Icon

g. If Data View does not display any parameters, see *Section 8 APPENDIX A: Checking for Humidity in the Profile/MET Canisters, Step 5* to load in a pre-existing configuration to view MET data (text files).
    i. To add your own parameter, select a box and click "**Add**".
    ii. Select a parameter from one of the many available Tables; the **Public Table** holds current data.
h. Record the values for **HEADING**, **PITCH** and **ROLL** to go along with the physical measurements made with the compass and level. See Figure 44 below.

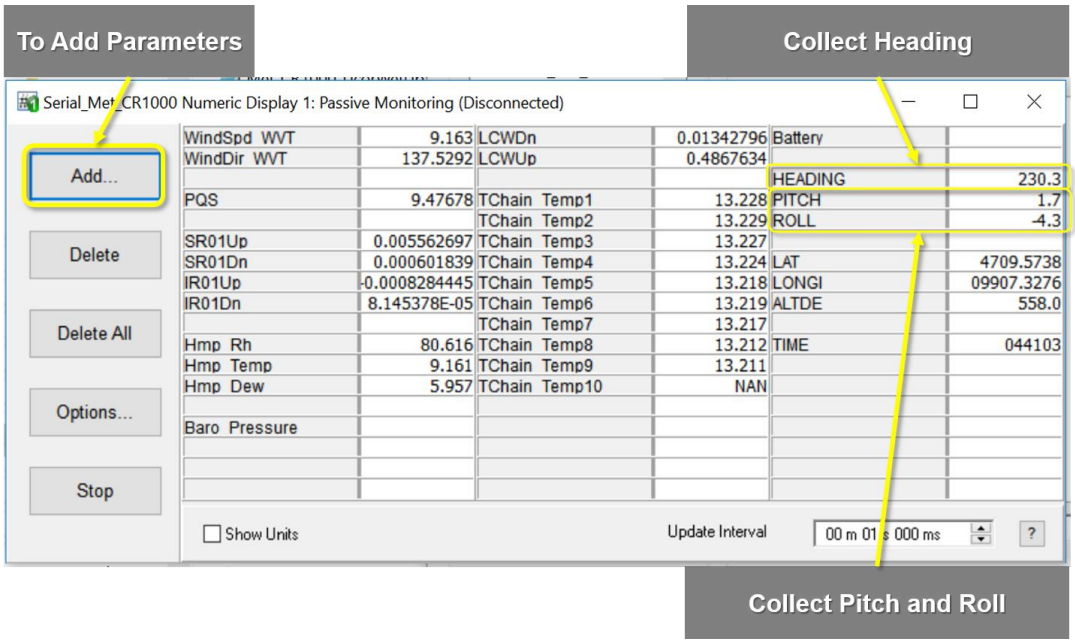


Figure 44. Collect Heading, Pitch and Roll for Offsets

10. After collecting the values, click "**X**" to exit the Numeric Display window.
11. Click "**Disconnect**" and disconnect the cable from the RS-232 diagnostic port.

12. Cap the diagnostic port.
13. Guide the T-frame cover over the tracks to close it and secure it via its latches.
14. Submit/save/send this information to an AIS Science approved location.

6.3 Cleaning & Packaging of Returned Sensor

Field Operations staff decontaminate, package, and ship 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. See *Section 7* for additional instruction).

Please remove all arachnids/insects and any biofouling from buoy instruments prior to packing and shipping.

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. Reference RD [12] for additional information on Sensor Refresh administrative procedures. Ensure the CFG location reflects the current site of the sensor. All devices leaving a CFGLOC must move to SITE first, then TRANSIT/DxxSUPPORT.

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

After installation of the sensors, verify sensor data state of health (DataProduct) in the SAS report the next day (this report updates every 24 hours). Validate sensor data stream(s) and L0 data is good (in green).

6.4.2 Remote Connection Program Information Requirements

This procedure primarily supports the use of a local connection to the AIS Lake Buoy (directly to the Buoy from your laptop). If there is ever a need to access LoggerNet™ (Profiler and MET Software) remotely (from the Domain or HQ), ENG must shut down the RTU program (software that collects and transmits the data from the AIS Lake Buoy to HQ). The RTU program uses the same port we would use to connect remotely to communicate with LoggerNet™. Submit a ticket via the NEON Issue Management/Reporting System to coordinate this action with HQ.

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 aquatic 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.

7.1 Preventive Maintenance Documentation

Maintain a permanent record of site preventive maintenance work. The degree of detail depending on the operating conditions. In any event, it is a valuable reference for subsequent maintenance work and for operation of the AIS Lake Buoy. Include the occurrence of preventive maintenance, the condition of equipment and any corrective actions or events requiring issue reporting. Table 4 is a template of the minimum standard. Technicians are welcome to expand upon this template.

Table 4: AIS Lake Buoy Metadata Output Checklist

Issue Reporting Datasheet		
Datasheet field	**Entry**	
NEON Site Code		
Maintenance Date		
Maintenance Technician		
Preventive Maintenance	**Issue Noted**	**Issue Summary**
AIS Lake Buoy Infrastructure – Condition Check	☐	
Winch Assembly – Condition Check	☐	
Mooring System – Condition Check	☐	
Buoy Instrumentation – Condition Check	☐	

Issue Reporting Datasheet		
Cables & Connectors - Condition Check	☐	
Other Specific Checks/Inspections or Item to Note	☐	
Environmental Information	☐	
Notes		

For AIS Lake Buoy 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 an AIS 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. Figure 45 displays where to create a sub-task from an issue involving a defective asset returning to NEON HQ.

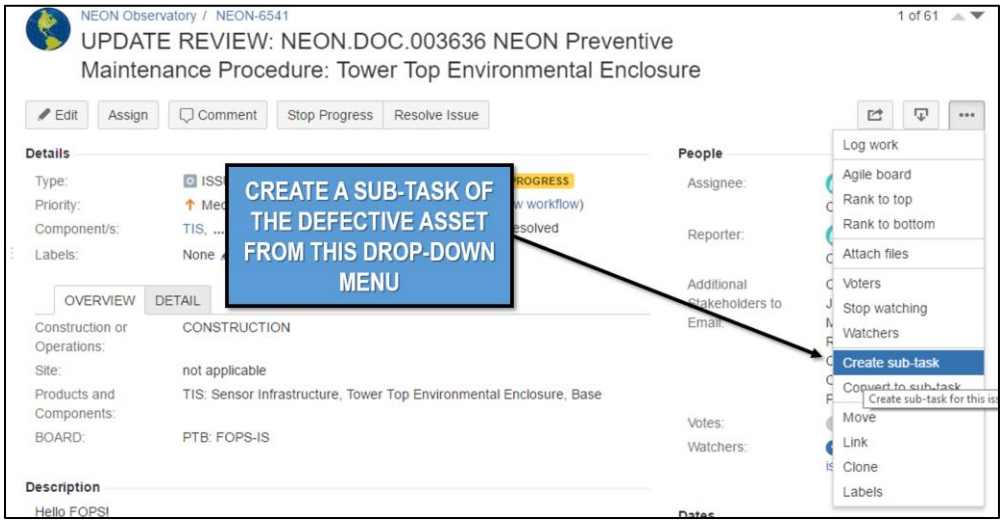


Figure 45. Create a Sub-Task for Chain of Custody of the Defective Asset for HQ Root Cause Analysis

2. Ship all defective equipment/assets with a red “Rejected” tag. Figure 46 displays the minimum information requirements for each tag.

