NEON PREVENTIVE MAINTENANCE PROCEDURE: PRIMARY PRECIPITATION GAUGE AND DOUBLE FENCE INTERCOMPARISON REFERENCE (DFIR)

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See configuration management system for approval history.

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Change Record

REVISION	DATE	ECO #	DESCRIPTION OF CHANGE
A	01/05/2018	ECO-04642	Initial release
B	12/01/2022	ECO-06920	Updated NEON logo and minor formatting fixes

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1 DESCRIPTION

1.1 Purpose

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

This document details the procedures necessary for the preventive maintenance of the **Primary Precipitation Gauge - Belfort AEPG MKIII Precipitation Gauge and Double Fence Intercomparison Reference (DFIR)**, herein referred to as the Primary Precipitation Gauge and NEON DFIR.

1.2 Scope

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

This document specifically addresses the preventive procedures to maintain the Belfort AEPG MKIII Precipitation Gauge and Double Fence Intercomparison Reference for all applicable NEON terrestrial and aquatic sites. This covers the instrumentation, subsystem and infrastructure.

The procedures in this document are strictly preventive. Address corrective maintenance issues uncovered while performing preventive maintenance using the corrective maintenance procedure associated with this subsystem.

2 RELATED DOCUMENTS AND ACRONYMS

2.1 Applicable Documents

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

AD [01]	NEON.DOC.004300	NEON Environmental, Health, Safety and Security (EHSS) Policy, Program And Management Plan
AD [02]	NEON.DOC.004301	NEON Environmental, Health, Safety and Security (EHSS) Environmental Protection Manual
AD [03]	NEON.DOC.000724	Chemical Hygiene Plan and Biosafety Manual
AD [04]	NEON.DOC.004316	Operations Field Safety and Security Plan
AD [05]	NEON.DOC.050005	Field Operations Job Instruction Training Plan
AD [06]	NEON.DOC.001427	TIS Communications Interconnect Map
AD [07]	NEON.DOC.000897	NEON Sensor Command, Control, and Configuration (C3) Document: Primary Precipitation
AD [09]	NEON.DOC.000898	Algorithm Theoretical Basis Document (ATBD): Primary Precipitation Gauge
AD [09]	NEON.DOC.000804	Site Flora and Fauna Maintenance Plan
AD [10]	NEON.DOC.002768	TIS Subsystem Architecture, Site Configuration and Subsystem Demand by Site - SCMB Baseline
AD [11]	NEON.DOC.002767	AIS Subsystem Architecture, Site Configuration and Subsystem Demand by Site - SCMB Baseline
AD [12]	NEON.DOC.003519	How-To: Turn on a Communication Box Relay
AD [13]	NEON.DOC.004756	Domain 08, Talladega Primary Precipitation Data Transmission Procedure
AD [14]	NEON.DOC.004257	NEON Standard Operating Procedure (SOP): Decontamination of Sensors, Field Equipment And Field Vehicles

2.2 Reference Documents

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

RD [01]	NEON.DOC.000008	NEON Acronym List
RD [02]	NEON.DOC.000243	NEON Glossary of Terms
RD [03]	NEON.DOC.000705	NEON Bolt Torque Specifications
RD [04]	NEON.DOC.003289	L1P100 Field Calibration/Validation Primary Precipitation Sensor Standard Operating Procedure N:\Common\CVL\Field_Calibration\Manuals\NEON.DOC.003289.1PrecipSOP.pdf
RD [05]	NEON.DOC.003484	Primary Precipitation Gauge (DFIR) Installation Procedure

RD [06]	TU11340000	DFIR/Primary Precipitation Gauge Drain System
RD [07]	NEON.DOC.011072	FIU Precipitation Collector Site Design Requirements
RD [08]		Site Network Configuration Documents N:\Common\SYS\Site Network Configurations

2.3 External References

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

ER [01]	Belfort Instrument, All Environment Precipitation Gauge (AEPG) Instruction Manual Filename: AEPG-Instruction-Manual-1.pdf SHA1 Checksum: af7a984502abe53793947a6e1b8b1dd502fab8cd
ER [02]	Belfort Instrument, AEPG Model MKIII Manual. June 02, 2014 Filename: AEPG-MKIII-Manual 06-02-2014.pdf SHA1 Checksum: 60d03beb3a52e7fb719d319281ec09fe4137370b
ER [03]	Belfort Instrument, Alter Shield Installation Assembly Instructions, Rev D. Sept. 13, 2012 Filename: Belfort Alter Shield Installation Assembly Instructions Rev D 09132012.pdf SHA1 Checksum: 35fda70e1da392a9169bb5b000a05db4dda42330
ER [04]	Belfort Instrument (website) URL: http://belfortinstrument.com
ER [05]	Safety Data Sheet (SDS) – Isopar M (isoparaffinic hydrocarbon oil) See Appendix 8.5
ER [06]	Safety Data Sheet (SDS) – Light Renoil White Oils (food grade mineral oil) See Appendix 8.5.2
ER [07]	Safety Data Sheet (SDS) – 60/40 Methanol/Propylene Glycol Mixture (antifreeze) See Appendix 8.5.3
ER [08]	NOAA Technical Note NCDC No. USCRN-0404, USCRN Weighing Precipitation Gauge Drain Pump URL: ftp://ftp.ncdc.noaa.gov/.../TN04004Pump.pdf
ER [09]	Climate Reference Network (CRN) Site Information Handbook, NOAA-CRN/OSD-2002-0002R0UD0, December 2002 URL: ftp://ftp.ncdc.noaa.gov/.../X030FullDocumentD0.pdf
ER [10]	MSDSOnline (NEON Project Access) URL: https://msdsmanagement.msdsonline.com/ec04e43d-e72d-4174-9369-c81635eb9493/ebinder/?nas=True

2.4 Acronyms

Acronym	Description

A/R	As Required
AEPG	All Environment Precipitation Gauge
AIS	Aquatic Instrument Systems
ANSI	American National Standards Institute
CIMO	Commission for Instruments and Methods of Observations
CRN	Climate Reference Network
DFIR	Double Fence Intercomparison Reference
ESD	Electrostatic Discharge
FHT	Female Hose Thread
FNTP	Female National Pipe Thread
FTP	Female Pipe Thread
HAZMAT	Hazardous Materials
ID	Identification
IOC	International Organizing Committee
IP	Internet Protocol
ISO	International Organization for Standardization
JSA	Job Safety Analysis
LC	Location Controller
LOCO	Lock-Out/Tag-Out
MAC	Media Access Control
SDFIR	Small Double Fence Intercomparison Reference
SDS	Safety Data Sheet
NCDC	National Climate Data Center
NOAA	National Oceanic and Atmospheric Administration
LED	Light-Emitting Diode
PT	Pressure-Treated
PTFE	Polytetrafluoroethylene (i.e. Teflon)
PVC	Polyvinyl Chloride
QR	Quick Response
SHA-1	Secure Hash Algorithm-1
SPICE	Solid Precipitation Intercomparison Experiment
TEP	Terminal Emulator Program
TIS	Terrestrial Instrument Systems
USCRN	U.S. Climate Reference Network
UUT	Unit Under Test
UV	Ultraviolet
WMO	World Meteorological Organization
NA	Not Applicable

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 AND COMMON NAME(S)	NEON TECHNICAL REFERENCE NAME

NEON DFIR, USCRN DFIR, SDFIR, double octagonal fences, double concentric fences	Double Fence Intercomparison Reference (DFIR)
Alter windshield, metal Alter shield, metal windshield, metal shield, inner shield	Alter shield
Wire strain gauge, strain gauge, transducer	Vibrating wire strain gauge
Belfort, precipitation gauge, rain gauge, precipitation collector, rain collector	Primary Precipitation Gauge
Aluminum deflector, fin, Alter shield fin, deflector fin, metal fin, shield fin, deflector, wind deflector	Alter shield deflector fin

3 SAFETY AND TRAINING

Personnel working at a NEON site must be compliant with safe fieldwork practices as outlined in AD [01] and AD [04]. Refer to the site-specific EHSS plan(s) and procedure-specific Safety Data Sheet (SDS) via the NEON Project's account on MSDSOnline or via the NEON Safety document portal for electronic copies. Conduct the appropriate Job Safety Analysis (JSA) before conducting any preventive maintenance.

The Field Operations Manager and the Lead Field Technician have primary authority to stop work activities based on unsafe field conditions; however, all employees have the responsibility and right to stop their work in unsafe conditions. All technicians must complete required safety training and protocol-specific training for safety and implementation of this protocol as required in AD [05].

NEON HQ recommends that two technicians are present to complete the preventive maintenance procedures herein.

3.1 Hazard Communication Safety Data Sheets (SDS)

The Primary Precipitation Gauge requires the use of several chemicals for proper operation (see Section 4.2.2.1). Refer to the appropriate SDS in Appendix 8.5.

SDS's can always be accessed via the NEON Project's account on MSDSOnline.

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

Neon Inc.

Scan to access an MSDS

4 SENSOR OVERVIEW

4.1 Associated Equipment

4.1.1 External Components

- Concentric Octagonal Wooden Lath Fence
    - Outer Fence
    - Inner Fence
- Alter Shield
- Grape – Merlot G4 12V
- 240AC to 12VDC Power Supply (Heated Sites)
- Arbor

4.1.2 Internal Components

- Primary Precipitation Gauge
    - Outer Housing
    - Internal Support Frame
    - Weighted Bucket Support
    - Vibrating Wire Strain Gauges (3)
    - 6-Gallon Collection Bucket
    - Central Processor and Controller
    - Orifice Heater Control Unit (Heated Sites Only)
    - Heated Tube Inlet (Heated Sites Only)
    - Mounting and Leveling Base
    - Strain Gauge Shields

4.1.3 Calibration Components

- Field Calibration Box
- Calibration Weight Set
- Weight Centering Jig

4.1.4 Other Components

- Primary Precipitation Gauge Drain System (see Appendix 8.4)

4.2 Description

4.2.1 Double Fence Intercomparison Reference (DFIR) Overview

Conceptually, measurements of precipitation are straightforward and easy to take; however, accurate precipitation measurements are extremely challenging. This is due to wind-induced flow distortion around the gauge orifice. The distorted wind flow around the orifice creates vortices and updrafts that prevents precipitation from falling into the gauge (see **Figure 1**), causing measurement inaccuracies and biases.

Figure 1. Visual example of wind updrafts at the Primary Precipitation gauge orifice. (Rasmussen et al. 2011).

The most accurate measurements of precipitation during windy conditions occurs when:

- wind flow around the collection orifice is horizontal
- wind speed at gauge height is equal to that at ground level
- no vortices or updrafts develop around the orifice

To reduce wind-induced measurement errors and biases, the NEON project uses standard shielding techniques around the Primary Precipitation Gauge. These windshields decrease the wind speed over the gauge (see **Figure 2**) and decrease the strength of updrafts and vortices around the gauge orifice, leading to an increase in collection efficiency.

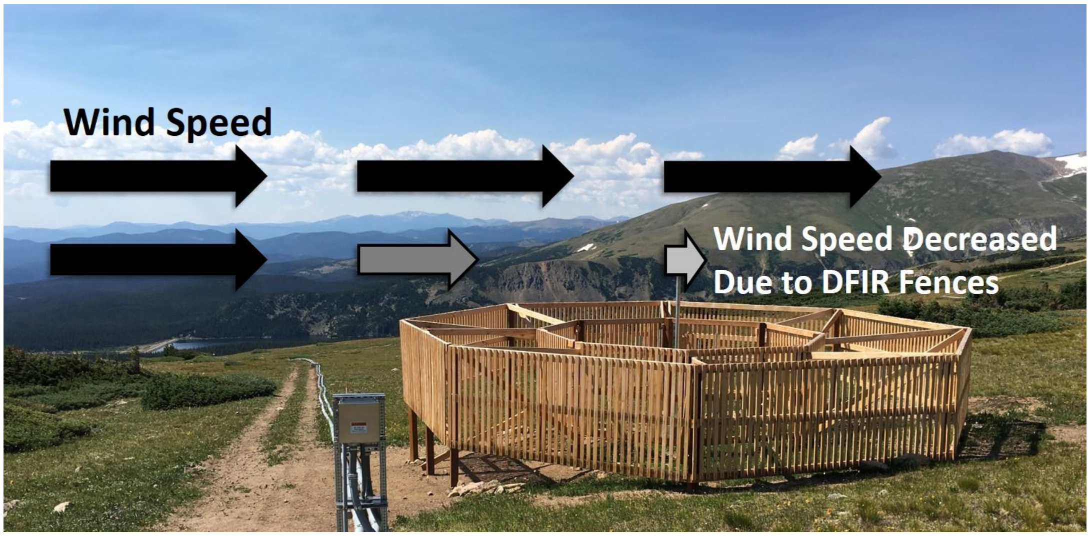

Figure 2. Wind speed decreases significantly due to DFIR fences.

In 1985, the World Meteorological Organization (WMO) designated the Double Fence Intercomparison Reference (DFIR) as a reference standard for solid precipitation (Goodison et al. 1989). The primary reference standard for solid precipitation measurement is a shielded Tretyakov gauge in a sheltered three hectare bush site located at the Valdai hydrological station in Russia (Golubev 1985). The primary standard for liquid precipitation is a ground-level pit gauge (WMO 1969).

The WMO DFIR consists of a shielded manual Tretyakov gauge surrounded by two concentric octagonal vertical lath fences. The diameter of the outer fence is 12.0 m (39.4 ft.), and 4.0 m (13.1 ft.) for the inner, with fence heights of 3.5 m (11.5 ft.) and 3.0 m (9.8 ft.), respectively. The lath lengths are 1.5 m (4.9 ft.) and spaced so the surface area covered by the fences have 50% void spaces (i.e. 50% porosity).

The U.S. Climate Reference Network (USCRN) uses a smaller, 2/3 scaled version of the WMO DFIR (see **Figure 14** to **Figure 16**) , which consists of the Geonor T-200B primary precipitation gauge surrounded by an Alter windshield (Alter 1937). Due to the smaller 2/3 scale of the USCRN DFIR, it is considered a small-DFIR (SDFIR) among the international scientific community; however, it is commonly called a DFIR.

The NEON project conforms to the USCRN SDFIR standard, but has instead selected the Belfort AEPG MKIII as its Primary Precipitation Gauge (herein referred to as the NEON DFIR and Primary Precipitation Gauge).

4.2.1.1 Alter Shield

The purpose of the Alter Shield (see **Figure 10**) is to provide an additional level of wind shielding that further increases collection efficiency and accuracy in precipitation measurements. The Alter shield resides within the inner ring of the NEON DFIR and surrounds the Primary Precipitation Gauge. It comprises of 32 individual aluminum wind deflectors, which affix to a stainless steel support hoop. Each wind deflector is 45.4 cm (18 in.) long. It hinges to a steel support hoop to allow for individual movement of each deflector in the wind. Rubber grommets limit the travel of the deflectors to 30° from vertical, making it a constrained Alter shield. The deflectors are spring loaded to return each deflector vertical in low-to-no wind conditions.

4.2.1.2 DFIR Site Classifications

Terrain, obstacles, and local vegetation type and structure may influence the quality of the precipitation measurements. This influence occurs from wind-induced flow distortion and wind turbulence around the Primary Precipitation Gauge. The NEON DFIR locations have been selected to balance between the quality of the precipitation measurement and the site/area representativeness.

The International Organization for Standardization (ISO) and the WMO classification scheme for terrestrial surface observing stations (WMO 2014) includes the siting classifications for precipitation measurements (scale of 1-5 with 1 representing the highest quality). The classifications depend on site-specific terrain and the height of the surrounding vegetation or other obstacles. A list of these classifications[i] are, as follows:

- **Class 1** – *Flat horizontal ground surrounded by a cleared surface with a slope ≤19°. Any obstacle must be located at a distance of at least 4 times the height of the obstacle.*
  - *An obstacle is an object seen from the precipitation gauge with an angular width of ≥10°, or a subtended elevation angle of >14°.*
- **Class 2** – *(error 5%) – Same as Class 1, except an obstacle is located at a distance of at least 2 times its height.*
  - *An obstacle is an object seen from the precipitation gauge with an angular width of ≥10°, or a subtended elevation angle of >26.5°.*
- **Class 3** – *(error 10% to 20%) – Ground with a slope below <30°. Any obstacle is located at a distance of at least its height.*
- **Class 4** – *(error >20%) – Ground with a slope >30°. Obstacles located at a distance less than their height.*
- **Class 5** – *(error >50%) – Obstacles overhanging the gauge.*

The NEON project collaborated with each site host to identify areas that would meet or exceed Class 1 or Class 2 areas for NEON DFIR locations. NEON DFIRs are present at the Terrestrial Instrument Systems (TIS) Core site of each Domain, and select Aquatic Instrument Systems (AIS) sites. **Table 1** lists the Domain, Site Identification (ID), Site Name, and DFIR Class for TIS Core sites.

[i] see ER [09] for additional information site classification criteria

Table 1. NEON Terrestrial Core Sites and DFIR Classes.

Domain	Site ID	Site Name	DFIR Class
1	HARV	Harvard Forest	2
2	SCBI	Smithsonian Conservation Biology Institute	2
3	OSBS	Ordway-Swisher Biological Station	1
4	GUAN	Guanica Forest	2
5	UNDE	UNDERC	2
6	KONZ	Konza Prairie Biological Station	1
7	ORNL	Oak Ridge	2
8	TALL	Talladega National Forest	2
9	WOOD	Woodworth	1
10	CPER	Central Plains Experimental Range	1
11	CLBJ	LBJ National Grassland	1
12	YELL	Yellowstone Northern Range (Frog Rock)	2
13	NIWO	Niwot Ridge Mountain Research Station	1
14	SRER	Santa Rita Experimental Range	1
15	ONAQ	Onaqui-Ault	1
16	WREF	Wind River Experimental Forest	2
17	SJER	San Joaquin Experimental Range	2
18	TOOL	Toolik	1
19	BONA	Caribou Creek - Poker Flats Watershed	2
20	PUUM	Pu'u Maka'ala Natural Area Reserve	1

Table 2 lists the Domain, Site ID, Site Name, Site Type and DFIR Class for AIS sites.

Table 2. NEON Aquatic Sites and DFIR Classes.

Domain	Site ID	Site Name	Site Type	DFIR Class
10	ARIK	Arikaree River	Core	1
11	BLUE	Blue River	Relocatable	1
11	PRIN	Pringle Creek	Core	2
15	REDB	Red Butte Creek	Core	1

NEON DFIRs located at TIS Cores sites are typically within 500 m (1640 ft.) of the Tower[ii] and have their power and communications supported via the Instrument Hut. Several NEON sites have DFIRs that are located farther away and are therefore Non-Instrument Hut Supported and have an auxiliary Portal,

[ii] NEON Science Requirement: NEON.TIS.4.1172

Location Controller (LC) and supporting infrastructure (see e.g. **Figure 13**). **Table 3** is a list of Non-Instrument Hut supported TIS NEON DFIRs.

Table 3. Non-Instrument Hut Supported TIS Primary Precipitation Gauges and DFIRs.

Domain	Site ID	Site Name
8	TALL	Talladega National Forest
11	CLBJ	LBJ National Grassland
16	WREF	Wind River Experimental Forest
20	PUUM	Pu'u Maka'ala Natural Area Reserve

The following section display examples of NEON DFIRs:

- Domain 16 – Wind River Experimental Forest (WREF) (see **Figure 3**, **Figure 11**, **Figure 12**, and **Figure 13**).
- Domain 19 Caribou Creek – Poker Flats Watershed (BONA) (see **Figure 4**).
- Domain 13 – Niwot Ridge Mountain Research Station (NIWO) (see **Figure 5**).
- Domain 10 – Central Plains Experimental Range (CPER) (see **Figure 6**, **Figure 9** and **Figure 10**, which is an example of an Alter shield).
- Domain 14 – Santa Experimental Range (SRER) (see **Figure 8**).
- Domain 04 – Guanica Forest (GUAN) (see **Figure 7**).

*NOTE: The Alter shield or primary precipitation gauge are not present in **Figure 3** to **Figure 5**.*

Figure 3. Side view of a NEON DFIR. This displays a non-standard (i.e. taller) DFIR fence heights (see Appendix 8.6.4).

NEON DFIR location: D16 WREF

Figure 4. Side view of a NEON DFIR in the winter.

NEON DFIR location: D19 BONA

Figure 5. View of the concentric octagonal fences of a NEON DFIR.

NEON DFIR location: D13 NIWO

Figure 6. A NEON DFIR surrounded by a cattle fence.

NEON DFIR location: D10 CPER

Figure 7. A NEON DFIR within a water catchment basin.

NEON DFIR location: D04 GUAN

Figure 8. View of the outer DFIR fence gate.

NEON DFIR location: D14 CRER

Figure 9. View of the inner DFIR fence and inner fence gate. This also provides an abstract view of the Alter shield and rain gauge.

NEON DFIR location: D10 CPER

Figure 10. View of the metal Alter shield residing within the two outer concentric octagonal fences. The Primary Precipitation Gauge is inside the Alter shield.

NEON DFIR and Alter shield location: D10 CPER

Figure 11. View of the associated Primary Precipitation Gauge Grapes.

NEON DFIR location: D16 WREF

Figure 12. View of the DFIR fences and associated infrastructure.

NEON DFIR location: D16 WREF

Figure 13. Associated infrastructure for the Primary Precipitation Gauge.

a) Power disconnect box
b) Power meter
c) "H" Frame
d) Portal

NEON DFIR location: D16 WREF

Figure 14 to **Figure 18** provide specific dimensions and measurements of the NEON DFIR for reference purposes. **Figure 16** shows the standard NEON DFIR fence heights, while **Figure 43** to **Figure 45** show the NEON sites with non-standard (i.e. taller) NEON DFIR fence heights.

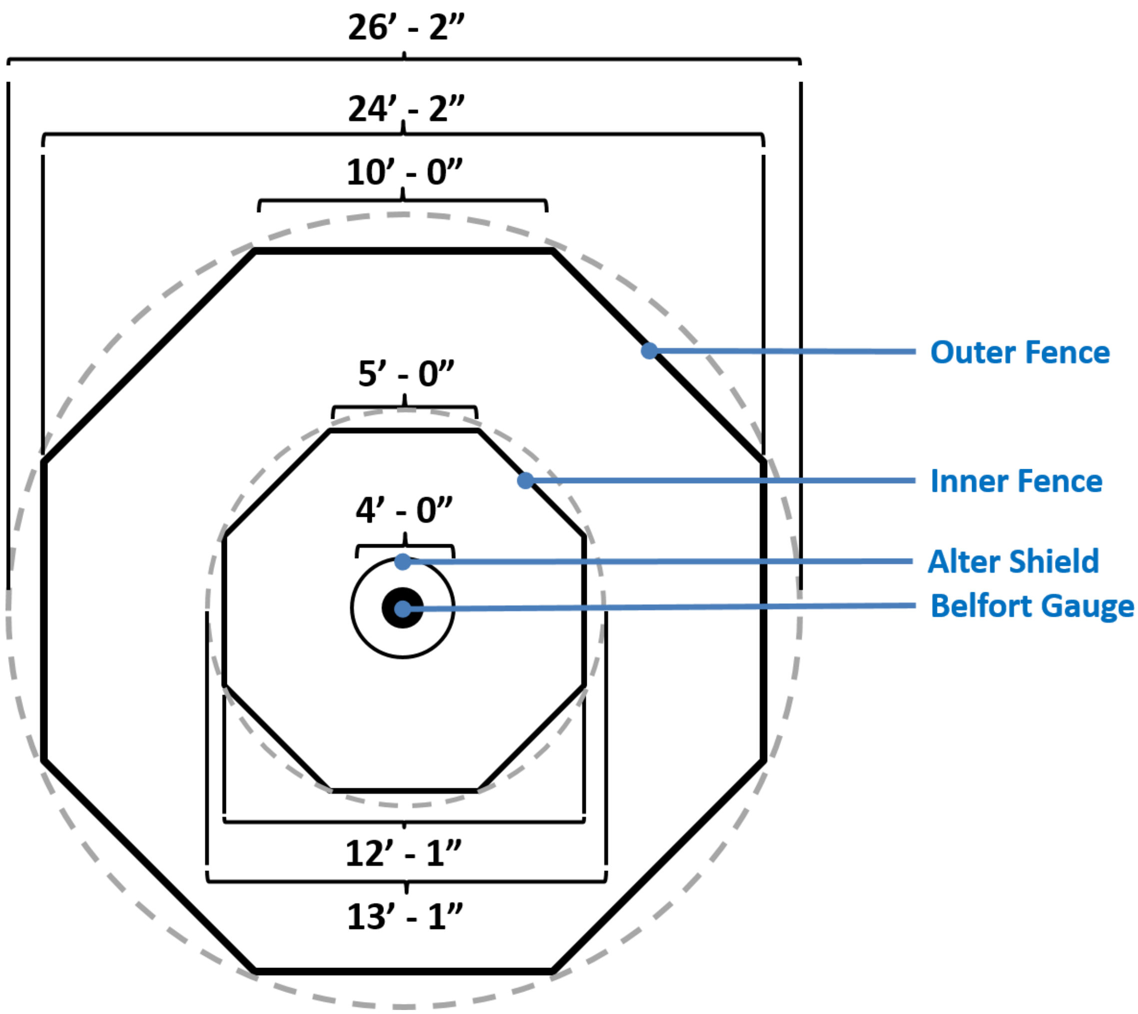

Figure 14. Dimensions of the Concentric Octagonal Fences and Alter shield for NEON DFIRs.

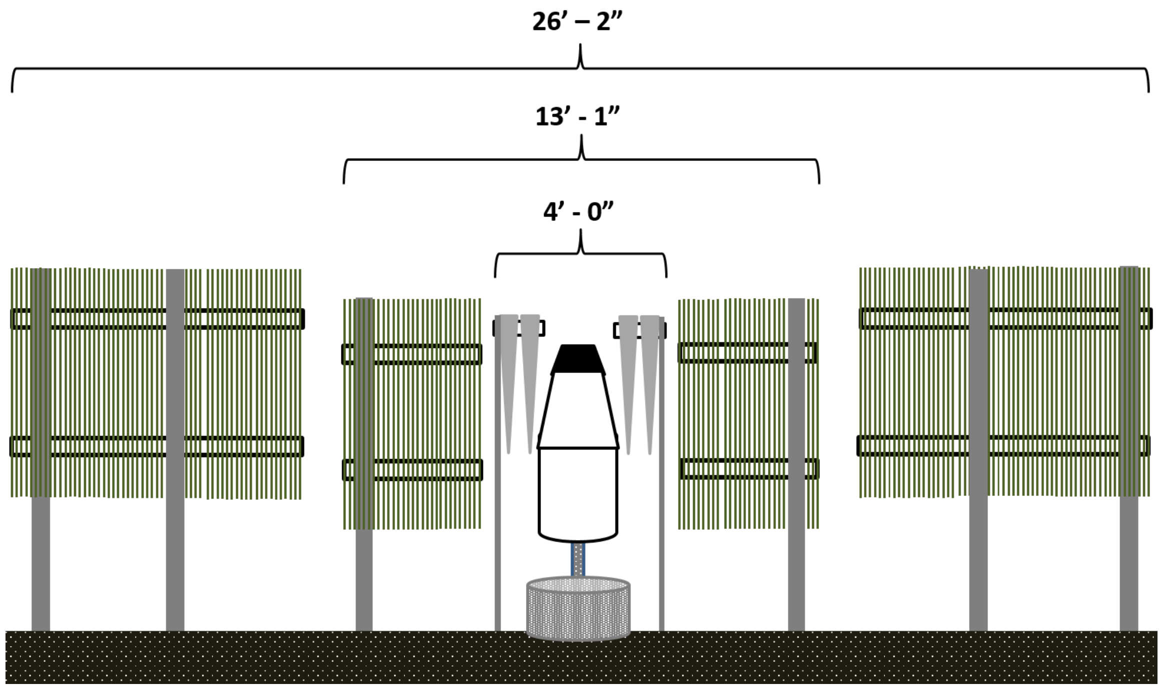

Figure 15. Side Cross-Section of DFIR Fences and Alter Shield, and their Respective Widths.

Standard Heights:

Outer Fence = 5' - 8"
Inner Fence = 5' - 4"
Alter Shield = 5' - 2"
Gauge Orifice= 5' - 0"

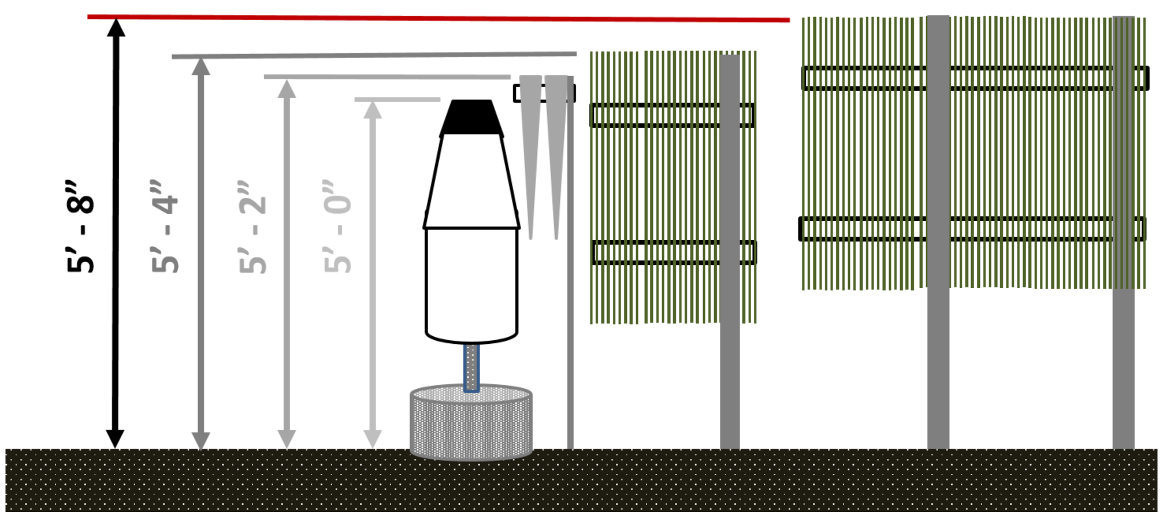

Figure 16. Side Cross-Section of the Standard NEON DFIR Fence and Alter Shield Heights.

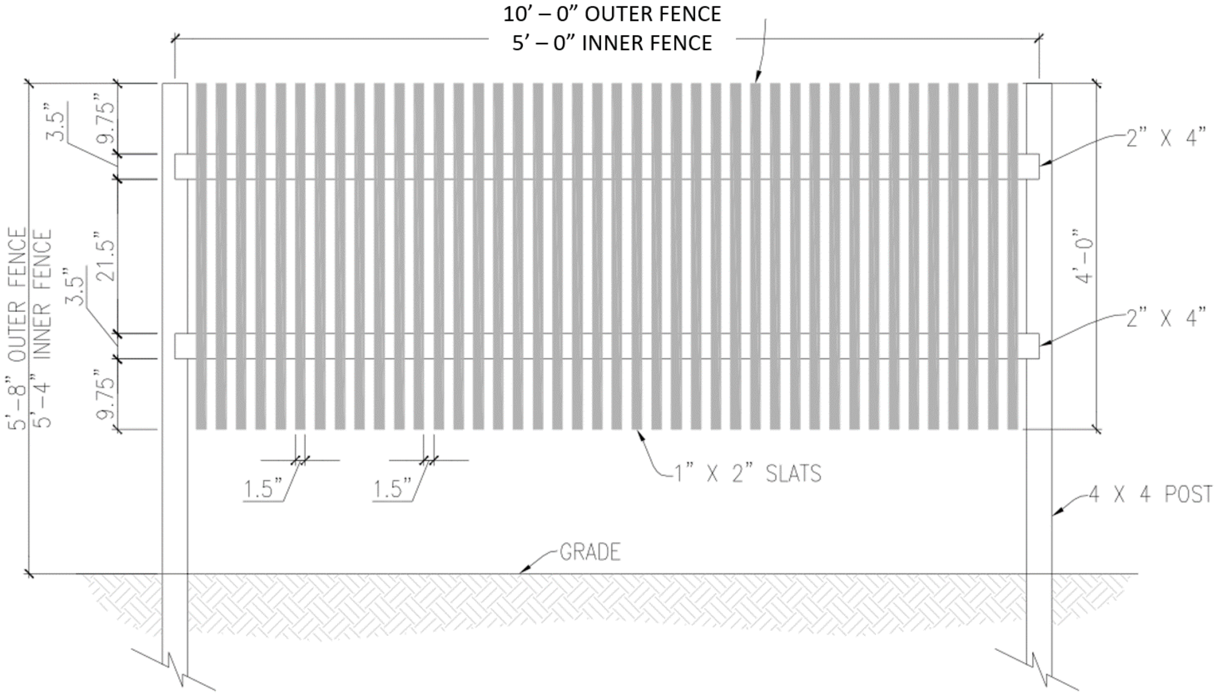

Figure 17. NEON DFIR inner and outer fence width, height, and dimensions.

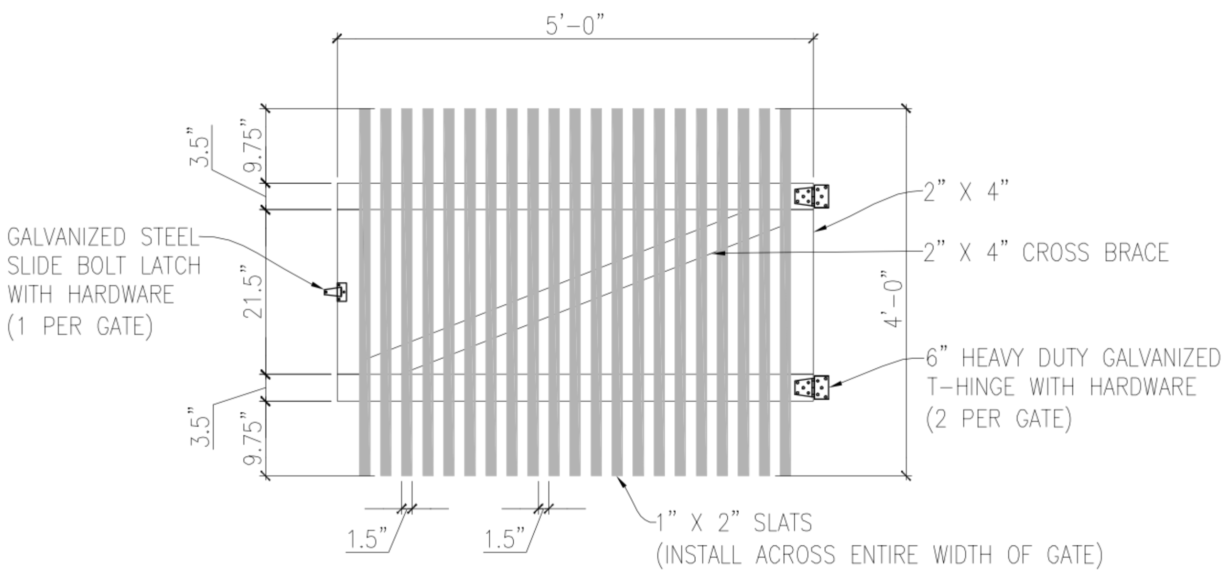

Figure 18. NEON DFIR gate width, height, and dimensions.

4.2.2 Precipitation Gauge Overview

The NEON project uses the Belfort AEPG MKIII Precipitation Gauge as the Primary Precipitation Gauge. It is an automatic weighing-type precipitation gauge that measures liquid (e.g., rain), solid (e.g., snow), or a mix of both liquid and solid precipitation.

The Primary Precipitation Gauge consists of a high impact ultraviolet (UV) resistant thermal plastic outer housing with a WMO Standard 15.958 cm diameter collection orifice (200 cm^2 area). A non-stick, black, fluoropolymer material coats the collection orifice to prevent snow and ice buildup. NEON sites where rapid snow and ice accumulation may block the collection orifice (for heated sites see **Table 4** and **Table 5**, as well as Appendix 8.2 and Appendix 8.3) have an additional heater on the collection orifice. The outer housing has two handles and three spring latches that secure the outer housing to the base. The base and internal frame are aluminum and secure to a standard 2 in. internal dimension American National Standards Institute (ANSI) Schedule 40 pipe. The pipe is secured into the ground via a concrete pedestal.

The internal components of the gauge consist of an internal aluminum support frame with a weighted bucket support base, three vibrating wire strain gauges, and a central processor and controller unit. There are also custom NEON shields attached to the internal frame that help protect the three vibrating wire strain gauges from damage. Primary Precipitation Gauges with orifice heaters also have an additional heater control unit, which attaches to the support frame with a cable connecting to the exterior of the outer housing. A plastic 6-gallon collection bucket sits upon a suspended weighted support base. The 6-gallon collection bucket has a capacity of 24 L (6.3 gallons), or 1200 mm (47.2 in.) of precipitation (see **Figure 29** and **Figure 30**).