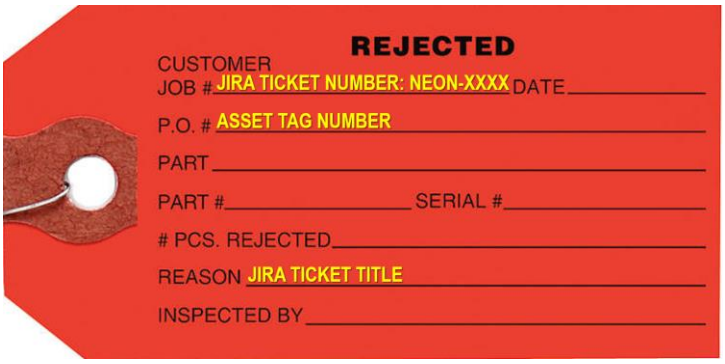


Figure 46. Red Rejected Tag for Defective Assets (MX104219)

8 APPENDIX A: CHECKING FOR HUMIDITY IN THE PROFILE/MET CANISTERS

1. Connect a laptop to the Controller Assembly using the diagnostic cable. Attach the buoy serial cable to the RS-232 diagnostic port on the profiler (lower) canister and to a laptop (using a USB to serial adapter). Figure 34 displays the RS-232 diagnostic port in green.
2. Start LoggerNet™ and connect to the canister. Click "**Connect**".
3. Click on the "**Num Display**" in Figure 47.

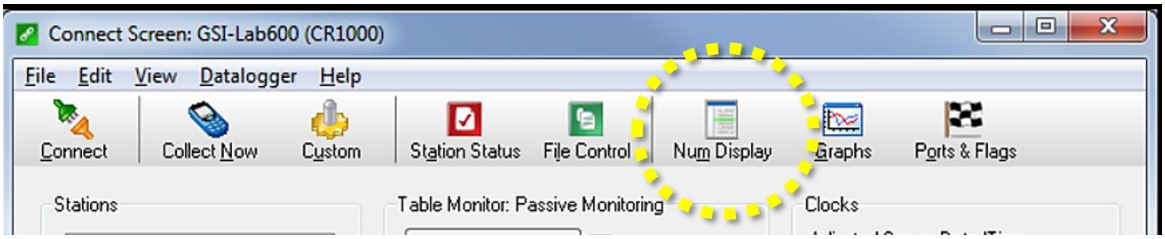
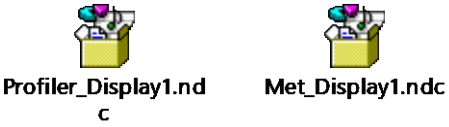


Figure 47. Click Num Display to Load the Configuration Files

4. Click "Load".
5. Use the following text files to load into software (Profiler Display and Met Display):



6. The values are "RH_Avg".
7. Per YSI, the data should display a downward trend once the desiccant is sealed within the canisters. Over time, a leak may present itself in the data in the shape of a rising curve. This may also mean the desiccant requires a refresh or replacement (if no leak is present).

9 APPENDIX B: AIS LAKE BUOY INSTRUMENT OPERATING/STORAGE TEMPERATURES

Table 5 is a summary of environmental parameters for specific equipment on the AIS Lake Buoy.

Table 5. AIS Lake Buoy Equipment Environmental Parameters*

INSTRUMENT	OPERATING TEMPERATURE	STORAGE TEMPERATURE	OTHER INFORMATION
M650H BEACON	Operating Temp.: -45 to 124 ºF (-43 to 51 ºC)	Storage Temp.: -45 to 176 ºF (-43 to 80 ºC)	Technical Support: Email: customerservice@carmanah.com Toll Free: 1.877.722.8877 (US & Canada)
GARMIN GPS16X-HVS GPS	-30° to +80°C operational	-40° to +80°C storage	
T-CHAIN			Requires no less than 9 VDC and no greater than 20 VDC
KIPP & ZONEN PAR, PQS-1	–40 to 80 °C	-30^{o} to +70^{o} C	
DIGITAL COMPASS, HMR3300	-20°C to +70°C	-55°C to +125°C	
RM YOUNG 2D WIND		-50^{o} to +50^{o} C	
UNDERWATER PAR			
BAROMETRIC PRESSURE		-40 to +60C	Firmware Version 1.13, requires calibration
NET RADIATION, NR01		-40^{o} to +80^{o} C	
SDM-SIO1 SERIAL INPUT/OUT MODULE FOR CAMPBELL DATA LOGGERS (IN CANISTER WITH CR1000S)	–25ºC - +50ºC		Humidity: 0% - 95% (non-condensing)
RM YOUNG WIND MONITOR (2D WIND)	-50 to 50°C (-58 to 122°F)		
AIS LAKE BUOY ANTENNA (ON T-FRAME)	-40° C to 85°C		The cable with the connector for the Antenna has an operating range of - 40°F to 165°F and Storage Temperature -65°F to 175°F

**This table lists information that was available at the time of writing this document. It does not include all the equipment on the AIS Lake Buoy.*

10 APPENDIX C: CONNECTING TO THE SUNA ON THE BUOY

This procedure provides instructions for AIS Technicians to connect to the SUNA V2 Nitrate Analyzer on the AIS Lake Buoy. ***Please read this procedure prior to conducting it in the field; disconnecting from the SUNA requires disconnecting from the software FIRST before unplugging the cable from the SUNA. NEVER UNPLUG THE SUNA WITHOUT DISCONNECTING FROM SUNACOM FIRST!***

1. At the Domain Office, download the following SUNA V2 Software, **SUNACom Version 3.0.11/Seabird UCI** and an **FTDI Driver** (if your USB does not have an FTDI Chip) onto a laptop accompanying you in the field.
2. Collect the following materials to complete this procedure in the field: SUNA V2 Cable (Connects to Laptop via USB, the SUNA V2 sensor, and power connection), fully charged Laptop with SUNA V2 Software, gloves to lift dual PAR SUNA mount out of the water, and knee pads to kneel on the Lake Buoy floating deck (as necessary).
3. Connect the SUNA V2 Cable USB into your laptop, the Amphenol power connection into the Radio box where the SUNA V2 derives its power on the Lake Buoy, and the sensor pin connection to the SUNA V2 instrument. The SUNA may remain in the cage for this process on the dual PAR SUNA mount.
    a. There are no issues directly unplugging/plugging into the power connection (this is not like dealing with a Grape).