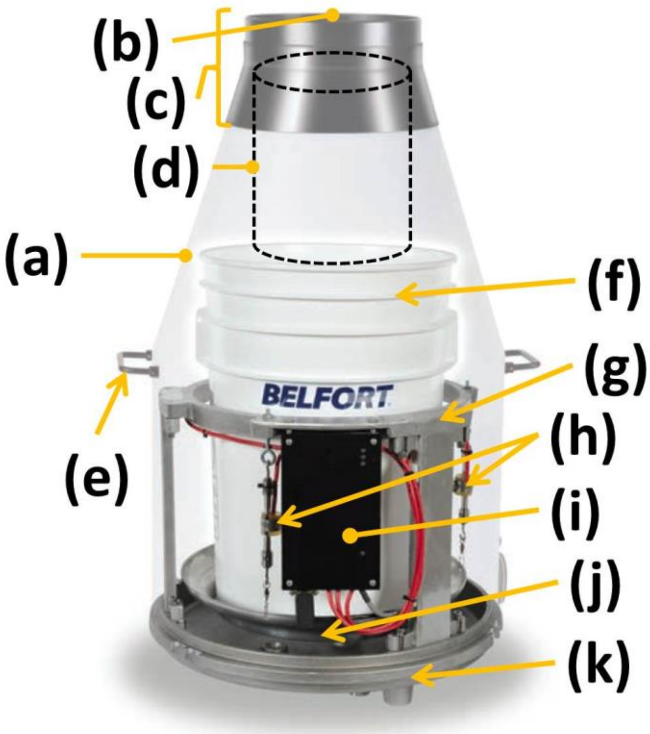

Figure 19. The main components of the Belfort AEPG MKIII Precipitation Gauge include:

External

(a) insulated outer housing
(b) 16 cm intake orifice
(c) coated snow build-up barrier
(d) internal heated inlet tube
(e) two handles, and three spring latches (not shown)

Internal

(a) 6-gallon collection bucket
(b) internal support frame,
(c) three vibrating wire strain gauges (two of three shown)
(d) central processor and controller
(e) a weighted bucket support mounting base

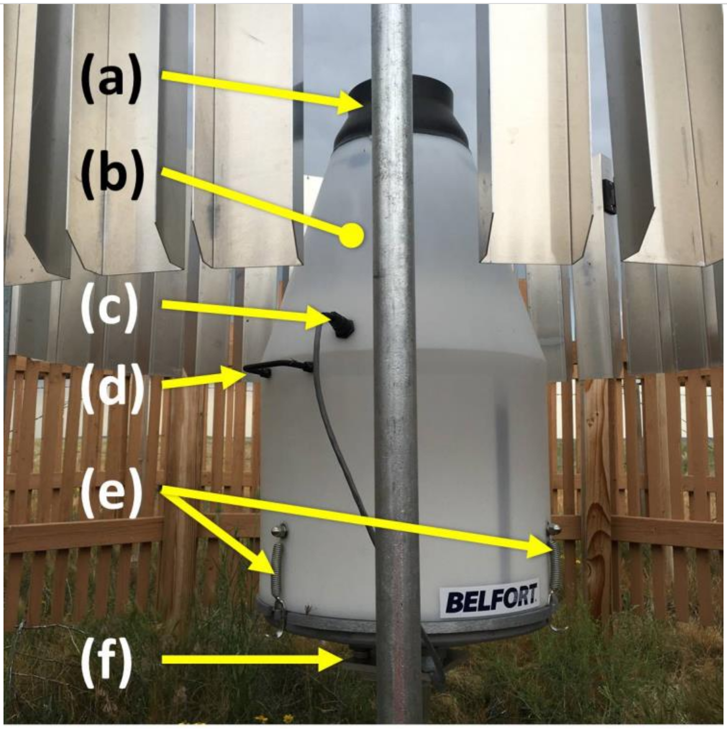

Figure 20. External view of the precipitation gauge.

(a) fluoropolymer coated collection orifice
(b) insulated outer housing
(c) orifice heater cable
(d) handle
(e) spring latches
(f) leveling base

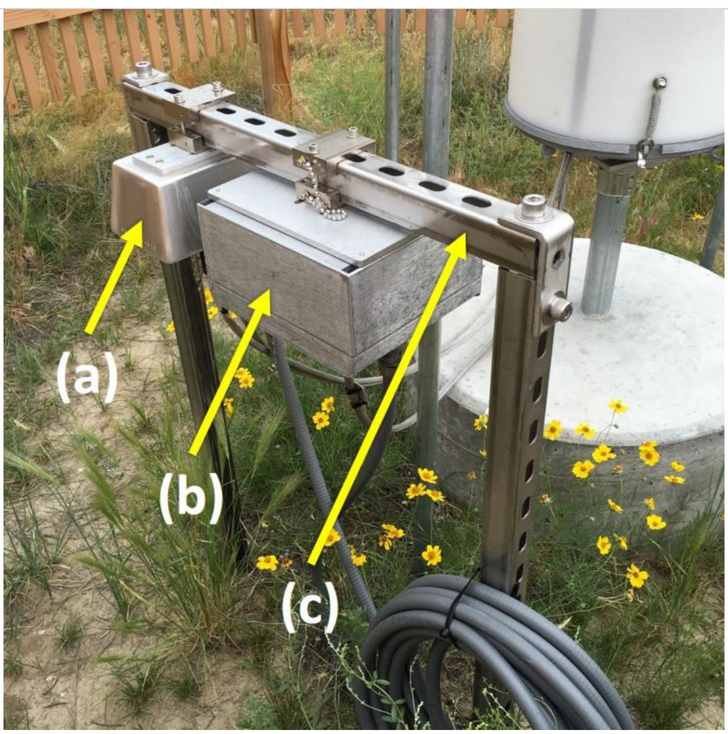

Figure 21. The arbor assembly next to the Primary Precipitation Gauge holds the Grape. If the site uses an orifice heater, it holds a 240AC to 12VDC power supply unit, in addition to the Grape.

(a) Grape Merlot G4
(b) 240AC to 12VDC power supply unit
(c) arbor

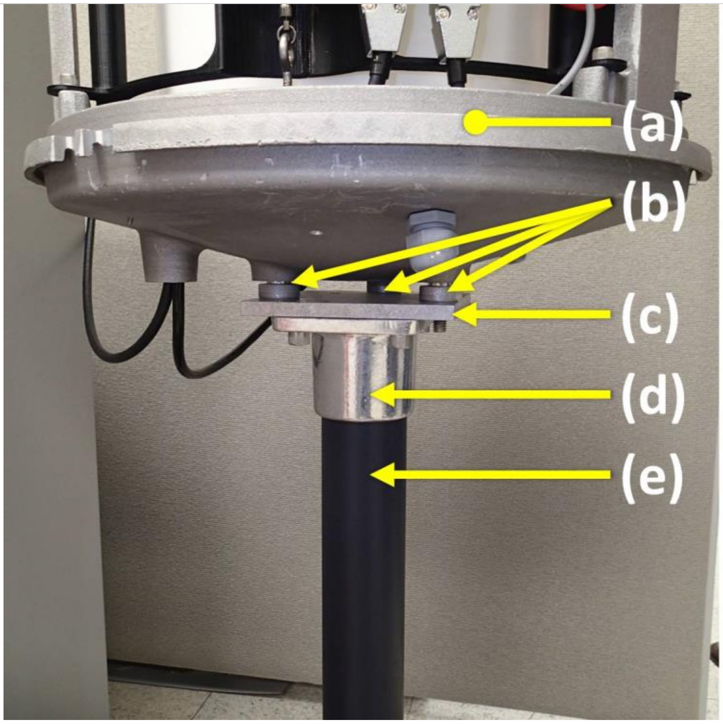

Figure 22. Close up view of the mount and base. These are:

(a) mounting base
(b) leveling screws
(c) base adapter plate
(d) pipe fitting base
(e) metal pipe

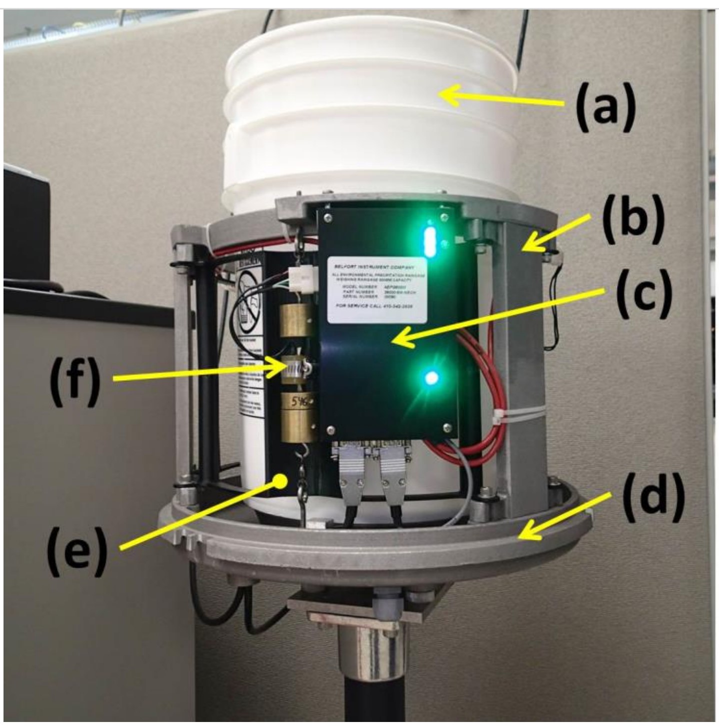

Figure 23. A view of the internals of the precipitation gauge. These are:

(a) 6-gallon collection bucket
(b) internal support frame
(c) central processor and controller
(d) mounting base
(e) strain gauge shield
(f) vibrating wire strain gauge

Sites that experience extreme cold weather have an additional control unit to control the orifice heater, which also attaches to the internal support frame (see **Figure 25**).

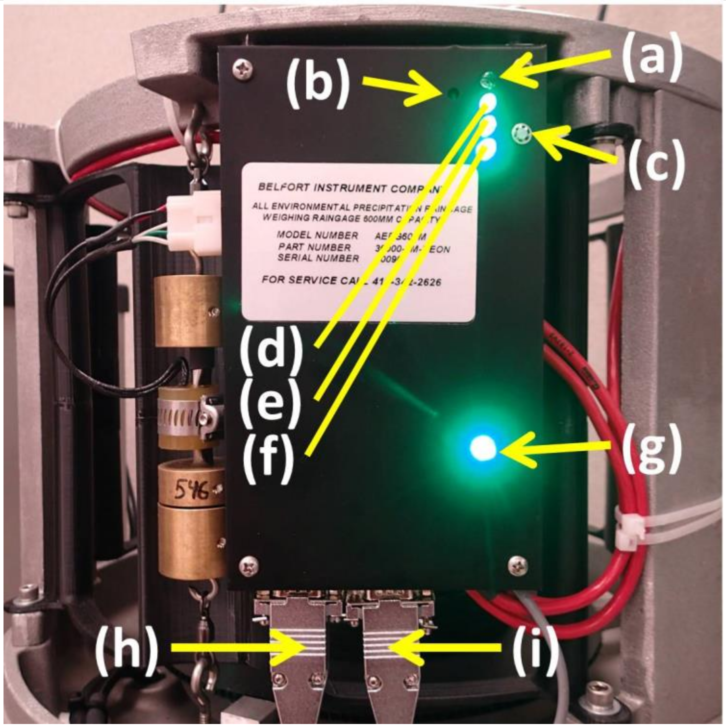

Figure 24. Close up view of the Central Processor and Controller. There are several buttons and indicator (light-emitting diodes) LEDs on the front of the unit. These are:

(a) memory stick safe LED
(b) memory stick control button
(c) unit zero button
(d) sensor 1 status LED
(e) sensor 2 status LED
(f) sensor 3 status LED
(g) unit power LED
(h) COM0 cable connector
(i) COM1 cable connector

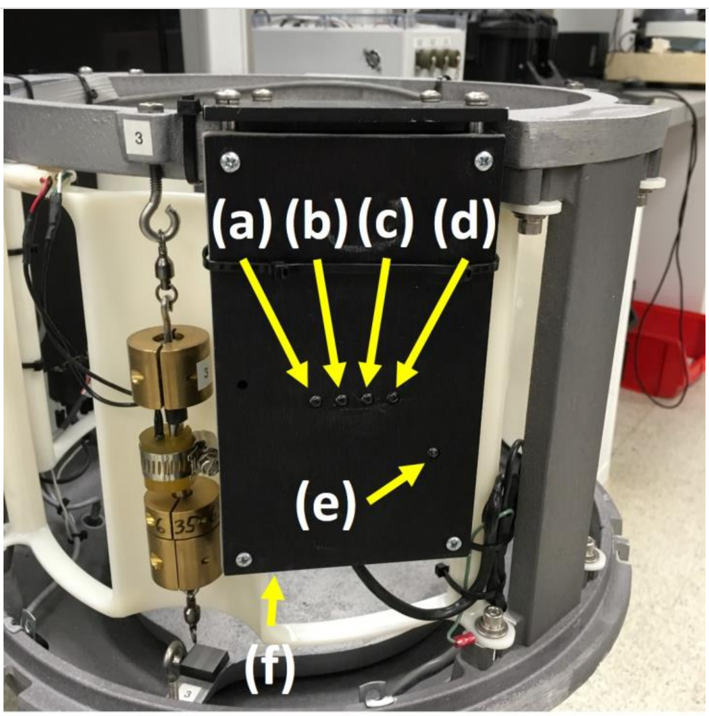

Figure 25. Close up view of the heater control unit.

Select NEON DFIR sites use a heater unit on their Primary Precipitation Gauge. There are five indicator LEDs on the front of the unit and one connection port. These are:

(a) heater 1 status LED
(b) heater 2 status LED
(c) heater 3 status LED
(d) relay 4 status LED
(e) orifice heater control unit power LED
(f) USB connection port

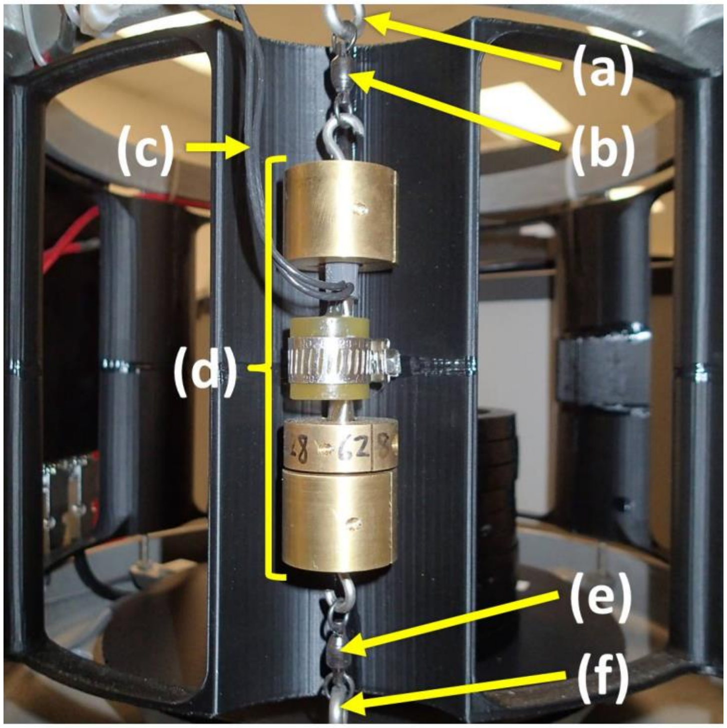

Figure 26. Close up view of one of the three vibrating wire strain gauges. These are:

(a) top eye bolt
(b) top swivel
(c) sensor wire
(d) vibrating wire strain gauge
(e) bottom swivel
(f) bottom eye bolt

NOTE: Sometimes the wire strain gauges are referred to as transducers (see Section 2.5 Terminology*).*

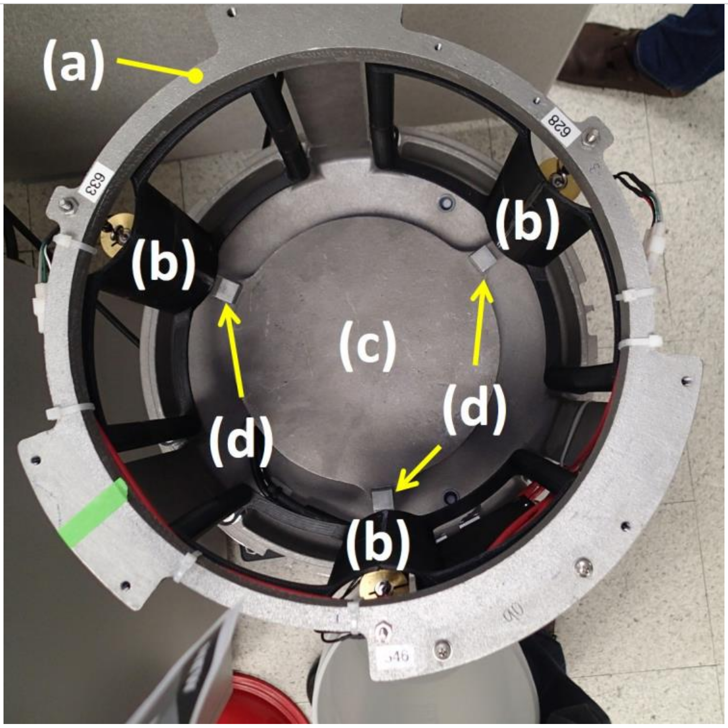

Figure 27. A top-down view of the internal structure of the precipitation gauge. These are:

(a) internal support frame
(b) the strain gauge shields
(c) weighted bucket support
(d) bucket centering guides

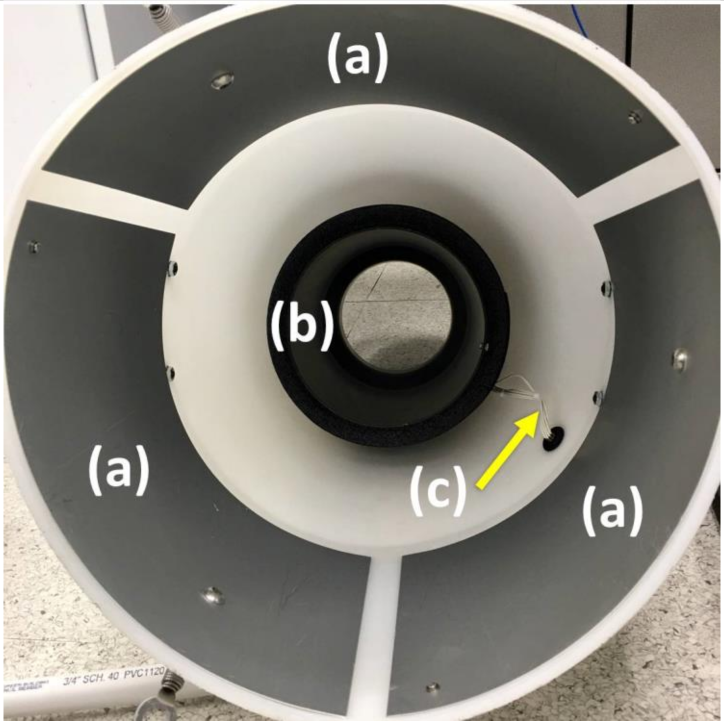

Figure 28. The inside of the outer housing. Three metal sheets provide stability to the outer housing.

(a) metal sheets
(b) internal heated inlet tube
(c) orifice heater cable

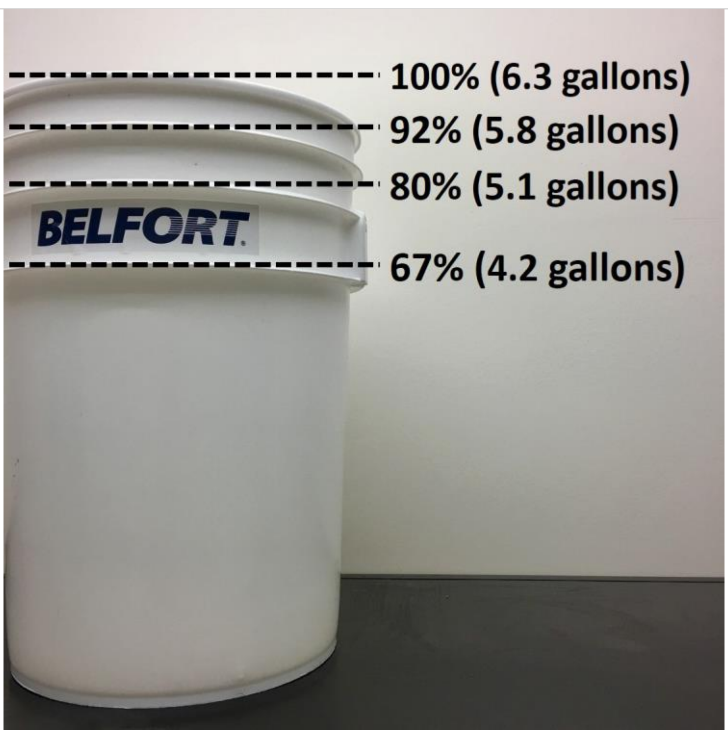

Figure 29. The ribs on the outside of the 6-gallon collection bucket indicate percentage of bucket capacity.

Total bucket capacity is ~24 L (6.3 gallons).

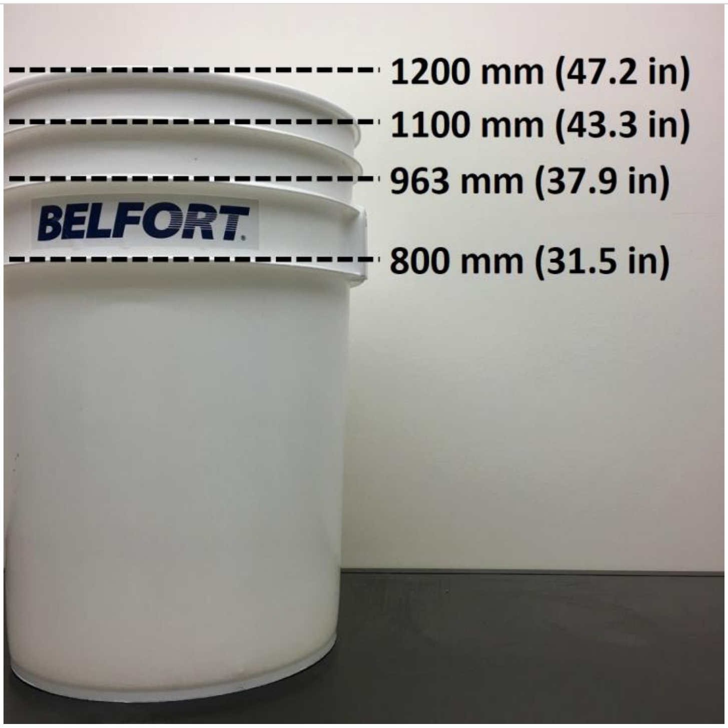

Figure 30. 6-gallon collection bucket capacities in terms of cumulative precipitation amounts.

4.2.2.1 Heated Primary Precipitation Gauges

Table 4 and **Table 5** respectively lists the 15 TIS and 4 AIS sites with heated Primary Precipitation Gauges.

Table 4. TIS Sites with Heated Primary Precipitation Gauges.

Domain	Site ID	Site Name
1	HARV	Harvard Forest
2	SCBI	Smithsonian Conservation Biology Institute
5	UNDE	UNDERC
6	KONZ	Konza Prairie Biological Station
7	ORNL	Oak Ridge
9	WOOD	Woodworth
10	CPER	Central Plains Experimental Range
11	CLBJ	LBJ National Grassland
12	YELL	Yellowstone Northern Range (Frog Rock)
13	NIWO	Niwot Ridge Mountain Research Station
15	ONAQ	Onaqui-Ault
16	WREF	Wind River Experimental Forest
17	SJER	San Joaquin Experimental Range
18	TOOL	Toolik
19	BONA	Caribou Creek - Poker Flats Watershed

Table 5. AIS Sites with Heated Primary Precipitation Gauges.

Domain	Site ID	Site Name
10	ARIK	Arikaree River
11	BLUE	Blue River
11	PRIN	Pringle Creek
15	REDB	Red Butte Creek

4.2.2.2 Oil and Antifreeze

Every 6-gallon collection bucket has an initial volume (aka "charge") of 0.47 L (16 oz.) of oil added to it. This layer of oil prevents evaporation of both the water and the volatile components of the antifreeze mixture. Sites that experience freezing conditions and snowfall have an additional volume of antifreeze solution added to the oil to prevent the bucket contents from freezing.

The fluid properties of the oil and the antifreeze solution are low density and low viscosity to ensure the oil/antifreeze mixture does not freeze. It allows both solid and liquid precipitation to pass through the oil into the antifreeze solution, ensures rapid melting of solid precipitation, and promotes a self-mixing property (Mayo 1972) of the antifreeze solution. These properties limit stratification[iii] and slush/ice accumulation above the antifreeze mixture.

The selection of specific oils and antifreezes are dependent on site-specific conditions, product availability, and to some extent, site host limitations. The WMO Commission for Instruments and

[iii] Formation of distinct layers due to different densities of the fluids.

Methods of Observations (CIMO) provides several recommendations on both the oil and the antifreeze mixture based on the International Organizing Committee (IOC) Solid Precipitation Intercomparison Experiment (SPICE). The WMO recommends an isoparaffinic hydrocarbon oil and an antifreeze mixture of methanol and propylene glycol[iv] (WMO-CIMO 2014). This is the best combination of low density and low viscosity at all tested temperatures (WMO-CIMO 2014).

As a result, the NEON project employs an isoparaffinic hydrocarbon oil for all primary precipitation locations, with exception of Domain 04 Guanica Forest (GUAN) in Puerto Rico due to site host limitations. The NEON project uses a 60% methanol and 40% propylene glycol mixture for antifreeze, which is also the USRCN standard antifreeze mixture. **Table 6** provides product name, type and notes for Primary Precipitation Gauge fluids.

Table 6. Primary Precipitation Fluids (Oil and Antifreeze).

Primary Precipitation Fluids			
	Product Name	**Type**	**Notes**
Oil			
	Isopar M	Isoparaffinic hydrocarbon	All NEON DFIR sites
	Renoil 70-W	*White mineral oil (food grade)*	*D04 GUAN Only*
Antifreeze			
	60/40 Methanol/Propylene Glycol	Antifreeze	Pre-mix

The initial volume of isoparaffinic hydrocarbon oil provides a layer that completely covers the surface of the water/antifreeze, and is thick enough to limit the evaporation of water and volatile components within the antifreeze mixture. The initial volume of the antifreeze is derived from the minimum temperature the gauge may encounter and the dilution of the antifreeze mixture when the 6-gallon collection bucket reaches capacity.

The site-specific conditions determine an antifreeze temperature class for each Primary Precipitation Gauge (see Appendix 8.2 and 8.3). Antifreeze temperature classes align with NEON DIFR sites (regardless of the heating component). Several of these sites fall under an extreme cold weather classification (see AD [10] and AD [11]). To determine the thresholds to classify these sites, the NEON Science Team conducted an analysis of each site's historic meteorological data and defined three temperature ranges. These site analyses include the duration (in days) of each temperature range and correlations with humidity as a proxy for intense icing/frost conditions. **Table 7** lists the specifications for the three antifreeze temperature classes.

[iv] ANNEX VIII, (WMO-CIMO 2014)

Table 7. NEON Antifreeze Temperature Classes and Ranges.

Antifreeze Temperature Class	Temperature Specifications	Duration
Warm	> 0 °C	Entire year
Cold	-20 °C to 0 °C	> 100 days
Extreme	< -20°C	> 0 days

4.2.3 Calibration and Validation Overview

The NEON Calibration, Validation and Audit Laboratory (CVAL) conducts an initial calibration process for initial baselining and verification of the sensor operations for the Primary Precipitation Gauge prior to field deployment. After the installation of the primary precipitation gauge at the site, it undergoes an additional on-site calibration before data collection. This on-site calibration is mandatory to meet NEON science requirements.

The NEON Field Operations (FOPS) staff maintain the sensor's calibration post-deployment, which must occur after every cleaning/servicing of the sensor's 6-gallon collection bucket.

CVAL provides FOPS calibration and validation instructions via RD [06] - NEON.DOC.003289, *L1P100 Field Calibration/Validation Primary Precipitation Sensor Standard Operating Procedure,* which can be found via: N:\Common\CVL\Field_Calibration\Manuals\NEON.DOC.003289.1PrecipSOP.pdf

For the most recent calibration procedure, programs, drivers, and calibration notes, visit the NEON project's CVAL network drive location via ***N:\Common\CVL\Field_Calibration***.

4.3 Sensor Specific Handling Precautions

The Primary Precipitation Gauge encompasses sensitive components requiring extra care and awareness while conducting preventive maintenance and/or field calibration and validation procedures. Use two Technicians to conduct these procedures, if possible.

Please ensure the removal and replacement of the top (heavy duty UV stable polyethylene resin housing) of the sensor never interferes with the brass strain gauges (also known as transducers), or wires in and/or around the gauges. Loose wires may snag and disrupt calibration and/or cause damage.

The three brass strain gauges within the Primary Precipitation Gauge are extremely delicate and expensive to replace; the most frequent cause of damage to these components are from the removal/replacement of the exterior housing of these sensors.

Ensure wires from below the gauges are secure to the interior sides with the existing metal clamps (see **Figure 31**). These clamps help prevent interference to calibration/operation or damage to gauges by securing the wires from wedging under the weight plate or other interior areas.

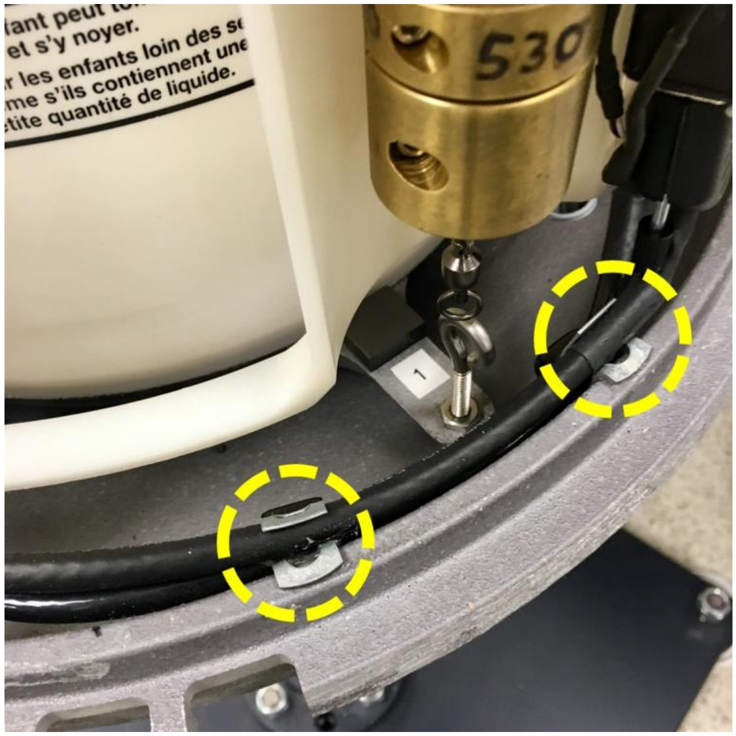

Figure 31. Ensure Internal Wires Secure to the Sides with existing Metal Clamps.

The Primary Precipitation Gauge contains an optional orifice heater to heat the top of the exterior outer housing. This adds an additional connection to the outer housing and to the Grape. **For sites using a heater, disconnect the heater power cable BEFORE disconnecting the heater cable on the outer housing.**

In addition, please be aware of the two buttons on the outside of the data processor and signal-conditioning unit, next to the LED status lights in the upper right hand corner (post-removal of the top during maintenance or calibration and validation). **The right button is the internal unit zero button. If pressed, this button zeros out the calibration of the sensor, requiring re-calibration and validation** (see **Figure 24**). The left button is the Memory Control Stick button[v].

[v] Memory Control Stick Button: "*With the unit powered up, press and hold the Memory Stick Control Button shown on the Digital Processor and Signal Conditioning Unit (P/N 36090). When the Memory Stick Safe LED comes on, it is safe to insert the memory stick into the Memory Stick USB Connector on the bottom edge of the Heater Control Module. Release the Memory Stick Control Button after the Memory Stick inserts. To remove a memory stick press and hold the Memory Stick Control Button… When the Memory Stick Safe LED comes on, it is safe to remove or replace the memory stick into the Memory Stick USB Connector on the bottom edge of the Heater Control Module. Release the Memory Stick Control Button after the Memory Stick has been removed or a new unit inserted*." (see Page 46 of ER [01] AEPG-Instruction-Manual-1.pdf, or Page 50 of ER [02] AEPG-MKIII-Manual 06-02-2014.pdf)

During calibration procedures, **DO NOT** drop the weights or the 6-gallon collection bucket on the plate. **CAREFULLY** set weights on the plate for calibration/validation and operational purposes.

Finally, the Merlot Grape associated with the sensor requires electronic discharge (ESD) handling and packaging procedures. Wear an anti-static wristband while conducting any maintenance on the Grape and when removing/replacing the Grape for annual sensor refresh/swaps.

4.4 Operation

The Primary Precipitation Gauge is an automatic weighing-type gauge that uses three vibrating wire strain gauges as its weighing mechanism. The use of three strain gauges provide redundancy to increase the accuracy of the measurement.

The general principle of a vibrating wire strain gauge is that a steel wire under tension vibrates at a resonant frequency. The resonant frequency of the wire increases as tension on the wire increases. In the case of the Primary Precipitation Gauge, as precipitation collects, the weight of the 6-gallon collection bucket increases and therefore, the tension and resonant frequency of the wire increases. The wire is electronically 'plucked' and the gauge measures the resonant frequency. Calibration of the changes in resonant frequency by weight (i.e. strain) on the gauges provides for an output that converts to the amount of precipitation accumulation.

The three vibrating wire strain gauges are equilaterally spaced around the internal support frame (**Figure 23**), which suspends the weighted support (**Figure 27**) and provides the initial tension on the wire. Once calibration of the system occurs (Section 4.2.3), the 6-gallon collection bucket and specified amounts of oil and/or antifreeze in the 6-gallon collection bucket are re-zeroed. Precipitation accumulation increases the weight of the 6-gallon collection bucket and with the calibration information applied, total cumulative amounts of precipitation are calculated.

4.5 References

Alter, J. C. 1937. Shielded Storage Precipitation Gages. Monthly Weather Review **65**:262-265.

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Goodison, B. E., P. Y. T. Louie, and D. Yang. 1989. WMO Solid Precipitation Measurement Intercomparison. World Meteorological Organization, Geneva, Switzerland.

Mayo, L. R. 1972. Self-Mixing Antifreeze Solution for Precipitation Gages. Journal of Applied Meteorology **11**:400-404.

Rasmussen, R., B. Baker, J. Kochendorfer, T. Meyers, S. Landolt, A. P. Fischer, J. Black, J. M. Thériault, P. Kucera, D. Gochis, C. Smith, R. Nitu, M. Hall, K. Ikeda, and E. Gutmann. 2011. How Well Are We Measuring Snow: The NOAA/FAA/NCAR Winter Precipitation Test Bed. Bulletin of the American Meteorological Society **93**:811-829.

WMO-CIMO. 2014. Final Report of the Fifth Session of the Project Team and (Reduced) IOC for the WMO Solid Precipitation Measurement Intercomparison. Sodankyla.

WMO. 1969. Commission for Instrument and Methods of Observation, Final Report of the Fifth Session (CIMO-V). Geneva.

WMO. 2014. Guide to Meteorological Instruments and Methods of Observation. Geneva, Switzerland.

5 INSPECTION AND PREVENTIVE MAINTENANCE

NOTE: If precipitation is occurring (e.g., raining, snowing, hailing) during the scheduled routine maintenance of the system, wait until it stops before proceeding. If precipitation is imminent and likely to start while performing maintenance on this system, stop and conduct maintenance at a time where maintenance may occur without interruption.

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

5.1 Preventative Maintenance Procedural Sequence

5.1.1 Monthly

The sequence for routine preventative maintenance of the Primary Precipitation Gauge and DFIR is, as follows:

1. Check strain gauge status (Section 5.4.1.1)
    a. Obtaining the Internet Protocol (IP) address of the Location Controller (LC) (Section 5.4.1.1.1)
    b. Obtaining the Media Access Control (MAC) address of the Primary Precipitation Gauge (Section 5.4.1.1.2)
    c. Checking the strain gauge status (Section 5.4.1.1.3)
2. Perform vegetation maintenance (Section 5.4.1.2)
3. Perform DFIR fence maintenance (Section 5.4.1.3)
4. Perform Alter shield maintenance (Section 5.4.1.4)
5. Inspect external cables and connectors (Section 5.4.1.5)
6. Check fluid level (Section 5.4.1.6)

After checking the fluid level within the 6-gallon collection bucket, the subsequent procedural sequence depends on the fluid level within the bucket, or the time of year. See **Figure 32** below.

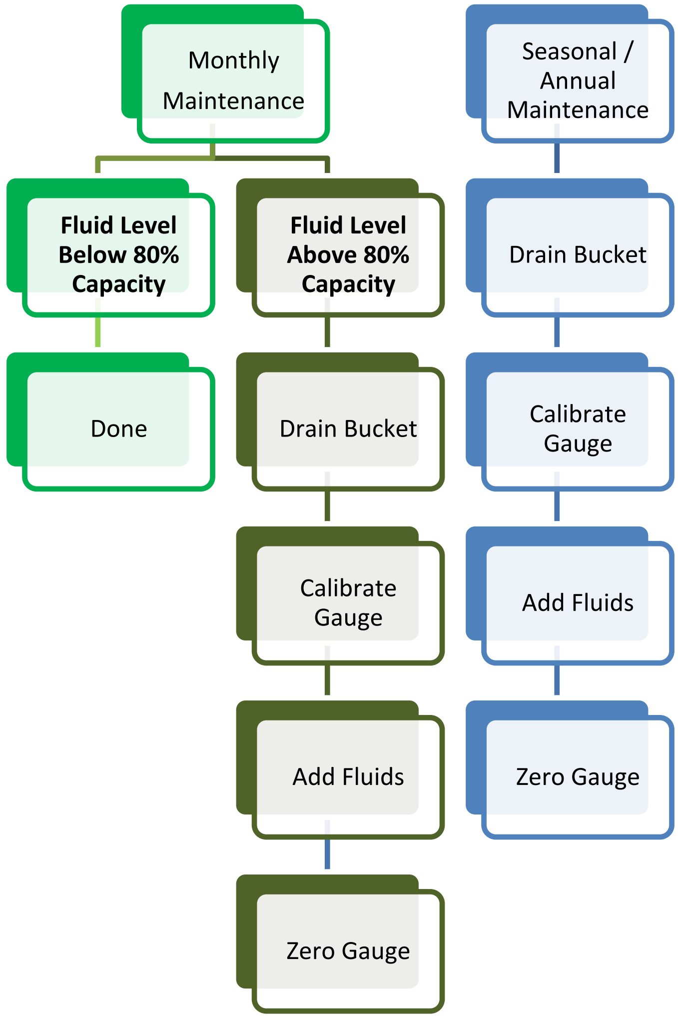


Figure 32. Maintenance procedure decision tree following checking the fluid level.