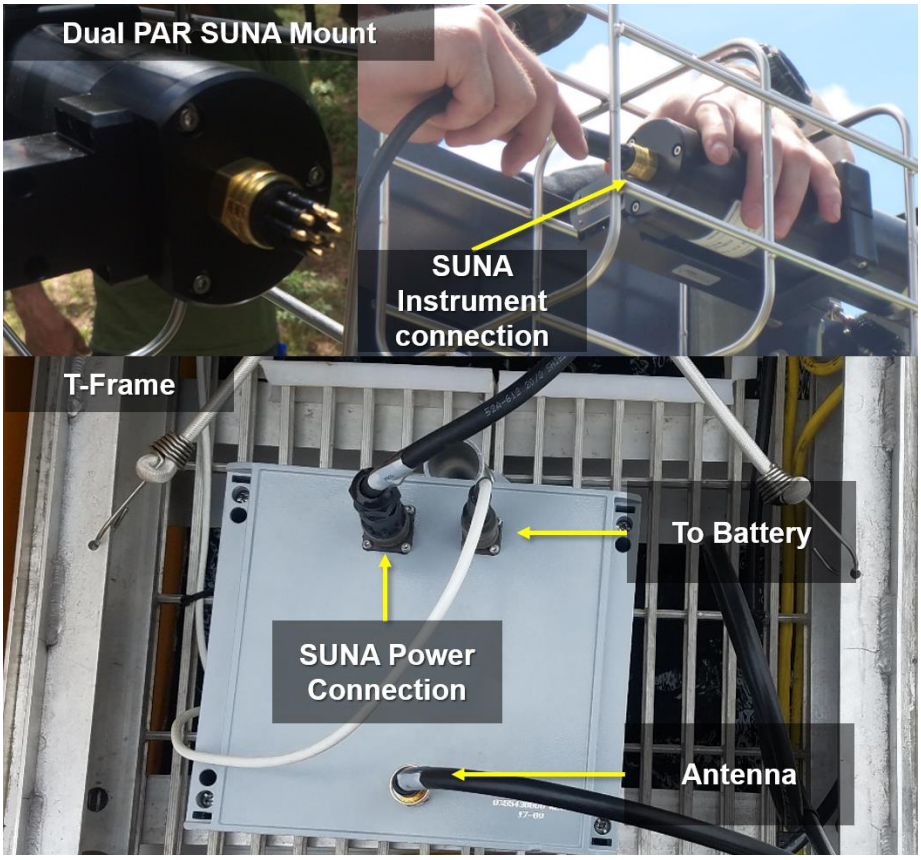


Figure 48. SUNA Instrument and Power Connections on the AIS Lake Buoy

4. Open the **SUNAcom/UCI** software on your laptop.
5. Select the "**Connect**" icon on the left hand side of the window (see Figure 49 and Figure 50)

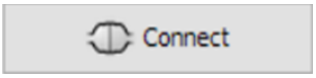


Figure 49. "Connect" Icon

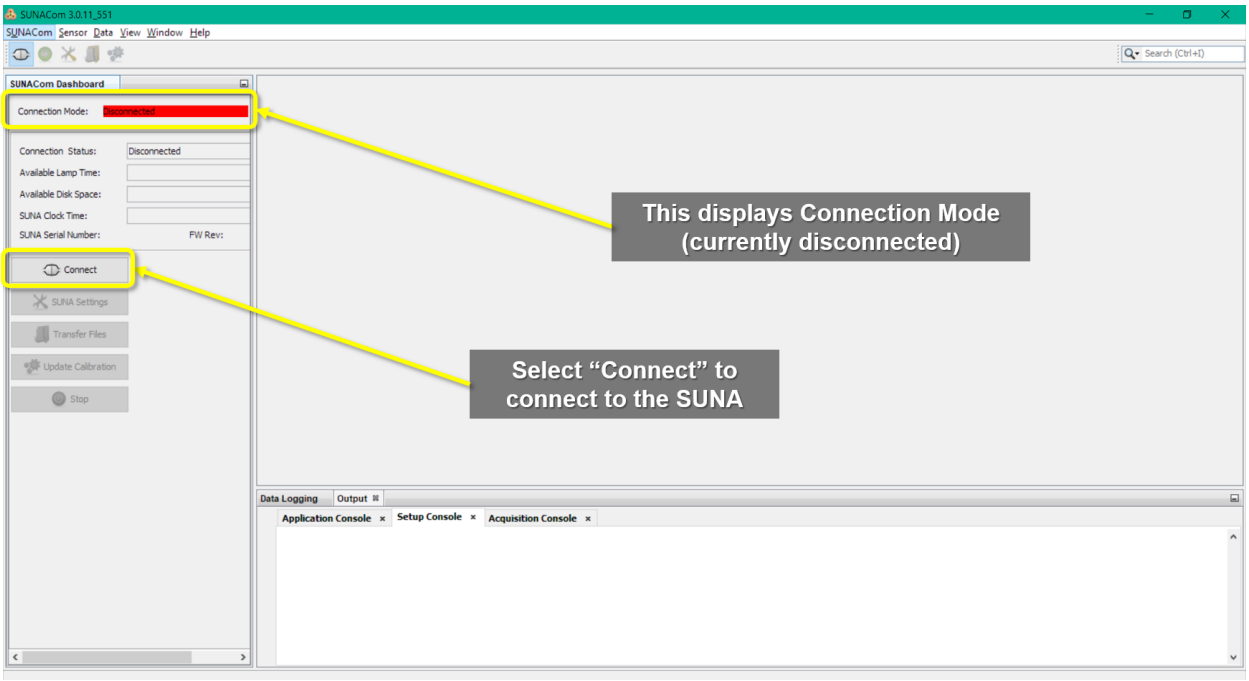


Figure 50. Select the "Connect" Icon (Connection Mode: Disconnected)

6. In the Connect pop-up window, select the Baud Rate from the drop down options (see Figure 51).
   a. Select a Baud Rate of "**115200**" for a SUNA on a Lake Buoy.
   b. Select a Baud Rate of "**57600**" for the SUNA at an S-2.
   c. Select "**COM27**" for both Baud Rates and click "**Connect**".