5.1.1.1 Fluid Level Below 80% Capacity

If the 6-gallon collection bucket capacity is below 80% (see **Figure 29**), and the anticipated amount of precipitation to fall within the next maintenance cycle will not fill the bucket's capacity, routine maintenance is complete.

If the 6-gallon collection bucket capacity is below 80% capacity, but it is anticipated that the amount of precipitation to fall within the next maintenance cycle may fill the bucket close to or to capacity, continue to Section 5.1.1.2, Fluid Level Above 80% Capacity.

5.1.1.2 Fluid Level Above 80% Capacity

If the 6-gallon bucket capacity is at or above 80% (see **Figure 29**):

1. Drain the contents of the 6-gallon collection bucket (Section 5.4.1.6.2.2)

2. Remove outer housing and 6-gallon collection bucket (Section 5.4.1.6.2.3)
3. Inspect internal components and cables (Section 5.4.1.6.3)
4. Level the internal frame (Section 5.4.1.6.4)
5. Power on the system (Section 5.4.1.6.5)
6. Calibrate the gauge (see Section 5.4.1.6.6)
7. Replace the 6-gallon collection bucket and add fluids (Section 5.4.1.6.7)
8. Zero the gauge (see RD [06] and Section 5.4.1.6.8)
9. Replace the outer housing (Section 5.4.1.6.9)
10. Verify level of the outer housing (Section 5.4.1.6.10)
11. Check status of the three strain gauges again (Section 5.4.1.1)

5.1.2 Seasonal

Sites under cold or extreme classifications must replace the fluids and calibrate the gauge twice a year. Once at the onset of the "winter" or freezing months and once at the onset of the "summer" or warm months. See Appendix 8.2 and Appendix 8.3 for oil and antifreeze capacities and seasonal change dates.

5.1.3 Annually

Sites under warm classification (see Appendix 8.2 and 8.3) must replace the fluids and calibrate the gauge annually. NEON recommends the annual preventive maintenance to occur during the annual sensor refresh of the site, or the refresh of the Primary Precipitation Gauge Grape(s) to minimize downtime.

Follow the procedures in Section 5.4 to conduct this annual calibration and maintenance.

5.2 Equipment

Table 8 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 8. Tools, Consumables, and Resource Lists for Preventive Maintenance.

Item No.	Description	Quantity
	Tools	
1	Handheld Drill	1
2	Telescoping Mirror	1

Item No.	Description	Quantity
3	24” Digital Level	1
4	Bubble Level	1
5	Needle nose pliers	1
6	Allen wrench set	1
7	7/16” Socket wrench or open-end Wrench	1
8	Step ladder	1
9	Large plastic funnel	1
Consumable items		
1	Formula 409, Multi-surface Cleaner (32 oz. spray bottle)	A/R
2	Distilled or Deionized water (Squirt/Spray Bottle)	A/R
3	Lint-free Cloths or Kimwipes	A/R
4	Powder-free Nitrile Gloves	A/R
5	Trash bags	A/R
6	Spill containment mats	A/R
7	Rags or roll of paper towels	A/R
8	Oil - Isopar M	0.47 L (16 oz)
9	Oil - Renoil 70-W – D04 GUAN Only	0.47 L (16 oz)
10	Antifreeze – 60/40 Methanol/Propylene Glycol Mixture [CORECHEM[vi]] [Part # 190205-026-0029]	Site specific. See Appendix 8.2 and 8.3
Resources		
1	6-7 gallon oil/antifreeze sealable waste container(s)	1-2
2	Primary Precipitation Gauge Drain (see Appendix 8.4)	1
3	Spill containment bin or berm	1

5.3 Subsystem Location and Access

Primary precipitation gauges and DFIRs reside at NEON TIS Core sites, and various AIS sites (see **Table 1** and **Table 2**).

The Primary Precipitation Gauge is in the center of the NEON DFIR fence and the Alter shield. Access to the primary precipitation gauge is via two gates on the NEON DFIR fences. There is no gate on the metal Alter shield. To access the gauge itself for maintenance, remove one or two small sections of the Alter shield (see Section 5.3.1 below for instructions).

5.3.1 Alter Shield Access

Access through the Alter shield requires removal of at least one of the four sections of the shield. Each shield section affixes to support poles by an aluminum backing plate and a 1/4 in. stainless steel hoop.

[vi] Formerly Greenway Products, Inc.

Removal of a section is relatively easy, as each end of the stainless steel hoop has a slit at the securing bolts that allow it to slide off the support structure.

Figure 33. The aluminum backing plate and the ends of the stainless steel hoops. There are slits in the stainless steel hoop by the bolts that facilitate easy removal and re-installation of the Alter shield sections.

NOTE: The Alter shield sections are cumbersome and may have sharp edges. NEON recommends employing two Technicians to perform the removal/re-installation of an Alter shield section.

	**Step 1.** Loosen one of the bolts securing one section of the Alter shield with a 7/16 in. nut driver or standard wrench. Loosen the bolts enough to slide the metal hoop out from underneath the bolt.

Step 2. Loosen the other side of the Alter shield section to be removed, and slide out the metal hoop out from underneath the bolt.

Step 3. While holding up the Alter shield section, slide the other side of the metal hoop out from underneath the bolt.

Step 4. Place the Alter shield in a safe location within the DFIR fencing.

NOTE: You may remove more than one Alter shield section if needed for added room.

5.4 Maintenance Procedure

The NEON DFIR and Primary Precipitation Gauge require very little maintenance since there are no moving parts; however, routine inspections and checks ensure proper functioning of the measurement system.

5.4.1 Monthly/Seasonally/Annually

The preventive maintenance procedure for Monthly/Seasonally/Annually timeframes are the same except for seasonal changes in the amount of antifreeze. See Appendix 8.2 and Appendix 8.3 for oil and antifreeze capacities and seasonal change dates.

See Section 5.1.2 for Seasonal maintenance requirements, and Section 5.1.3 for Annual requirements at sites with low precipitation amounts.

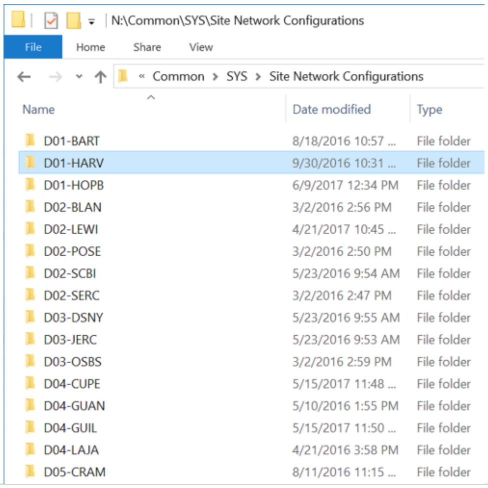
5.4.1.1 Check Strain Gauge Status

Checking the status of each of the three strain gauges before performing preventive maintenance provides information regarding the condition of the strain gauges. Their condition determines the level of maintenance necessary to maintain proper function of the instrument. To check the status of the three strain gauges, NEON uses two software tools to accomplish this task.

1. Acquire the instruments IP address of the LC and the MAC address of the Grape associated with the Primary Precipitation Gauge. **Do not use the LC for these procedures**. These procedures are in Section 5.4.1.1.1 and Section 5.4.1.1.2.
2. Download the NEON custom program ***Belfort LC Check.exe*** (developed via CVAL) to check the status of the three vibrating wire strain gauges.
    a. To install the ***Belfort LC Check.exe*** software, follow the installation instructions in Appendix 8.7 and reference Section 5.4.1.1.3.

5.4.1.1.1 Obtaining the IP Address of the LC

This section provides instructions to obtain the IP address of the LC. This is the first procedure to check the strain gauge status of the Primary Precipitation Gauge.

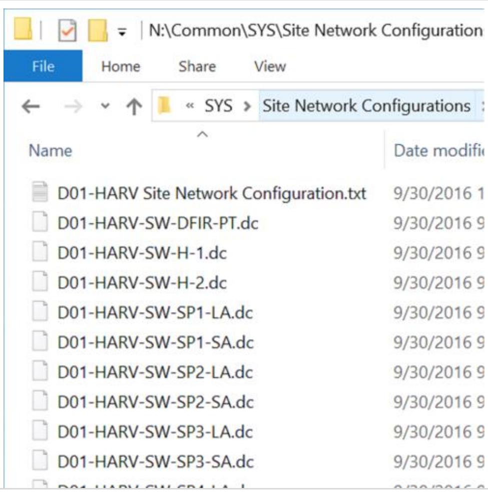


Step 1. While connected to the NEON Network, go to:

N:\Common\SYS\Site Network Configurations

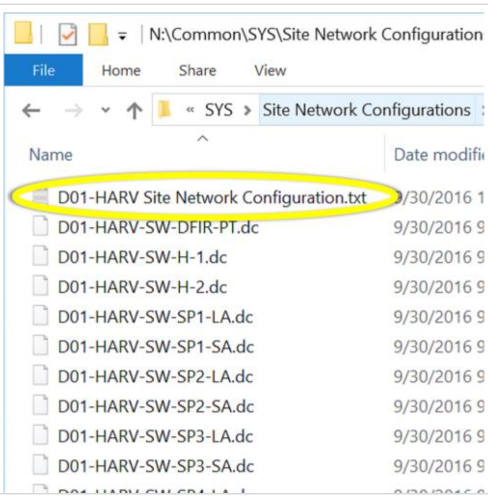
This will take you to a folder with all the NEON sites listed by Domain and Site.

Example: **D01-HARV**



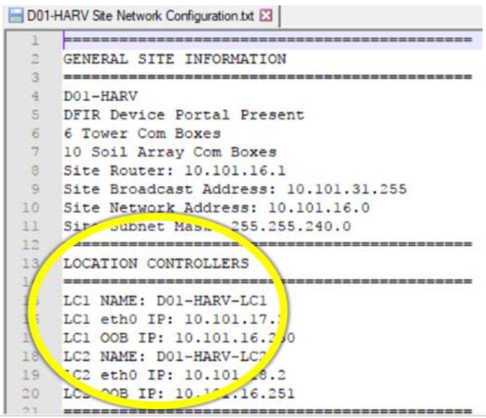
Step 2. Select the site of interest and double-click on the folder.

Contents of the folder will be displayed.



Step 3. Open the file that has "Site Network Configuration" in the title.

Example: **D01-HARV Site Network Configuration.txt**



Step 4. Look for the section titled "LOCATION CONTROLLERS"

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LOCATION CONTROLLERS

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LC1 NAME: D01-HARV-LC1

LC1 eth0 IP: 10.101.17.2

LC1 OOB IP: 10.101.16.250

LC2 NAME: D01-HARV-LC2

LC2 eth0 IP: 10.101.18.2

LC2 OOB IP: 10.101.16.251

Step 5. Locate LC1 and write down its IP Address.

Example: **D01-ORNL-LC1**
IP Address: **10.101.17.2**

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LOCATION CONTROLLERS

====================================

LC1 NAME: D01-HARV-LC1

LC1 eth0 IP: 10.101.17.2

LC1 OOB IP: 10.101.16.250

LC2 NAME: D01-HARV-LC2

LC2 eth0 IP: 10.101.18.2

LC2 OOB IP: 10.101.16.251

5a. If LC1 is unavailable, use the information for LC2.

Example: **D01-HARV-LC2**
IP Address: **10.101.18.2**

NOTE: AIS DFIR sites don't have an LC2. TIS DFIRs that are non-Instrument Hut supported (see ***Table 3****) will only have one LC.*

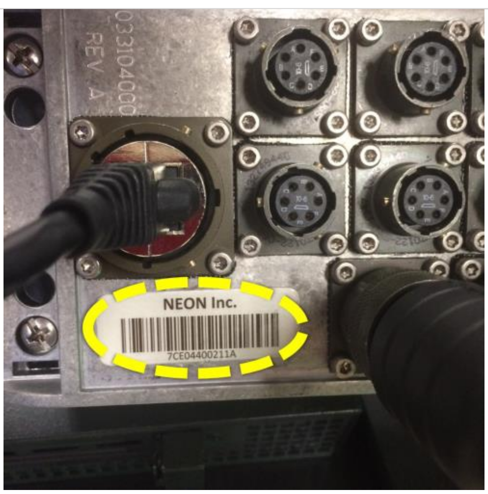
5b. If working with a co-located tower and DFIR, an alternative option is to physically look on the computer rack within the Instrument Hut. Typically, the IP Addresses of LC1 and LC2 are on labels. If these labels do not exist or are wearing down, please add new labels using the instructions above to verify each IP address.

NOTE: Non-Instrument Hut supported DFIRs (see Table 3) and and AIS DFIRs may have their own network and LC. Using the Site Network Configuration documents will eliminate confusion.

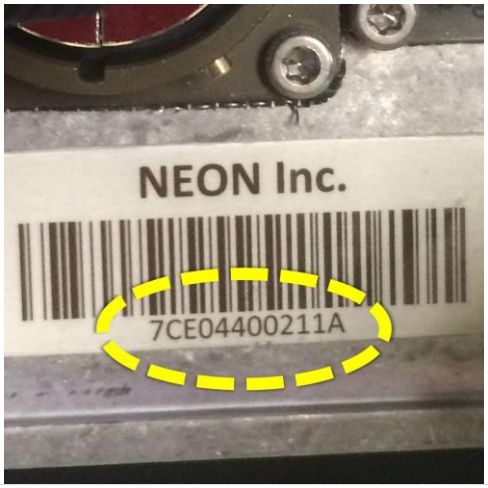
5.4.1.1.2 Obtaining the MAC Address of the Primary Precipitation Gauge

This section provides instructions to obtain the MAC address of the Grape that powers the Primary Precipitation Gauge. This is the second procedure to check the strain gauge status of the Primary Precipitation Gauge.

NOTE: The below steps are for when you are physically at the site.



Step 1. Locate the Grape associated with the Primary Precipitation Gauge. The Grape resides under a Grape Shield next to the Alter Shield in the inner fence of the NEON DIFR. Locate the NEON Asset Barcode tag.



Step 2. The MAC address is the string of characters printed below the barcode on the NEON Asset Barcode tag.

Example: **7CE04400211A**

Make note of the MAC address via tablet, paper or picture.

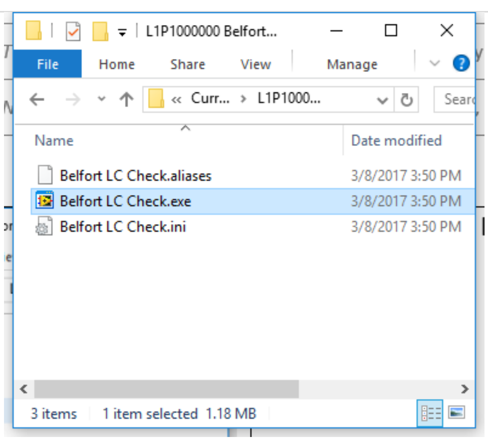
5.4.1.1.3 Checking the Strain Gauge Status

This section provides instructions to check the statuses of the Strain Gauges. This is the final procedure to check the strain gauge status of the Primary Precipitation Gauge.

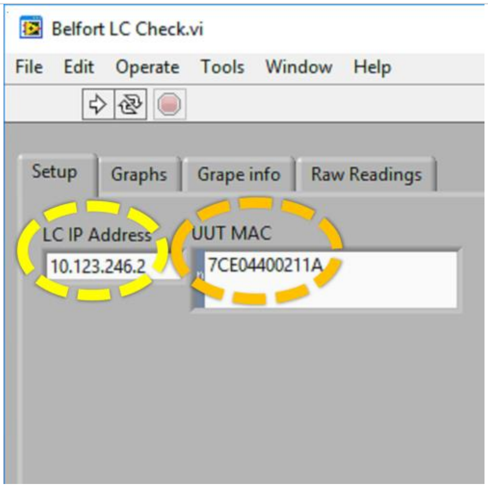
Step 1. Download the latest version of the **Belfort Check LC.exe** program.

Verify the latest version is available to use to determine if downloading is necessary (if this step was completed during a previous maintenance cycle). Use the file pathway location via the NEON network drive below to verify program version or download.

Program file path location:
N:\Common\CVL\Field_Calibration\Required Directory\Test_Data\Current Executables



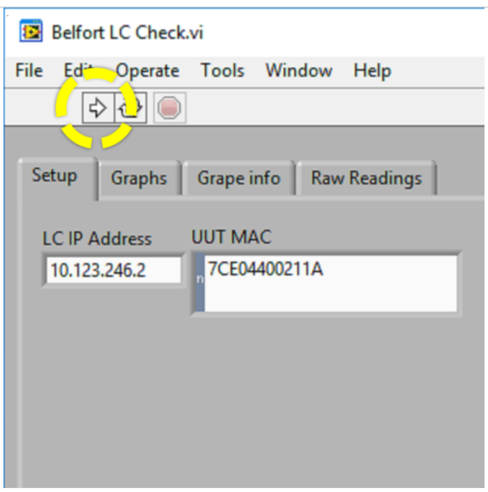
Step 2. Open the **Belfort Check LC.exe** program.



Step 3. Select the **"Setup"** tab. Under the **"Setup"** tab, conduct the following:

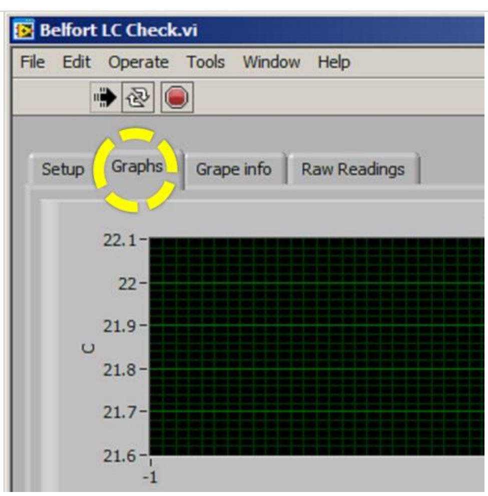
a. Enter the IP address of the LC in the **"LC IP Address"** field.

b. Enter the MAC address of the Belfort in the **"UUT MAC"** field. (UUT stands for Unit Under Test, which represents the instrument.)



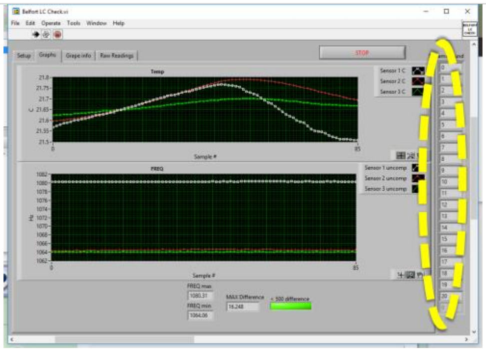
Step 4. Select the **"Play"** arrow button.

A delay may occur as the program connects and communicates with the LC and the Grape.



Step 5. Upon successful completion of Step 4, the **"Graphs"** tab automatically opens and displays two graphs.

At first, each graph displays nothing. Wait patiently and the graphs auto-populate data points.

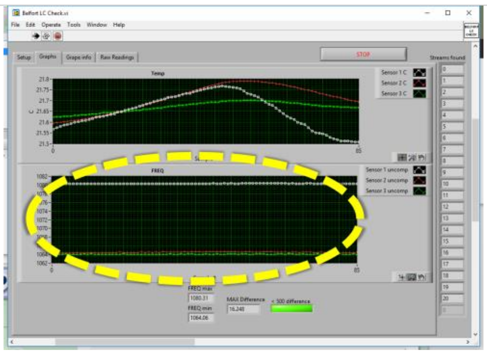


Step 6. Note the number of **"Streams"** found on the right side of the window.

An un-heated unit contains 19 streams (0 to 18).

A heated unit contains 21 streams (0 to 20).

⚙ *Missing streams may indicate a broken part or an issue with calibration. Submit a ticket via the NEON issue management and reporting system to rectify this issue.*

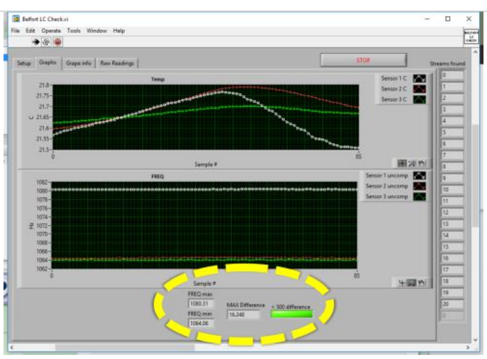


Step 7. Look at the graph titled **"FREQ"**.

Three graph lines display data that correspond to the three strain gauges.

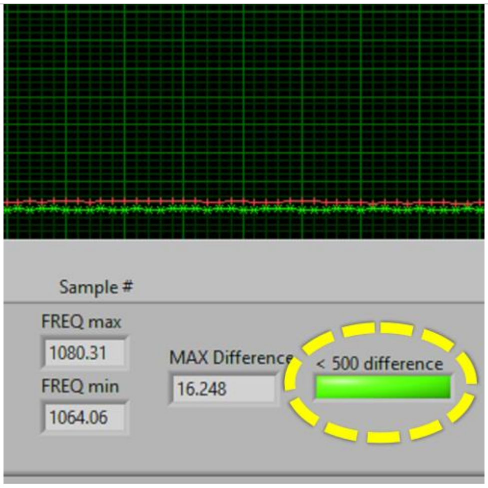
Step 8. Make note of each strain gauge value.

The graph adds new points every 10 seconds, so it may take some time to collect enough data points on the graph to capture a strain gauge value.



Step 9. At the bottom of the window, the program displays the following information:

- **FREQ max** (the gauge with the highest value)
- **FREQ min** (the gauge with the lowest value)
- **MAX difference** (the difference between max and min)
- **< 500 difference** (acceptable range indicator) [green = acceptable, red = out of range]



Step 10. If the < 500 difference indicator is green, the strain gauges are functioning correctly. If the indicator is red a problem exists. It may indicate a defective strain gauge.

If there are issues with any of the three strain gauges, submit a ticket via the NEON issue management and reporting system.

5.4.1.2 Vegetation Maintenance

Maintaining the surrounding the vegetation are mandatory to meet NEON science requirements. To ensure accurate measurements of the Primary Precipitation Gauge, actively monitor and maintain the height of the vegetation surrounding the NEON DFIR.

- Maintain the vegetation within 4 meters (~13 ft.) of the outer fence at 20 cm (~8 in.) below the height of the outer fence (see **Figure 34**) [vii].
- Maintain the vegetation within the outer fence and up to the Primary Precipitation Gauge to less than 0.5 m (~19.5 in.) above the ground (see **Figure 34**)[viii].

NOTE: The standard height of the outer fence of the DFIR is 5 ft. 8 in., however there are several DFIRs that are taller (see Appendix 8.6). Vegetation heights should be maintained accordingly.

[vii] NEON Science Requirement: NEON.TIS.6.1168 – Vegetation outside of the DFIR outer fence shall be maintained to a height greater than 20 cm below the top of the outer fence to a distance of the radius of the outer fence away (approximately 13 feet 1 inch).
[viii] NEON Science Requirement: NEON.TIS.6.1167 – Vegetation height inside the DFIR outer fence up to the primary precipitation collector itself shall be maintained to less than 0.5 m above ground.

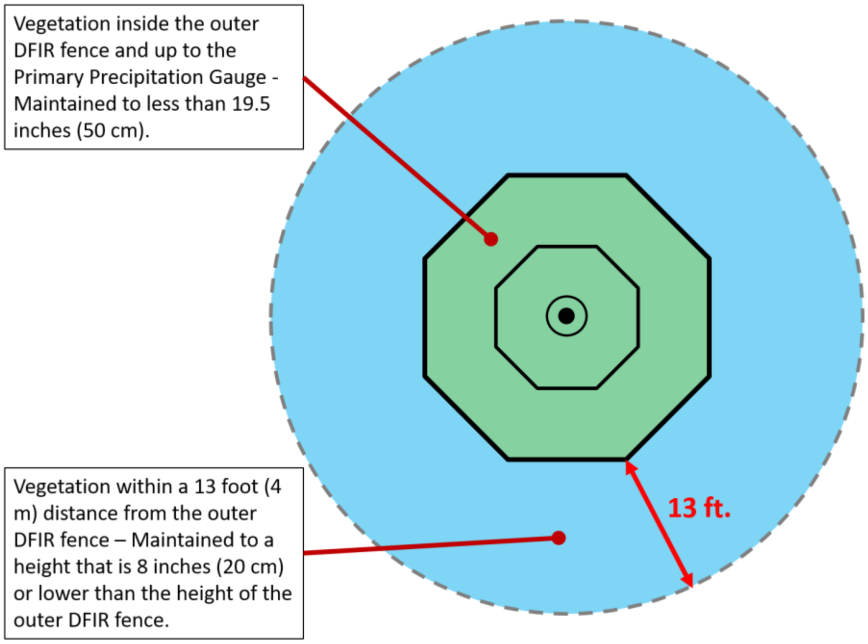


Figure 34. Vegetation maintenance heights and distances within and surrounding the DFIR fences.

5.4.1.2.1 Inspect Surrounding Vegetation Heights

1. Visually inspect the surrounding vegetation within 4 meters (~13 ft.) of the outer DFIR fence (see **Figure 34**).
    a. If vegetation is above the height requirements for the outer fence (see Section 5.4.1.2 and **Figure 34**), trim the vegetation so it is at least 8 inches below the outer DFIR fence.
2. Visually inspect the vegetation between the inner and the outer fence.
    a. If vegetation is above 19.5 inches, trim the vegetation so it is below 19.5 inches tall.
    b. If the site host allows, vegetation can also be mowed and be kept mowed throughout the year.
3. Visually inspect the vegetation within the inner fence and up to the Primary Precipitation Gauge.
    a. If vegetation is above 19.5 inches, trim the vegetation so it is below 19.5 inches tall.
    b. If the site host allows, vegetation can also be mowed and be kept mowed throughout the year.

5.4.1.2.2 Inspect DFIR, Alter Shield, and Primary Precipitation Gauge for Vegetation Growth

1. Visually inspect the DFIR fences, Alter shield, and Primary Precipitation Gauge for any vegetation (e.g. vines) growing on these structures.

a. Remove any vines or vegetation growing on any of these structures.

5.4.1.3 DFIR Fence Maintenance

Maintaining the two DFIR Fences is important in ensuring the highest accuracy measurements for the Primary Precipitation Gauge. The most important aspects of the DFIR Fences are its shape, heights, and the spacing of the wooden vertical slats. Each panel of the DFIR Fences are designed to provide a 50% spatial area (see for example **Figure 8** and **Figure 9**).

5.4.1.3.1 Fence Damage

1. Visually inspect the outer and inner octagonal vertical lath fences for damage, warping, deformation, or any debris that is caught within or between the fences, or fence slats.
    a. Remove any debris from the fence. Conduct the appropriate Job Safety Analysis (JSA) if the debris is large and/or contains sharp edges/objects.
    b. If any individual section of the lath fence is warped or deformed more than (4 in.) from vertical, submit a ticket via the issue reporting system. Replace these lath sections of the fence. See Appendix 8.1, for NEON DFIR construction materials.
    c. If any of the wooden vertical lath pieces are missing, submit a ticket via the issue reporting system. Replace these sections of the fence. See Appendix 8.1 - NEON DFIR Construction Materials, **Figure 17** and **Figure 18**.
    d. If there is significant damage to main support posts, submit a ticket via the issue reporting system. See Appendix 8.1, for NEON DFIR construction materials.

5.4.1.3.2 Fence Level

There are scientific requirements for the levelness of the inner and outer DFIR fences. The level of the fence should be inspected annually and leveled as needed.

The inner and outer fences should be horizontally level to within 1 degree[ix,x].

1. Place a digital level on each fence panel of the inner and outer fence. Each fence section should be horizontally level to within 1 degree.

[ix] NEON Science Requirement: NEON.TIS.6.1534 – The top of each inner fence panel of the DFIR shall be level to +/- 1 degree.
[x] NEON Science Requirement: NEON.TIS.6.1535 – The top of each outer fence panel of the DFIR shall be level to +/- 1 degree.

2. If they are not level, level each panel to within 1 degree of horizontal.

5.4.1.3.3 Fence Weather Treatment

The NEON DFIR fences are made with a variety of locally obtained wood (e.g. from The Home Depot, Lowes, or local lumber yard). Most of these fences are built with pressure-treated (PT) pine and PT corner posts. Some sites where PT wood was not readily available, or required a wood that was non-toxic and insect resistant were built with cedar (D04 GUAN, D09 WOOD, D19 BONA). A couple sites where a non-toxic, insect and rot resistant, and durable wood was requested by the site host was built with redwood (D17 SJER, D12 YELL).

Though the NEON DFIR fences were made with a variety of woods and designed to withstand years of outdoor exposure, it has been identified that the longevity of the NEON DFIR fences could be further enhanced with the application of some weather treatment, or weather sealant.

It is recommend that the wooden DFIR fences, support structures, wooden posts be weather-sealed with a water-based, non-toxic, VOC-free, and preferably "food-grade" sealant. The DFIR should not be painted (with paint) as over time the paint will chip and peel.

There are numerous products available that meet the above criteria. **Table 9** provides a list of recommended weather sealants.

Table 9. List of Recommended DFIR Fence Weather Sealants.

Manufacturer	Product	Product Link
AgraLife	Fence-Seal*	http://agralifeproducts.com/products/product/fence-seal-1-gal
	Lumber-Seal*	http://agralifeproducts.com/products/product/Lumber-Seal-1-Gal
	Cedar-Seal*	http://agralifeproducts.com/products/product/Cedar-Seal-1-Gal

* These are all essentially the same product.

The above sealants can be applied to all wooden DFIR fences, supporting structures, and posts.

Re-treatment should be applied at least once every two years.

5.4.1.4 Alter Shield Maintenance

The Alter shield comprises of 32 aluminum deflectors. The deflectors move depending on the wind speed and direction, up to 30° from vertical (rubber grommets constrain the movement to 30°). These deflectors are spring loaded to return to vertical in low-to-no wind conditions.

A Parts List for the Alter shield is in ER [03].

1. Visually inspect each aluminum deflector (also referred to as a fin) of the Alter shield.
    a. Remove any debris caught within the Alter shield fins.

b. Check the vertical orientation of each fin during low-to-no wind conditions. Ensure each fin is able to swing freely (up to 30° from vertical).

c. Verify the presence of all centering springs on each fin.

d. Inspect the condition of the rubber grommets, springs, S-hook connectors, backing plates, and the condition of the steel hoop (see **Figure 35**).

i. Look for broken or missing pieces, rust, or corrosion.

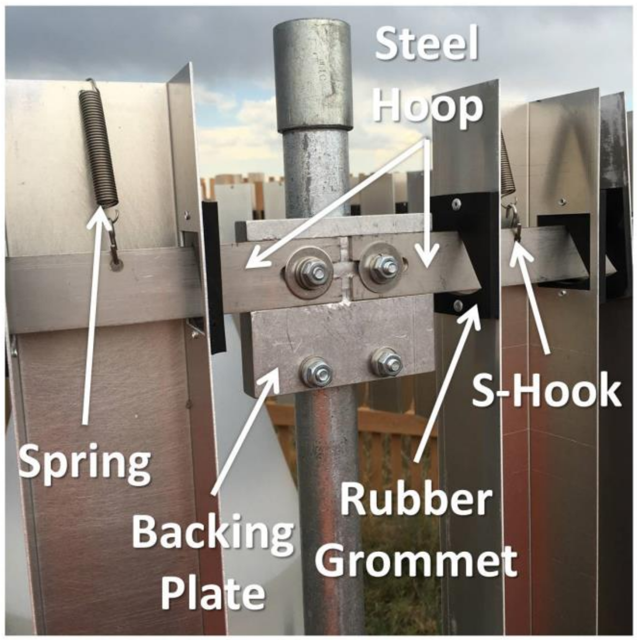


Figure 35. Inspection of the Alter shield should include the springs, rubber grommets, S-hooks, backing plates, and the steel hoops.

5.4.1.5 Inspect External Cables and Connectors

1. Visually inspect the external cables from the gauge to the Grape(s).
    a. Look for any damage from animals, insects, the elements, or other physical damage.
2. Check the connectors for damage, corrosion or evidence of overheating.
3. Tighten any loose connections and replace any broken or missing cable ties (as applicable).
4. Ensure connector caps on unused Grape connections are secure (locked in place).
5. Inspect and remove any dust and/or debris by vacuum or by dabbing areas with a lint-free cloth. Do not use compressed air.

5.4.1.6 Check Fluid Level

1. Visually inspect the gauge housing and the collection orifice for anything that may be blocking or obstructing the opening.

2. Remove any blocking debris.

3. <u>**Without removing the housing**</u>, visually inspect the height of the liquid inside the 6-gallon collection bucket.

    a. If the 6-gallon collection bucket capacity is below 80% capacity (see **Figure 29**), and the anticipated amount of precipitation to fall within the next maintenance cycle will not fill the bucket capacity, routine maintenance is complete.

    b. If the 6-gallon collection bucket capacity is below 80% capacity, **but** it is anticipated that the amount of precipitation to fall within the next maintenance cycle may fill the bucket close to or to capacity, continue to Section 5.4.1.6.2 Fluid Level Above 80% Capacity below.

5.4.1.6.1 Fluid Level Below 80% Capacity

If the 6-gallon bucket capacity is below 80% capacity (see **Figure 29**), and the anticipated amount of precipitation to fall within the next maintenance cycle will not fill the bucket capacity, routine maintenance is complete.

5.4.1.6.2 Fluid Level Above 80% Capacity

If the level of the fluid within the 6-gallon collection bucket reaches or exceeds 80% capacity (see **Figure 29**), follow the procedures below. Please be aware, a full calibration of the Primary Precipitation Gauge must occur post-removal of the fluid contents of the 6-gallon collection bucket. **Calibration must occur after <u>every</u> fluid removal/change.**

5.4.1.6.2.1 Check Status of the Three Strain Gauges

Follow instructions in Section 5.4.1.1 for checking the status of the three strain gauges.

5.4.1.6.2.2 Drain the Contents of the 6-Gallon Collection Bucket

This section contains the procedures to drain the contents of the 6-gallon collection bucket in the Primary Precipitation Gauge. Reference this procedure if the level of the fluid within the 6-gallon collection bucket reaches or exceeds 80% capacity.

Step 1. Assemble the Drain Pump System (see Appendix 8.4.5)

Step 2. Stage the hazardous materials (HAZMAT) liquid waste container, and secure the open end of the drain pump system into the liquid waste container.

NOTE: Make sure the HAZMAT liquid waste container is within a spill containment basin or a spill containment berm. Have spill containments mats readily accessible.

Step 3. Drain the contents of the 6-gallon collection bucket with the drain pump system to 2.5-5 cm (1-2 in.).

NOTE: The pump is directional, be sure drill is set to spin in the correction direction.

NOTE: If everything is successful, about 2.5-5 cm (1 in. to 2 in.) of fluid is remaining in the bucket. This ensures the bucket is light enough to remove (see next step).

Step 4. Remove the drain pump system by pulling it straight up from the precipitation gauge.

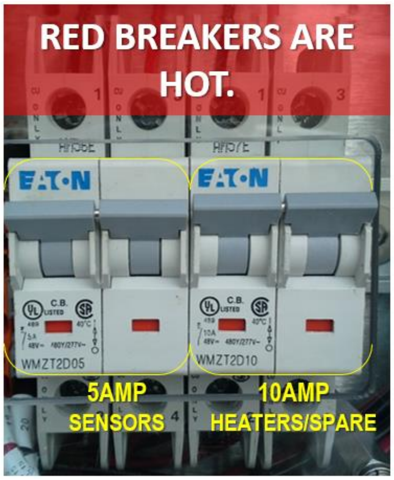
Step 5. Secure the liquid waste container, clean up any spills in the spill containment berm, and put away the drain pump system.

5.4.1.6.2.3 Remove Outer Housing and 6-Gallon Collection Bucket

> **CAUTION:** Always power off the precipitation gauge and heater (if installed) before removing the outer housing.
> * See Section 6.2.1 *

Conduct the appropriate JSA and Lock-Out/Tag-Out (LOTO) protocols per AD [01] for handling electrical and communication equipment in this next procedure.

Step 1. Disconnect the Ethernet cable from the Merlot Grape associated with the sensor.

	**Step 2.** If heated, turn off the relay switch for the Zinfandel Grape in DFIR Device Post Power Box to power down the heater unit (flip the breakers). Reference AD [12]. RED = BREAKERS ARE HOT GREEN = POWER IS OFF

	**Step 3.** Detach the orifice heater cable from the outer housing.

	**Step 4.** Unlatch the three spring latches connecting the outer housing to the base.

	**Step 5.** Position yourself so the outer housing lifts straight up. *NOTE: NEON recommends the use of two Technicians to remove the outer housing to avoid damaging any of the sensitive internal components.*
	**Step 6.** Lift the outer housing straight up until the bottom of the outer housing clears the top of the 6-gallon collection bucket. *NOTE: Having the outer housing tilt while removing the outer housing greatly increases the possibility of damaging any of the three vibrating wire strain gauges. Use two technicians to enable a straight lift of the outer housing.*
	**Step 7.** Place the outer housing in a safe location within the NEON DFIR.

Step 8. Inspect the collection orifice for any damage or excessive dirt.

If dirty, remove using Formula 409 Multi-Surface Cleaner with a clean lint-free cloth. Wipe down the black section of the collection orifice (inside and out).

Step 9. Look inside the 6-gallon collection bucket and make note of the debris within the bucket.

Take a photograph and submit a photo and/or capture notes for reference and/or reporting purposes.

Step 10. Carefully remove the 6-gallon collection bucket by lifting it straight up until the bottom of the bucket clears the internal support frame.

Maintain awareness of the strain gauges to mitigate hitting them while removing the bucket.

Step 11. Discard the remaining amount of fluid into a hazardous materials (HAZMAT) waste container.

Step 12. Rinse out and clean the inside the 6-gallon collection bucket of any remaining debris, and set aside.

5.4.1.6.3 Inspect the Internal Components and Cables

Step 1. Visually inspect the three strain gauges for any signs of damage.

The pre-check of the status of the strain gauges following the procedures in Section 5.4.1.1. This procedure provides an indication if there are issues with any of the gauges.