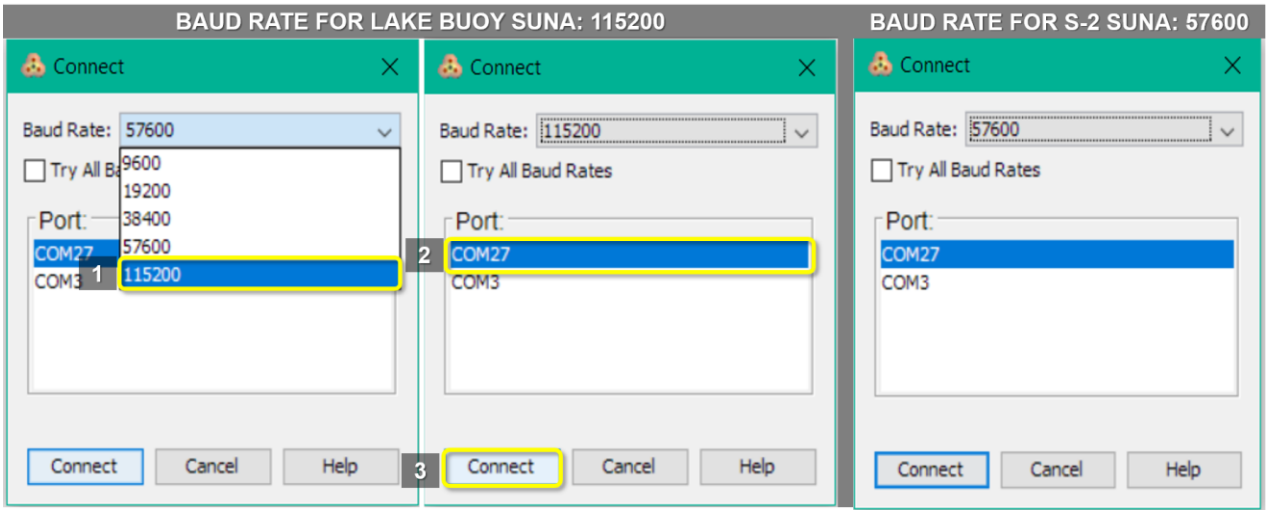


Figure 51. SUNA Baud Rate for AIS Lake Buoy and In-Stream (S-2)

7. The **Connection Mode** under the **SUNACom Dashboard** tab in the upper left hand corner of the window changes to yellow and the "**Setup Console**" tab starts displaying characters (see Figure 52).

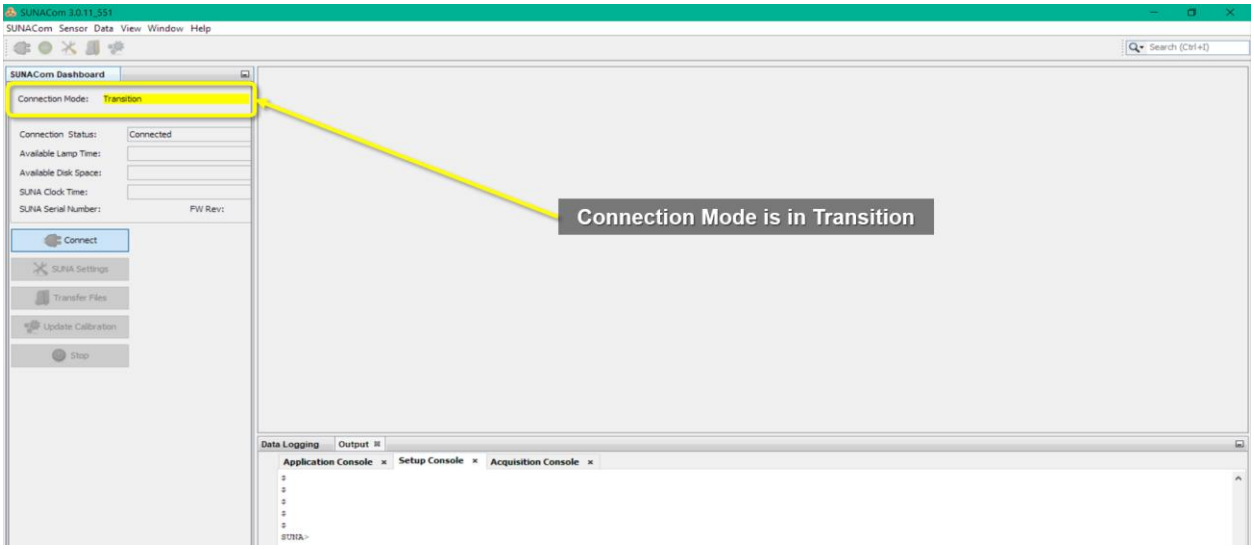


Figure 52. Connection to SUNA is in Transition

8. The connection is successful with the "**Setup Console**" tab displays "**SUNA>**" and connection data is continuously scrolling up, and the **Connection Mode** is green (see Figure 53).

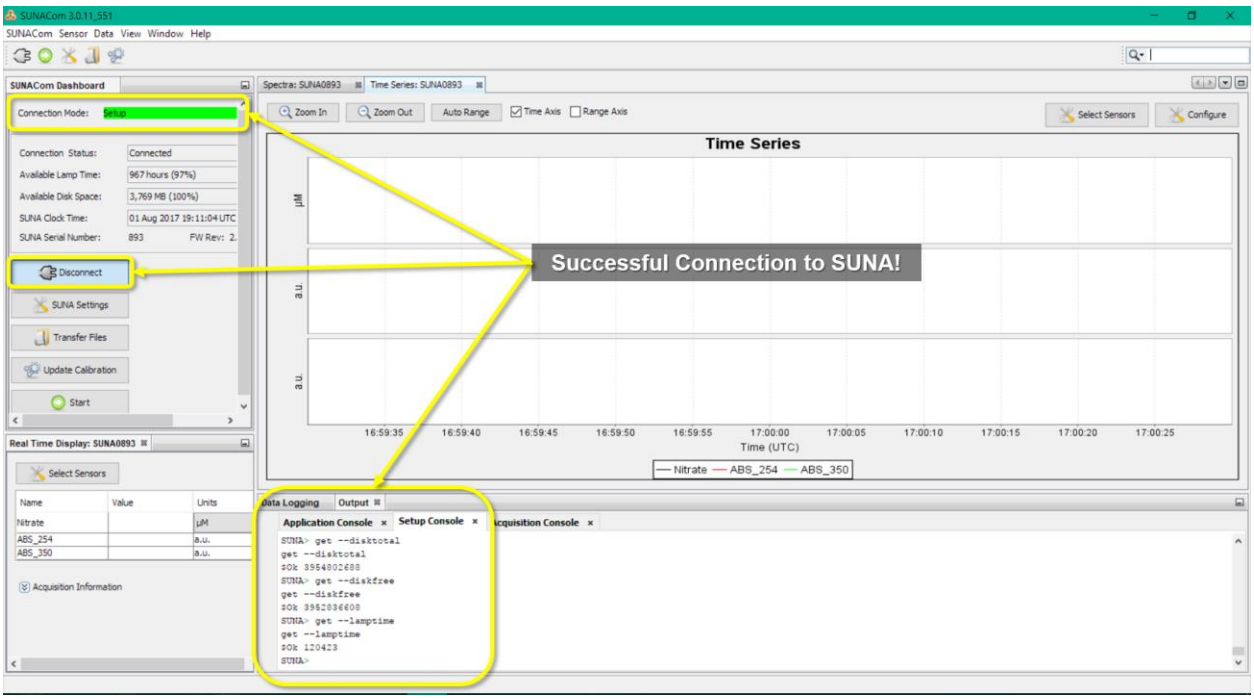


Figure 53. Successfully Connected to the SUNA

9. In the upper right hand corner, select the "**Sensor**" dropdown (see Figure 54).

a. Select "**Advanced**".
b. Select "**Command Terminal**"