⚙ *If there are issues with any of the three strain gauges, submit a ticket via the NEON issue management and reporting system.*

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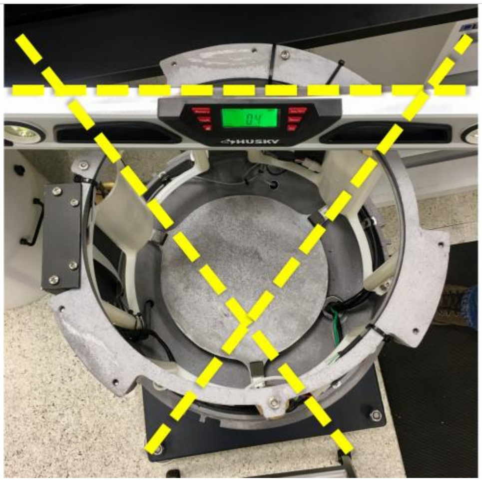
Step 2. Inspect the wires from below the gauges and make sure they are secure via metal clamps to the interior.

The cables are not to interfere with the movement of the weighted bucket support.

5.4.1.6.4 Level the Internal Frame



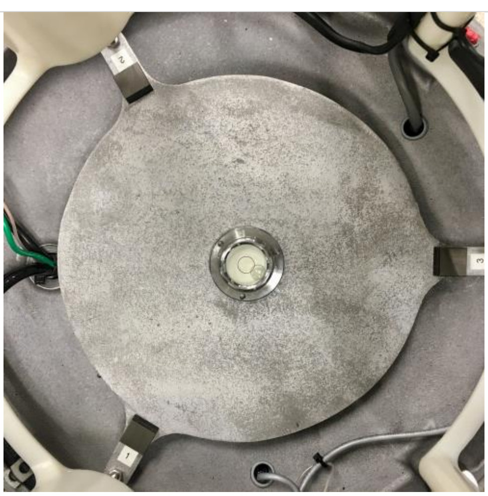
Step 1. Place a precision digital level on the top of the internal frame. Check the level along three horizontal planes as shown to the left.

a) If it is level, continue to the next step.

b) If it is not level, level the base. See the next Step.

Step 2. If necessary via Step 1, level the base by adjusting the three adjustment screws at the base of the support frame.

Level the frame to within ±0.5°.



Step 3. Place a bubble digital level in the middle of the weighted bucket support.

a) If it is level, then this action is complete.

If there are issues with leveling the base, submit a ticket via the NEON issue management and reporting system.

NOTE: Leveling the bucket support requires extensive work and procedures will be outlined on a case-by-case basis.

5.4.1.6.5 Power on the Primary Precipitation Gauge

See Section 6.2.1 Powering the Sensor Off/On for Maintenance and Swapping of the Merlot Grape for instructions on powering on the Primary Precipitation Gauge and its subsystem components.

5.4.1.6.6 Calibrate the Primary Precipitation Gauge

After completing Section 5.4.1.6.2.2 through Section 5.4.1.6.5, calibrate the Primary Precipitation Gauge. Calibration must occur every time the contents of the 6-gallon collection bucket change.

Follow the calibration and validation procedures via CVAL instruction in RD [06] - NEON.DOC.003289, L1P100 Field Calibration/Validation Primary Precipitation Sensor Standard Operating Procedure.

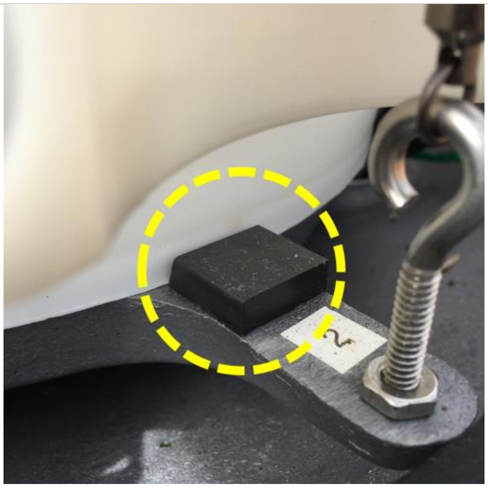
The most recent calibration procedure, programs, drivers, and calibration notes are on the NEON network drive (intranet) via ***N:\Common\CVL\Field_Calibration***.

KEEP THE POWER ON FOR THIS NEXT PROCEDURE POST-CALIBRATION.
See Section 5.4.1.6.7

5.4.1.6.7 Replace the 6-Gallon Collection Bucket and Add Fluids

Replace and add the initial charge volume of oil and/or antifreeze to the 6-gallon collection bucket (see Appendix 8.2 and 8.3, and Section 4.2.2.1). Conduct the following procedures.

	**Step 1.** Carefully insert the clean and empty 6-gallon collection bucket into the Primary Precipitation Gauge inner housing base. Do not drop the bucket into the gauge as that may damage the three strain gauges via the tension from the weight plate at the base the bucket sits on.



Step 2. Ensure the 6-gallon collection bucket is up against each of the three centering bucket guides.

The bucket should not rest on any of the guides. Allow little to no gap between the bucket and the centering guides to exist.

Step 3. To avoid contact with the oil and antifreeze mixture, apply safety glasses and nitrile gloves.

Step 4. Slowly add the specified amount of antifreeze to the 6-gallon collection bucket (see Appendix 8.2 and 8.3).

Try not to 'shock load' the strain gauges by simply dumping the liquid into the bucket. **Be deliberate and pour slowly.**

If your site does not require antifreeze, please continue to the next Step for adding the oil to the 6-gallon collection bucket.

Step 5. Slowly add 0.47 L (16 oz.) of oil to the 6-gallon collection bucket (see Appendix 8.2 and 8.3).

Try not to 'shock load' the strain gauges by simply dumping the liquid into the bucket. **Be deliberate and pour slowly.**

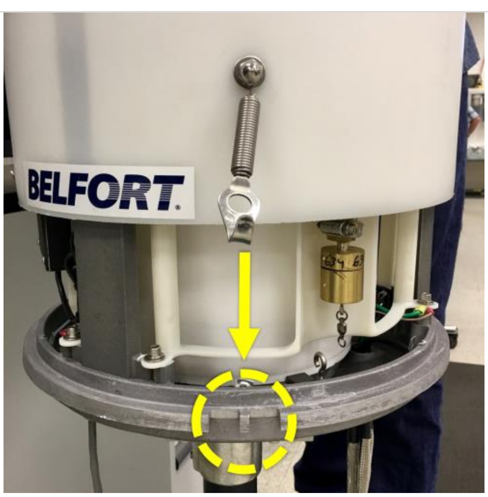
Step 6. Dispose of empty oil and/or antifreeze containers appropriately per the SDS and site requirements. Contact the NEON Safety office for additional guidance, if necessary.

Follow the procedures in Section 5.4.1.6.8 to zero the gauge.

5.4.1.6.8 Zero the Primary Precipitation Gauge

To zero the Primary Precipitation Gauge, follow the procedure in RD [06] - NEON.DOC.003289, L1P100 Field Calibration/Validation Primary Precipitation Sensor Standard Operating Procedure. Procedure to Section 5.4.1.6.9 upon successful completion.

5.4.1.6.9 Replace the Outer Housing



Step 1. Align the spring latches with the catches at the base.

If the site employs an orifice heater, make sure the exterior housing alignment is such that the heater cable from the base of the gauge aligns with its mating receptacle, which mounts on the side of the exterior housing.

Step 2. Carefully reinstall the outer housing.

Employ care as the inner metal plates can catch on the internal frame, or the strain gauges.

NEON recommends using two Technicians for this procedure.

Step 3. Secure the outer housing by attaching the spring latches to the catches on the base.

Step 4. Connect the heater cable, if the site employs an orifice heater. Disregard this step if the site does not employ this heating component.

Step 5. Connect the Primary Precipitation Gauge to the Grape (s). Connect the orifice heater to the Grape, if applicable to the site.

Continue on to Section 5.4.1.6.10.

5.4.1.6.10 Verify the Level of the Outer Housing

Step 1. Verify the level of the outer housing. Place a precision digital level at the top of the collection orifice.

Step 2. Check the level along three horizontal planes as shown to the left.

Verify that the outer housing is level to within ±0.5°.

a) If it **is** level, continue to next Section.

b) If it **is not** level, make tiny adjustments to at the base to level. See next Step.

Step 3. If necessary per Step 2, level the base by making tiny adjusting the three adjustment screws at the base of the support frame of the Primary Precipitation Gauge.

Proceed to Section 5.4.1.6.11.

5.4.1.6.11 Check Status of the Three Strain Gauges Again

Checking the status of each of the three strain gauges after performing preventive maintenance to verify the condition of the strain gauges. Follow the instruction in Section 5.4.1.1 for verifying the status of the three strain gauges to ensure their state of health is the same from the initial check.

6 REMOVAL AND REPLACEMENT (SUBSYSTEM ONLY)

6.1 Equipment

Table 10 contains a list of equipment to conduct sensor refresh at TIS sites for specific instrumentation and/or subsystem components that require calibrations and validations. This also includes unique equipment necessary for removal and replacement procedures. Equipment recommendations and applicability may adjust over time as the implementation of NEON sensors and subsystems mature.

Table 10. Tools, Consumables, and Resource Lists for Removal and Replacement of the Sensor.

Item No.	Description	Quantity
Tools		
1	Field Laptop (to include Power and USB Cables)	1
2	Field Calibration Box	1
3	Calibration Weight Set	1
4	Weight Centering Jig	1
5	Handheld Drill	1
6	Telescoping Mirror	1
7	24” Digital Level	1
8	Bubble Level	1
9	Needle Nose Pliers	1
10	Allen Wrench Set	1
11	7/16” Socket Wrench or Open-End Wrench	1
12	Step Ladder	1
13	Large Plastic Funnel	1
Consumable items		
1	ESD Packaging	2
2	Formula 409, Multi-surface Cleaner (32 oz. Spray Bottle)	1
3	Distilled or Deionized water (Squirt/Spray Bottle)	A/R
4	Lint-free Cloths or Kimwipes	A/R
5	Powder-free Nitrile Gloves	A/R
6	Trash Bags	A/R
7	Spill Containment Mats	A/R
8	Rags or Roll of Paper Towels	A/R
9	Oil - Isopar M	0.47 L (16 oz)
10	Oil - Renoil 70-W – D04 GUAN Only	0.47 L (16 oz)
11	Antifreeze – 60/40 Methanol/Propylene Glycol Mixture [CORECHEM[xi]] [Part # 190205-026-0029]	Site specific. See Appendix 8.2 and 8.3
12	Masking Tape	1

[xi] Formerly Greenway Products Inc.

13	Sharpie Marker/Paint Pen	1
Resources		
1	Field Calibration and Validation Kit/Box & RD [06]	1
2	Latest Copy of L1P1000000 Main.exe on Field Laptop	1
3	Pelican Case/Shipping Container	1
4	Technician	2
5	Armored Ethernet Cables (CF04250050)	A/R
6	Armored Heater Cables (CF06760050)	A/R
7	Merlot Grape 12VDC	1
8	6 or 7 Gallon Oil/Antifreeze Sealable Waste Container(S)	1 or 2
9	Primary Precipitation Gauge Drain (see Appendix 8.4)	1
10	Spill Containment Bin or Berm	1

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

6.2 Removal and Replacement Procedure

The FOPS Domain Manager is responsible for managing the removal and replacement of the sensors on site for preventive maintenance and/or sensor swaps and manages field calibration and validation of sensors, as appropriate. The NEON project Calibration, Validation and Audit Laboratory (CVAL) is responsible for the calibration and validation of select sensors and manages Domain sensor refresh (swap) schedules. The Merlot Grape (12VDC) that powers the Primary Precipitation Gauge requires annual calibration. CVAL establishes and disseminates a set schedule to FOPS for sensor refreshes/swaps annually, and provides ESD packaging and a pelican case containing a calibrated Merlot Grape for a one for one Grape swap.

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 11** for sensor refresh requirements for the sensor and subsystem infrastructure for the Primary Precipitation Gauge.

Table 11. Primary Precipitation Subsystem Sensor Refresh Requirements.

	LOCATION		**TIMEFRAME**		
	CVAL	***FIELD***	***BIWEEKLY***	***ANNUAL***	**COMMENTS**
Merlot (12V) Grape	**X**			**X**	
Primary Precipitation		**X**	***See Comments**		*Calibration must occur every time the contents of the 6-gallon collection bucket change. See Section 5.4.1.6.6* Calibrate the Primary Precipitation Gauge *on page 63.*

Follow the proper protocols for LOTO procedures per AD [01] to isolate energized devices when performing maintenance on electrical infrastructure/subsystems.

CAUTION: Always connect and disconnect the Ethernet cable from the Grape ***before*** plugging and unplugging any of the sensors cable connections.

6.2.1 Powering the Sensor Off/On for Maintenance and Swapping of the Merlot Grape

The Grape powers the Primary Precipitation (it acts as its on/off button since the sensor does not have one). Always disconnect the power prior to removing or replacing any components. To do this, disconnect the Ethernet cable from the Merlot Grape associated with the sensor. Once the Ethernet cable (RJF) is disconnected, disconnect the sensor's direct connections to the Grape to power off/swap the sensor.

If heated, turn off the relay switch for the Zinfandel Grape in Communications Box to power down the heater unit. Disconnect and remove the heater power cable (see **Figure 36**, if necessary). Refer to How-To: Turn on a Communication Box Relay (AD [12]) for systematic instructions on turning on/off a communications box relay.

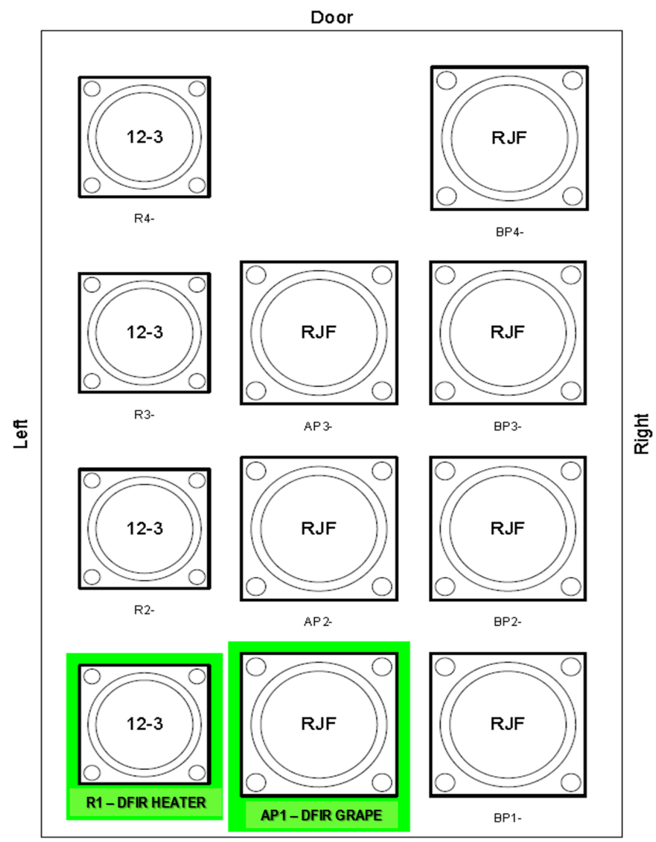


Figure 36. Communication Box Zinfandel Grape for Primary Precipitation Gauge specific Grape Map.

6.2.2 Grape Removal/Replacement Procedure

1. Wear an anti-static wristband and tie to earth ground. Employ ESD protocols when handling Grapes.
2. Disconnect the armored Ethernet cable connecting to the RJF/Eth to Comm connection.
3. Disconnect sensor connections.
4. Remove the one Merlot Grape via its Grape Shield (**Figure 37**). Remove the four screws that affix the Grape to the Grape Shield using a hex wrench.
   a. If there is a need to remove the Grape Shield from the Unistrut, remove the Grape Shield Unistrut mount/clamp using a 3/16" hex wrench.

Figure 37. Remove Grape from Grape Shields.

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

5. Place dust caps on Amphenol connectors of old Grape. Maintain Amphenol caps on the calibrated Grape until installation is complete. This prevents damage from ESD.

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

7. Remove dust caps on sensor connectors and Eth-To-Comm connector. Re-connect sensor and armored Ethernet cable in accordance with AD [06]. The Primary Precipitation sensor uses two primary connections on the Merlot Grape. Unpack the new/calibrated Merlot Grape and plug in the two direct connections per the Grape Mapping in **Figure 38**.

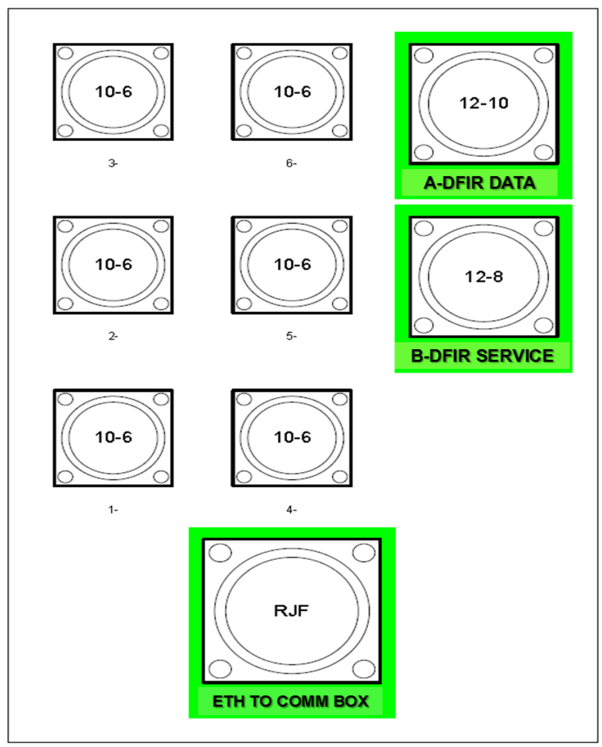


Figure 38. Primary Precipitation Merlot Grape.

8. Re-energize the site and verify Grape function. Connect locally to the Aquatics Portal or from the Domain using a Terminal Emulator Program (TEP), (such as PuTTy or MobaXterm) and **Table 12**.

Table 12. View Grape and Sensor Data Streams (MAC and EPROM ID are Examples for this Command).

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

Reference **Figure 36** for the Primary Precipitation Grape connections from the Communications Box Zinfandel Grape to the Merlot Grape. This also identifies the connection to the NEON DFIR Heater for site locations requiring a heater component for sensor orifice.

NOTE: For TIS, only Merlot, Concord and Catawba Grapes require annual calibration via CVAL.

For each sensor swap, maintain records on the sensor swapping powering down/on date and timeframe and update via NEON's project Asset Management and Logistic Tracking System (MAXIMO) records per CVAL guidance (see RD [09]).

6.3 Cleaning & Packaging of Returned Sensor

Field Operations staff clean, package, and ship the sensors back to the CVAL at the NEON project HQ (Battelle Ecology) for annual sensor swap/calibration requirements. For this procedure, the only item requiring CVAL calibration is the Merlot Grape. The Primary Precipitation sensor remains in the field for calibration and validation. (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 guidance). Reference **Table 10** for the equipment, tools and consumables necessary for conducting the NEON HQ, CVAL Sensor Refresh procedures.

Please conduct decontamination on the sensors/subsystems returning to NEON HQ. Remove all arachnids and/or insects from the Primary Precipitation Merlot Grape prior to packing in the ESD packaging and shipping container.