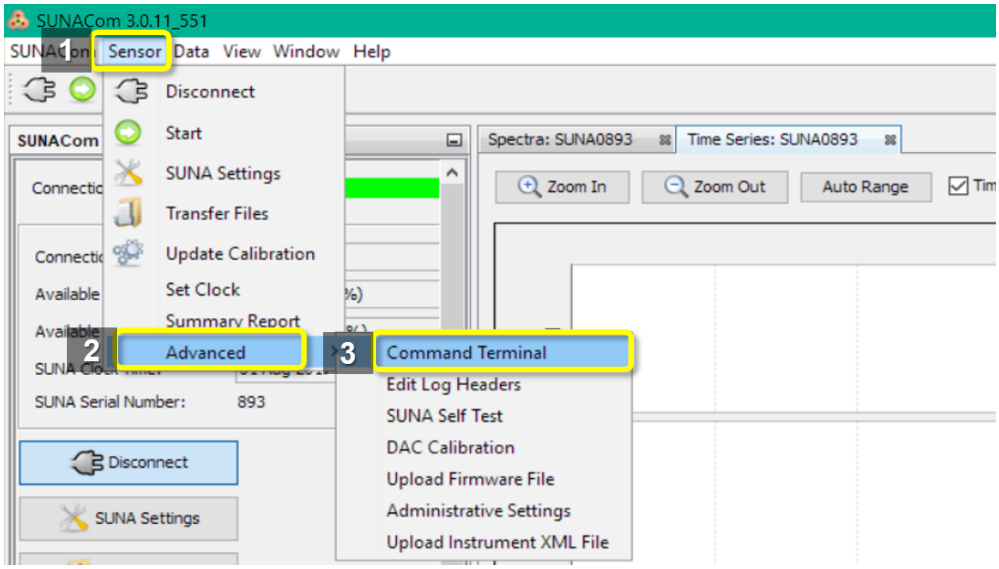


Figure 54. Select "Sensor>Advanced>Command Terminal" from Dropdown

10. This opens a "**Command Terminal**" window. Select "**get --cfg**" and click "**Submit**". This loads your SUNA configuration settings (see Figure 55).

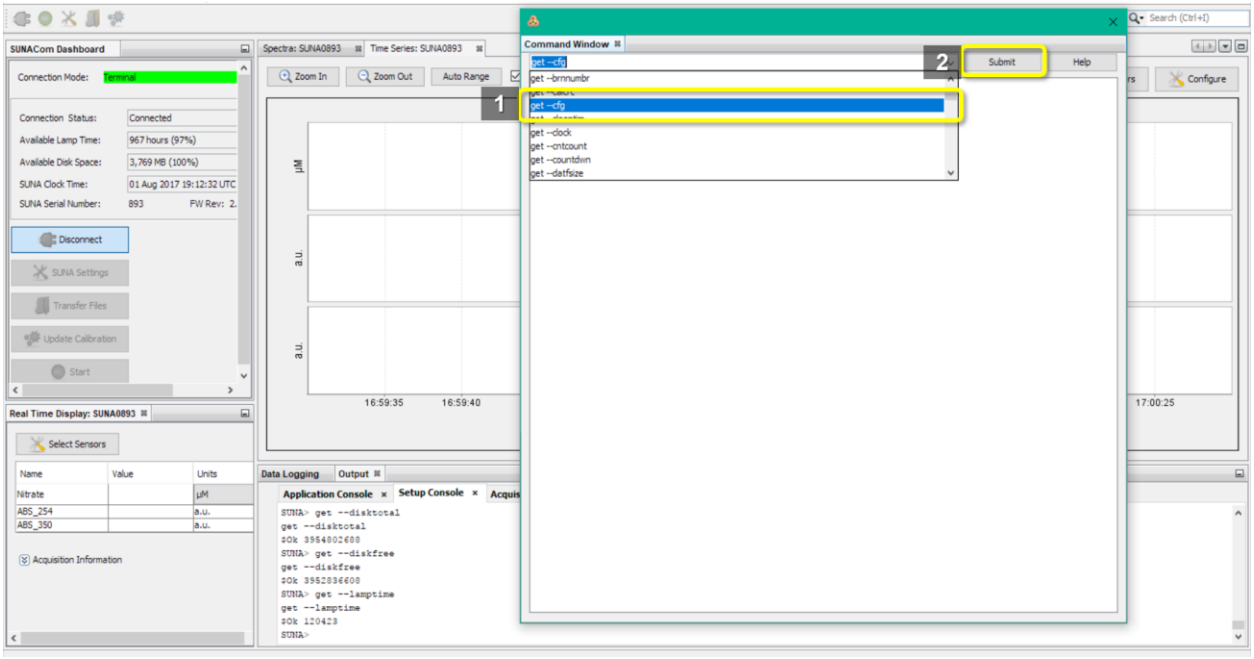


Figure 55. Command Terminal Window "get -- cfg"

11. Compare/cross-reference the SUNA configuration list in AD [05], the C3 for the AIS Lake Buoy (Table 25).

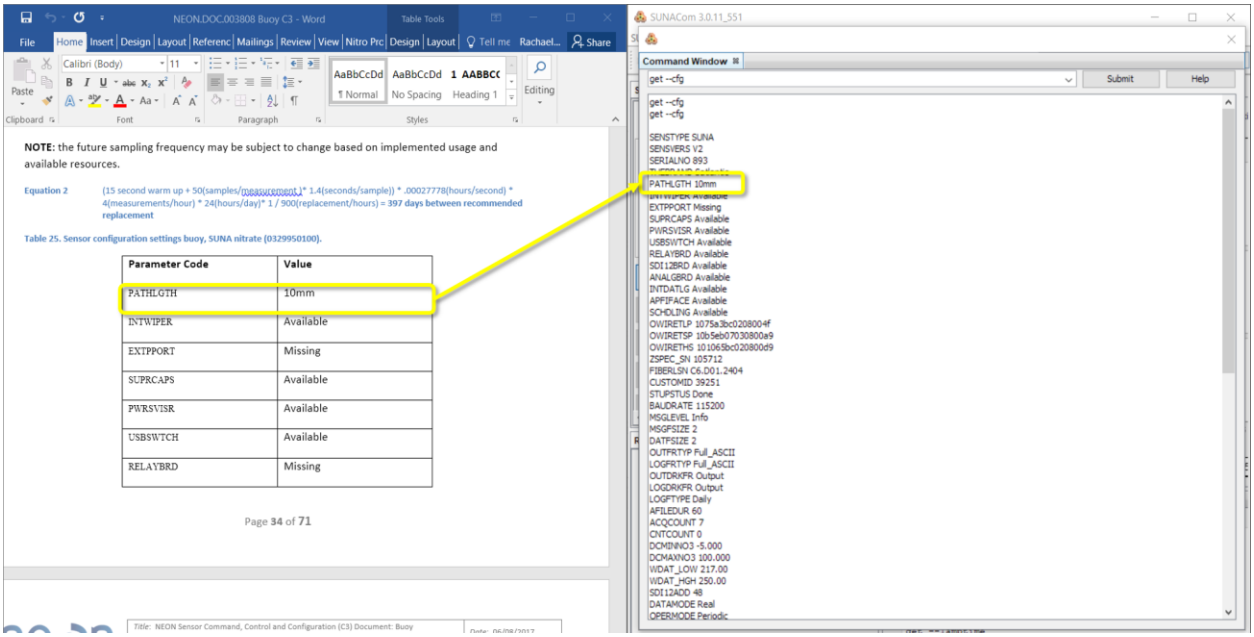


Figure 56. Verify SUNA Configuration Settings are Correct using the C3

12. In the event the SUNA configuration settings do not match, correct it in the **Command Window**.
    a. For example, if "**TEMPCOMP**" does not match the C3, select the dropdown in the **Command Window** and find the **Parameter Code** (see Figure 57).
    b. Select the **Parameter Code** "**tempcomp [value]**".
    c. Modify the **Parameter Code** directly in the **Command Window** dropdown field. Delete the area with the brackets and replace it with the **Value** from Table 25 "**tempcomp off**". If the brackets remain, the software does not apply the change and throws an error.
    d. Click "**Submit**".

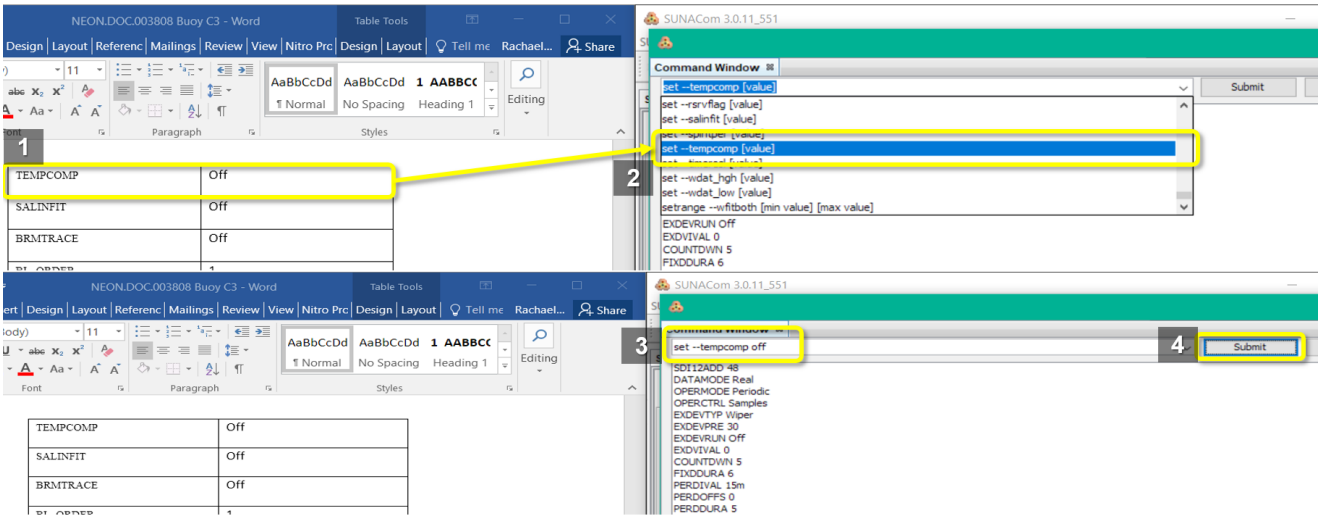


Figure 57. Change "tempcomp [value]" to "tempcomp off" Example

13. The changes display at the bottom of the screen as a confirmation (see Figure 58).

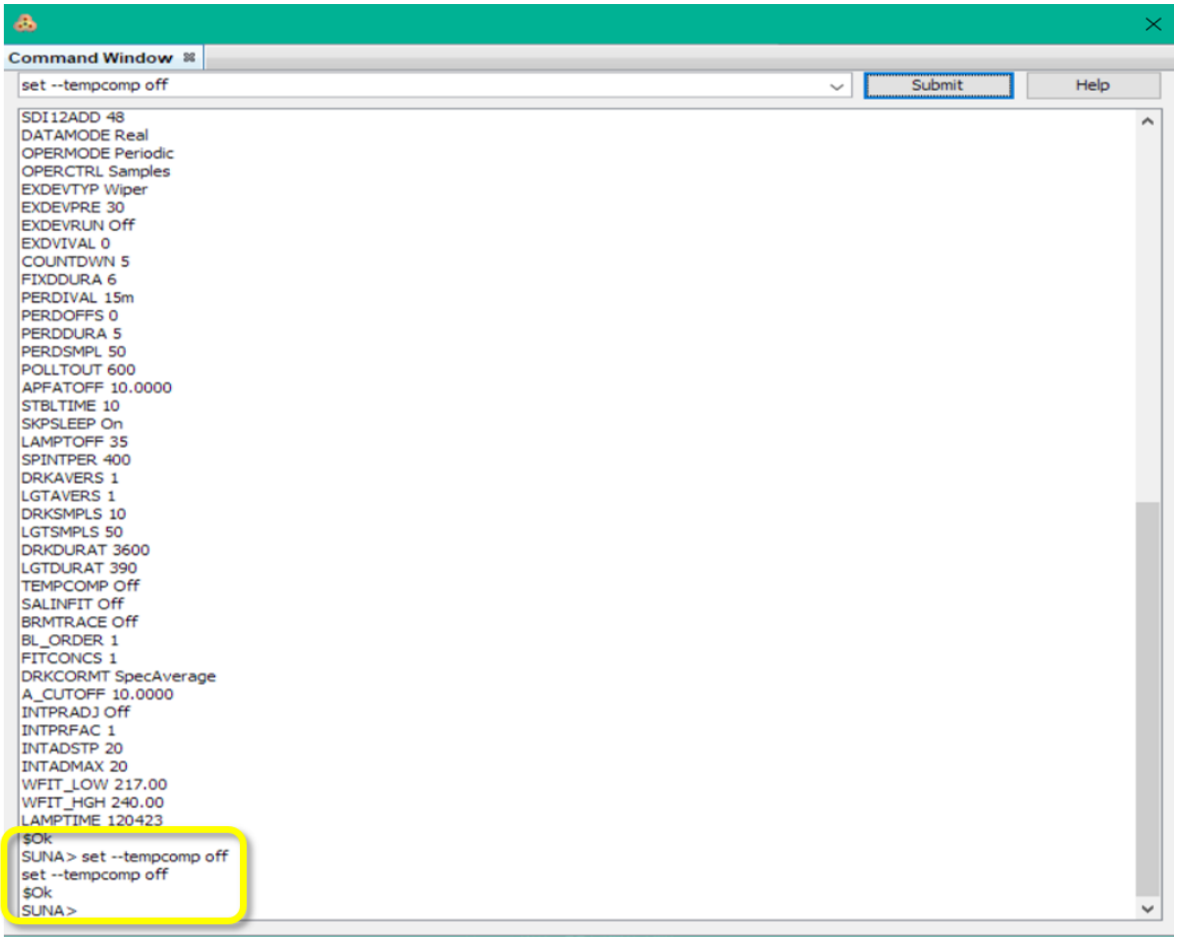


Figure 58. "tempcomp off" Changes Confirmed

14. Reload the SUNA configuration by selecting **"-- get cfg**" and click "**Submit**" to see the changes in the SUNA configuration file.
15. To disconnect from the SUNA configuration via the **Command Window**, click the "**X**" in the upper right hand corner of the **Command Window**.
16. To disconnect from the SUNA instrument, click "**Disconnect**" under the **SUNACom Dashboard** section of the main program window (see Figure 59 and Figure 60).

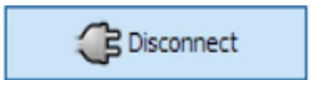


Figure 59. Click "Disconnect" Icon

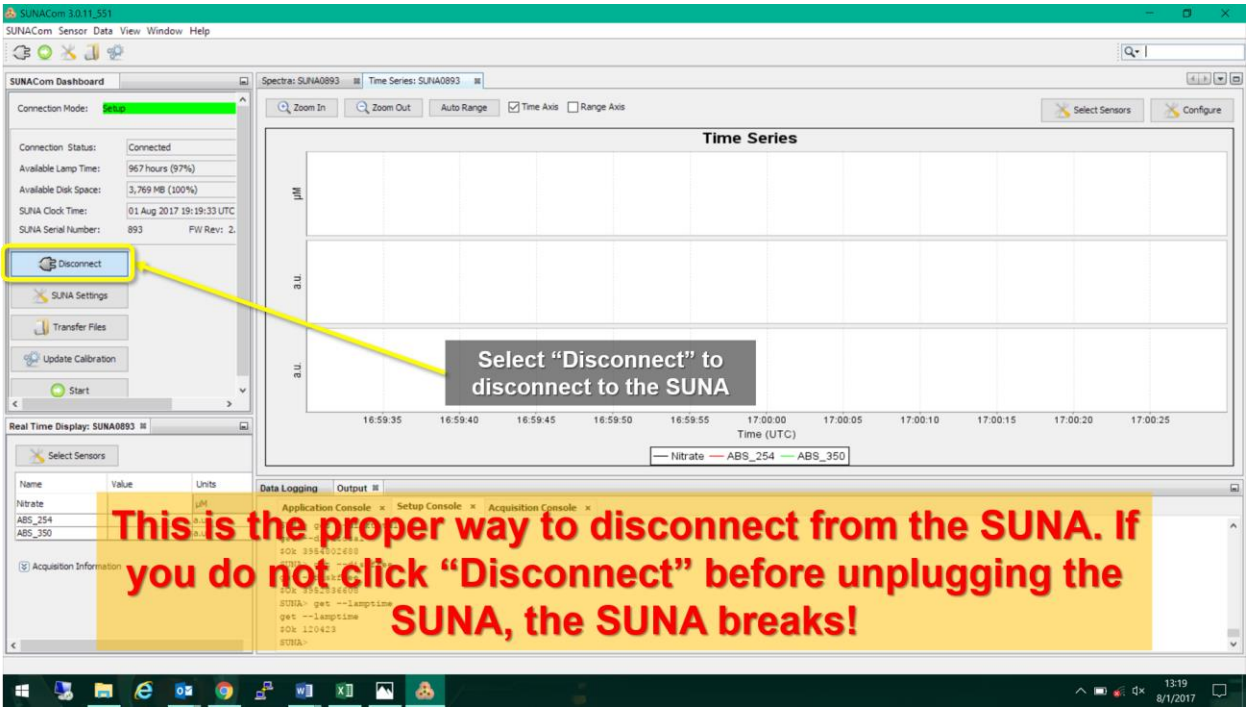


Figure 60. Click "Disconnect" to Properly Disconnect from the SUNA

17. When the SUNAcom software displays the Connection Mode as red, you can safely unplug the cable from the SUNA instrument (see Figure 61).

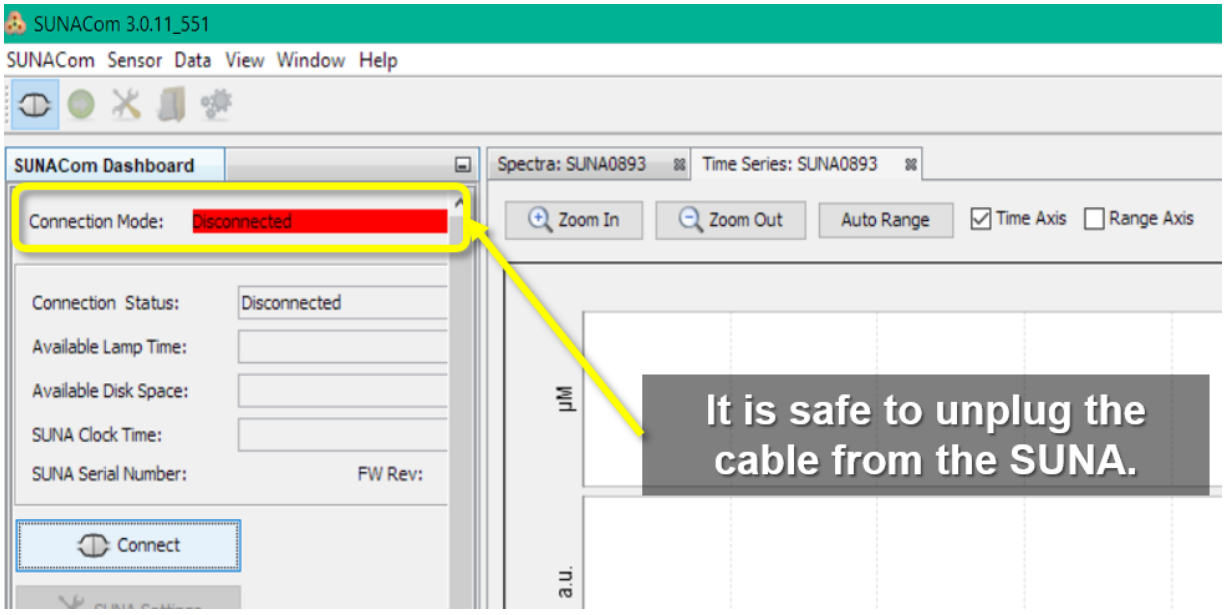


Figure 61. Safe to Unplug Cable from SUNA

11 APPENDIX D: SETTING THE SUNA INTERNAL CLOCK

The SUNA internal clock drifts over time, especially the longer the instrument has been in the field. It must be within +/- 30 seconds Universal Time Coordinated (UTC) for the Location Controller (LC) to collect data from the SUNA via radio link. This procedure provides instructions for AIS Technicians to correct for drift by synchronizing the SUNA internal clock to within +/- 30 seconds UTC. ***Please read this procedure prior to conducting it in the field; disconnecting from the SUNA requires disconnecting from the software FIRST before unplugging the cable from the SUNA. NEVER UNPLUG THE SUNA WITHOUT DISCONNECTING FROM SUNACOM FIRST!***

1. Select the "**Sensor**" dropdown and select "**Set Clock**".

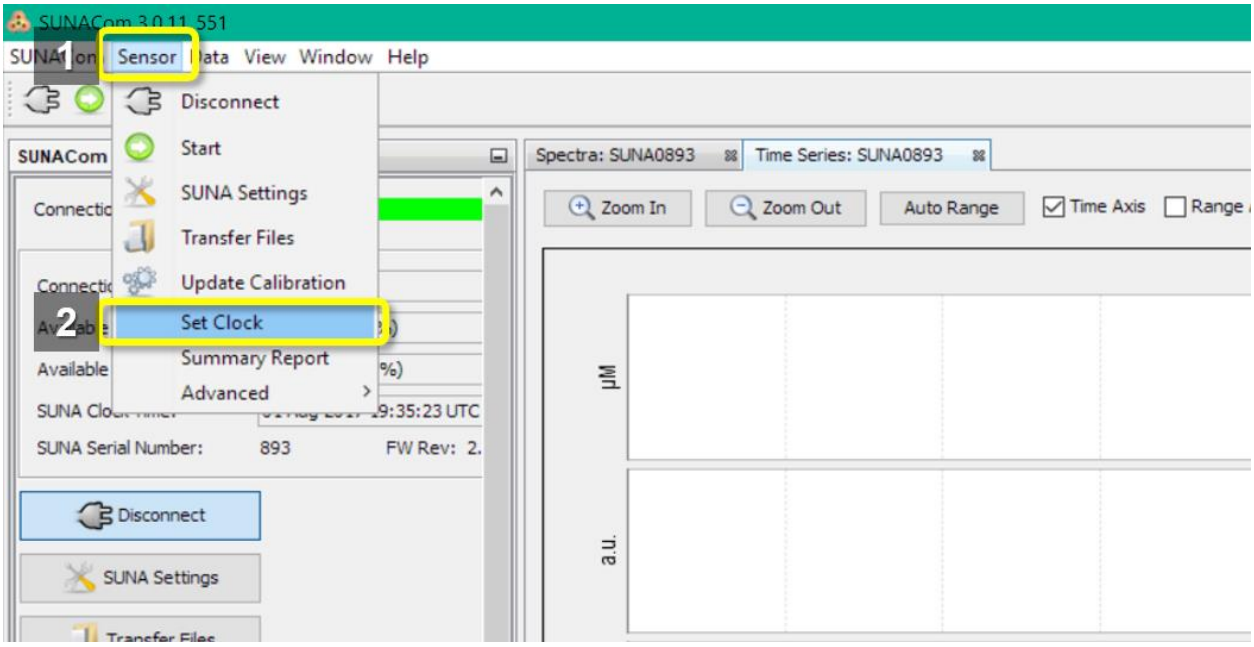


Figure 62. Select "Sensor" and "Set Clock"

2. A **Set Clock** window opens. Click "**Sync Time**" (the **SUNAcom** software automatically converts your computer time to UTC). See Figure 63.

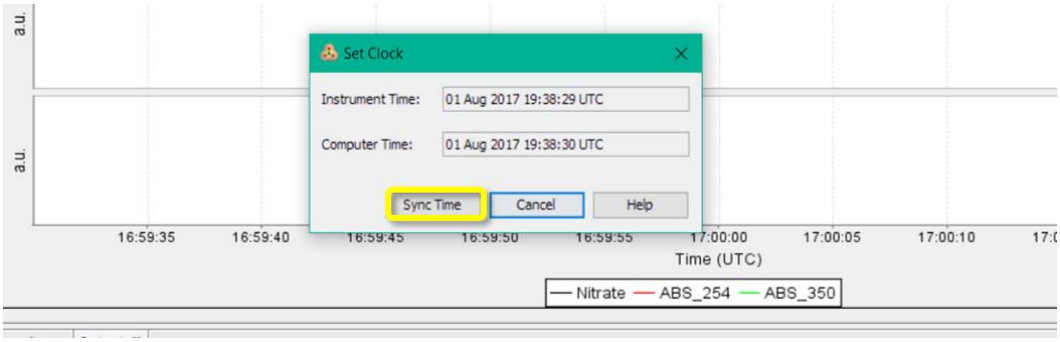


Figure 63. Click "Sync Time" to Synchronize SUNA Internal Clock

12 SOURCES

Allen, Dan. RE: RTU Program Email. September 14, 2017.

Bonarrigo, Santiago. RE: D09 PRPO and D05 CRAM LC Buoy Updates Email. July 24, 2017.

Cawley, Kaelin. Feedback provided via NEON-8659. August 02, 2017.

Corell, Stieg. Technique #3 information for the dual PAR SUNA mount via NEON-8659/in-person. August 3, 2017

Huffman, Corey. Electrical review for storage. August 02, 2017.

Hunter, Allen (YSI). NEON Mechanical Training Presentation PPT. May 2017.

Hunter, Allen (YSI). NEON Mooring Preventive Maintenance Recommendations Phone Discussion with Madeline Cavileer. June 29, 2017.

Hunter, Allen (YSI). RE: Question for Buoy Storage Email. August 02, 2017.

Kelly, Kenneth (YSI). RE: RH% Threshold in Data Logger Canisters Email. September 25, 2017.

Knapp, Liz and Brandon McLaughlin. Below Water PAR Presentation PPT. June 24, 2015.

Monahan, Dylan. NEON-8540: YSI Buoy Retrieval and Storage. July 21, 2017. https://neoninc.atlassian.net/browse/NEON-8540

R.M. Young Company. *Maintenance*. Wind Monitor-HD Alpine Model 05108-45 Instructions, Rev. A030513 (PN: 05108-45-90), Pages 2-3.

Scott, Matt and Megan Zopfi. PRPO Buoy Deployment Instructional Document. Feb 02, 2017.

Schroeder, Matt. FOPS and AIS Toolkit Spreadsheet via SharePoint. August 7, 2017.

Simonds, Geoff. NEON-8181: D18-TOOK Buoy Anchor Trip Lines. June 30, 2017. https://neoninc.atlassian.net/browse/NEON-8181

Simonds, Geoff. NEON.DOC.00XXXX Lake Buoy Formal Verification Procedures. June 02, 2017.

Simonds, Geoff. Mooring and Trip Line Maintenance Recommendations. July 29, 2017.

Tran, Chau. Feedback provided via NEON-8659. July 31, 2017.

Willingham, Rachael. SUNA Software Training Session and Graphics. August 1, 2017.

YSI Incorporated. About the Vertical Profiler Frequently Asked Questions. https://www.ysi.com/File%20Library/Documents/FAQs/Vertical-Profiler-FAQs.pdf

YSI Incorporated. Care, Maintenance, and Storage of YSI 6-Series Probes and Sondes. https://www.ysi.com/File%20Library/Documents/Technical%20Notes/T601-Care-Maintenance-and-Storage-of-YSI-6-Series-Probes-and-Sondes.pdf

YSI Incorporated. *Section 1.3 Getting Started*. Vertical Profiler System (CR1000) Manual, Version 3. December 19, 2011.

YSI Incorporated. *Section 6.4 Maintenance – Servicing Other System Components*. Vertical Profiler System (CR1000) Manual, Version 3. December 19, 2011.