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

1. Check mounting holes for spiders and spider webs. Remove biologics and clean connectors.
2. Cap all connectors.
3. Conduct decontamination on the exterior.
4. Place the device in an ESD bag and shipping container.

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

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

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

7. Prepare a Bill of Lading.

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

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

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

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).

6.4.2 NEON Asset Management and Logistic Tracking System Requirements

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

7 ISSUE REPORTING OUTPUTS

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

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

Table 13: Metadata Output Checklist.

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

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

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

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

2. Ship all defective equipment/assets with a red "Rejected" tag. **Figure 39** displays the minimum information requirements for each tag.

Figure 39. Red Rejected Tag for Defective Assets (MX104219).

8 APPENDIX

8.1 NEON DFIR Construction Materials

Table 14. NEON DFIR Construction Materials.

Fence Section Cross Members	
	2" x 4" Lumber (1 1/2" x 3 1/2")
	• (16 pieces at 10' each and 16 pieces at 5' each)
Fence Section Slats	
	1" x 2" Lumber (3/4" x 1 1/2")
	• (450 slats at 4' each)
Posts	
	4" x 4" Lumber (3 1/2" x 3 1/2")
	• (17 posts)
Support Members	
	2" x 4" Lumber (1 1/2" x 3 1/2")
	• (18 pieces at 8' each)
Alter Shield Posts	
	1" Schedule 40 galvanized metal pipe
	• (4 posts)
Hardware	
	Screws (150, 3" deck screws)
	• (Attaching sections to 4 x 4's)
	Nails (1000, 1 1/2" 8d finish nails)
	• (Attaching slats to 2 x 4's)
Gate Hardware	
	Latch (1 per gate)
	• (2 each)
	6" Tee hinge (2 per gate)
	• (4 each)
	Screws (30, #12 x 1 1/4" wood screws)

8.2 Terrestrial Sites - Oil/Antifreeze Capacities and Seasonal Change Dates

Domain	Site ID	Site Name	State	Heated/Non-Heated Sites	Antifreeze Temperature Class	Antifreeze Months	Antifreeze Amount (L)	Antifreeze Amount (gallons)	Oil Amount (L)	Oil Amount (ounces)
1	HARV	Harvard Forest	MA	Heated	Cold	Oct 15 - Apr 15	9	2 1/3	0.47	16
2	SCBI	Smithsonian Conservation Biology Institute	VA	Heated	Cold	Oct 15 - Apr 15	9	2 1/3	0.47	16
3	OSBS	Ordway-Swisher Biological Station	FL	Non-Heated	Warm	NA	0	0	0.47	16
4	GUAN	Guanica Forest	PR	Non-Heated	Warm	NA	0	0	0.47	16
5	UNDE	UNDERC	MI	Heated	Cold	Oct 15 - Apr 30	9	2 1/3	0.47	16
6	KONZ	Konza Prairie Biological Station	KS	Heated	Cold	Nov 15 - Mar 1	9	2 1/3	0.47	16
7	ORNL	Oak Ridge	TN	Heated	Cold	Nov 1 - Mar 15	9	2 1/3	0.47	16
8	TALL	Talladega National Forest	AL	Non-Heated	Warm	NA	0	0	0.47	16
9	WOOD	Woodworth	ND	Heated	Cold	Oct 1 - May 1	9	2 1/3	0.47	16
10	CPER	Central Plains Experimental Range	CO	Heated	Cold	Oct 15 - May 1	9	2 1/3	0.47	16
11	CLBJ	LBJ National Grassland	TX	Heated	Cold	Nov 1 - Mar 31	9	2 1/3	0.47	16
12	YELL	Yellowstone Northern Range (Frog Rock)	MT	Heated	Cold	Sep 1 - Jun 15	9	2 1/3	0.47	16
13	NIWO	Niwot Ridge Mountain Research Station	CO	Extreme	Extreme	Sep 15 - Jun 15	12.5	3 1/3	0.47	16
14	SRER	Santa Rita Experimental Range	AZ	Non-Heated	Warm	NA	0	0	0.47	16
15	ONAQ	Onaqui-Ault	UT	Heated	Cold	Oct 15 - Apr 15	9	2 1/3	0.47	16
16	WREF	Wind River Experimental Forest	WA	Heated	Cold	Nov 1 - Apr 15	9	2 1/3	0.47	16
17	SJER	San Joaquin Experimental Range	CA	Heated	Cold	Dec 1 - Feb 1	9	2 1/3	0.47	16
18	TOOL	Toolik	AK	Extreme	Extreme	Sep 1 - Jun 15	12.5	3 1/3	0.47	16
19	BONA	Caribou Creek - Poker Flats Watershed	AK	Extreme	Extreme	Sep 1 - Jun 1	12.5	3 1/3	0.47	16
20	PUUM	Pu'u Maka'ala Natural Area Reserve	HI	Non-Heated	Warm	NA	0	0	0.47	16

8.3 Aquatic Sites - Oil/Antifreeze Capacities and Seasonal Change Dates

Domain	Site ID	Site Name	State	Heated/Non-Heated Sites	Antifreeze Temperature Class	Antifreeze Months	Antifreeze Amount (L)	Antifreeze Amount (gallons)	Oil Amount (L)	Oil Amount (ounces)
10	ARIK	Arikaree River	CO	Heated	Cold	Nov 1 - Mar 31	9	2 1/3	0.47	16
11	BLUE	Blue River	OK	Heated	Cold	Nov 1 - Mar 31	9	2 1/3	0.47	16
11	PRIN	Pringle Creek	TX	Heated	Cold	Nov 1 - Mar 31	9	2 1/3	0.47	16
15	REDB	Red Butte Creek	UT	Heated	Cold	Oct 15 - May 1	9	2 1/3	0.47	16

8.4 Primary Precipitation Gauge Drain System

8.4.1 Introduction

The Primary Precipitation Gauge has an initial charge volume of oil and at cold and extreme sites an additional charge volume of antifreeze mixture (see Section 4.2.2.1). The capacity of the 6-gallon collection bucket within the gauge is 24 L (6.3 gal.) excluding the initial charge volume of oil and/or antifreeze.

The 6-gallon collection bucket suspends by three strain gauges, which are sensitive to shock damage by either damage by an object, or a downward impact on the weighted bucket support or the 6-gallon collection bucket. Either of these could damage or break the strain gauges. Maintenance of the primary precipitation gauge must minimize the possibility of damaging these strain gauges.

To protect the strain gauges from damage during insertion and removal of the 6-gallon collection bucket, NEON has developed internal shields to protect the strain gauges (see **Figure 27**). These shields do not cover the entire strain gauge and are thus susceptible to damage from the installation and removal of the outer housing. Installing and removing the outer housing greatly increases the potential to damage the strain gauges, therefore minimize repeated installation and removal of the outer housing. There are also no protections in place to prevent damage to the strain gauges if the 6-gallon collection bucket drops on the bucket support if filled with liquid.

A routine maintenance procedure had to be created that reduced the chances of damaging the strain gauges from repeated installation and removal of the outer housing, and the possibility of dropping the 6-gallon collection bucket on the bucket support when servicing the gauge. A pump system developed by NOAA for the USCRN program (see ER [08]) is the model for use with the Primary Precipitation Gauge with NEON modifications. This pump system greatly reduces the amount of times the outer housing requires removal and simplifies the draining of the 6-gallon collection bucket contents.

8.4.2 Description

The drain pump system comprises of commonly available off-the-shelf PVC components and other parts via local hardware stores or home improvement centers (see **Figure 40**, **Table 15**, and reference AD [14]).

The drain pump system clips on to the top of the outer housing of the Primary Precipitation Gauge with the PVC pipe will reach within 1 in. of the bottom of the 6-gallon collection bucket. This allows for the removal of nearly all liquid contents. Reference **Figure 40**, **Figure 41**, and **Table 15**.

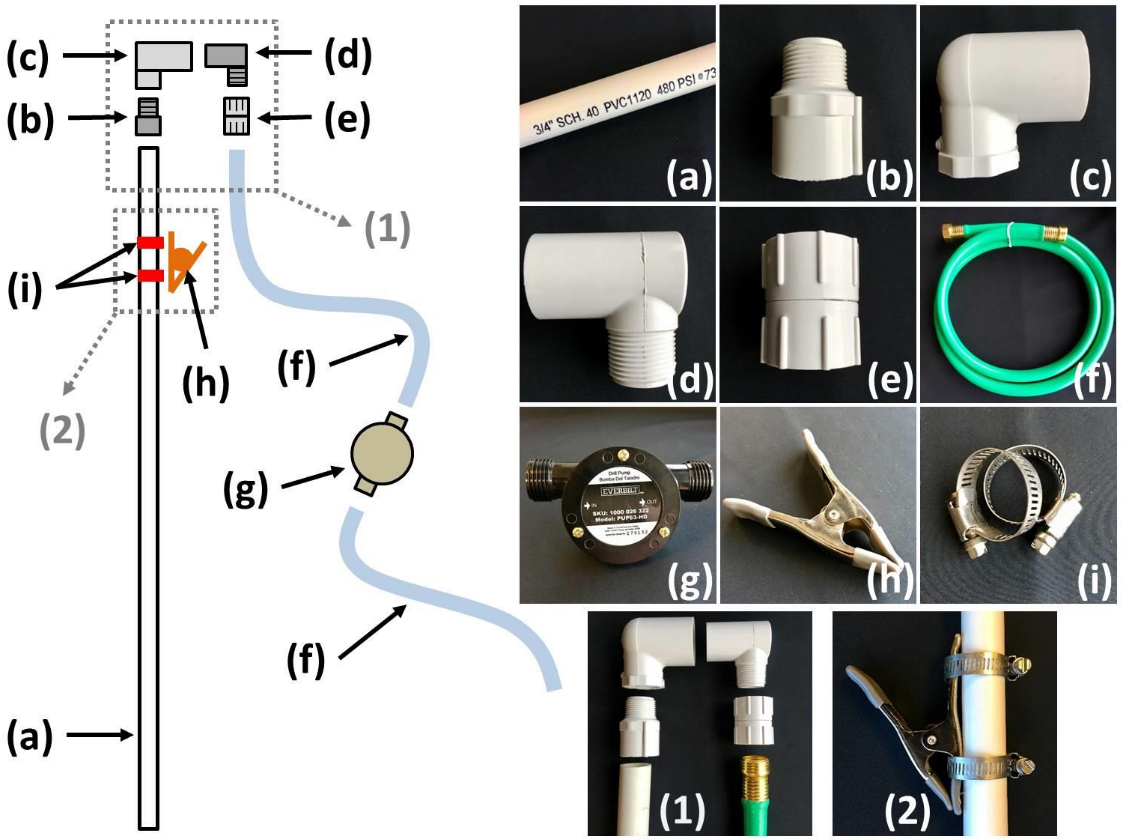


Figure 40. Primary Precipitation Gauge Drain System Installation and Components. Descriptions and manufacturer information found in **Table 15**.

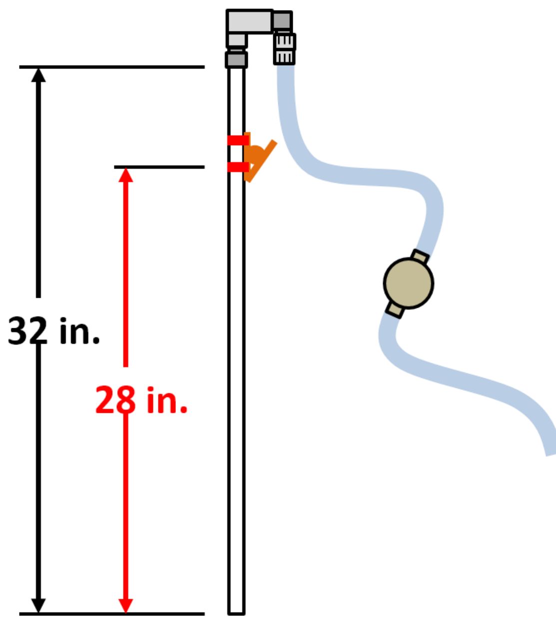


Figure 41. Length of the 3/4 in. PVC pipe of the drain pump system. The critical length (28 in.) is from the clamp to the bottom of the PVC pipe.

8.4.3 Materials

This section outlines the materials necessary to assemble the drain system (see **Table 15**).

Table 15. Materials and Consumables for Assembling the Drain System.

Item*	Part Description	Qty	Manufacturer Name	Manufacturer Number
Components				
a	3/4 in. x 10 ft. Schedule 40 PVC Pipe	1	JM Eagle	57471
b	3/4 in. Schedule 40 PVC Male Adapter	1	Dura	C436-007
c	1 in. x 3/4 in. PVC Schedule 40 Pressure 90-Degree Slip x Female Pipe Thread (FTP) Reducing Elbow	1	Dura	C407-131
d	3/4 in. Schedule 40 PVC 90-Degree Elbow	1	Dura	C410-007
e	3/4 in. Female National Pipe Thread (FNPT) x Female Hose Thread (FHT) PVC Swivel	1	Orbit	53363
f	5/8 in. Dia x 6 ft. Leader Water Hose Female and Male	1	WaterWorks	CLOLH5806FM
g	300 GPH Drill Pump Kit	2	Everbilt	PUP63_HD
h	1 in. Metal Spring Clamp	1	HDX	12386
i	1/2 - 1-1/4 in. Hose Repair Clamp	2	Everbilt	6712595

Consumables				
-	8 oz. PVC Cement	1	Oatey	310133
-	1/2 in. x 260 in. PTFE Tape	1	-	178502
* *Letters in this column correspond to component letters in Figure 40.*				

8.4.4 Assembly

Step 1. Acquire equipment materials and parts via Table 15.

Step 2. Conduct JSA for cutting/building/assembling these parts, as appropriate.

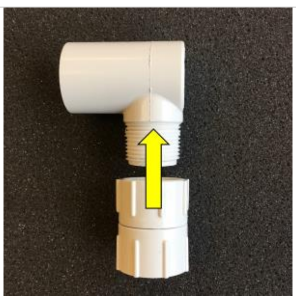
Step 3. Remove Schedule 40 PVC Pipe and measure tape to measure a length of 32 in.

Step 4. Cut the 3/4 in. Schedule 40 PVC Pipe to a length of 32 in.

Step 5. Apply Teflon tape to the threads of the 3/4 in. Schedule 40 PVC Male Adapter.

Step 6. Apply Teflon tape to the threads of the 3/4 in. Schedule 40 PVC 90-Degree Elbow.

Step 7. Screw in the 3/4 in. Schedule 40 PVC Male Adapter in to the 1 in. x 3/4 in. PVC Schedule 40 Pressure 90-Degree Slip x FTP Reducing Elbow and tighten.

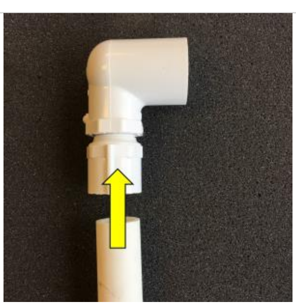


Step 8. Screw in the 3/4 in. FNPT x FHT PVC Swivel in to the 3/4 in. Schedule 40 PVC 90-Degree Elbow and tighten. The part that screws in at this step is the end without the rubber gasket.

The rubber gasket end is where the hose would connect.

Step 9. Have the 3/4 in. Schedule 40 PVC pipe ready for assembly. Apply PVC cement to the inside of the open end of the 3/4 in. Schedule 40 PVC Male Adapter.

Assemble the parts quickly as the cement needs to be fluid.

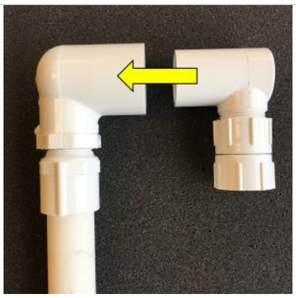


Step 10. Firmly push the 3/4 in. Schedule 40 PVC pipe into the fitting with a 1/4 turning motion until it stops. Hold these two together for 30 seconds.

Allow 15 minutes for good handling strength.

Step 11. Apply a small amount of PVC cement to the inside of the open end of the 31 in. x 3/4 in.

PVC Schedule 40 Pressure 90-Degree Slip x FTP Reducing Elbow.



Step 12. Firmly insert the 3/4 in. Schedule 40 PVC 90-Degree Elbow into the 1 in. x 3/4 in. PVC Schedule 40 Pressure 90-Degree Slip x FTP Reducing Elbow until it stops. Align the pieces as shown on the left. Assemble the parts quickly as the cement needs to be fluid.

Step 13. Set aside the assembled pieces to let the PVC cement fully cure (typically 2 hours).

Step 14. Measure from the bottom of the PVC pipe to 28 in., and attach the metal spring clamp with the two hose clamps as show on the left.

Step 15. Align the metal spring clamp so there is enough room to accommodate the hose.

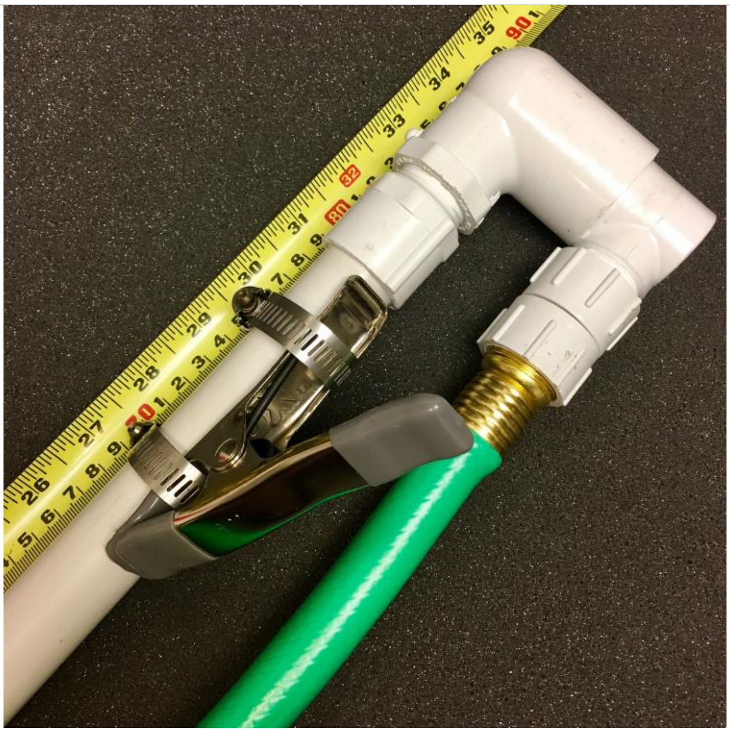


Figure 42. Upon completion of the assembly, the top of the drain pump system likes like the example in this picture. The clamp is set appropriately at 28 in. and offset to easy attach and remove a hose for maintenance purposes.

8.4.5 Field Assembly Procedures for Drain System

Step 1. Insert the long PVC pipe section of the drain pump system into the top of the collection orifice.

Insert as vertical as possible to avoid hitting the 6-gallon collection bucket.

NOTE: Do not insert past the steel clamp to avoid the PVC pipe hitting the bottom of the collection and causing damage to the strain gauges.

Step 2. Attach the steel clamp to the side of the collection orifice as shown.

Step 3. Hold the top of the PVC assembly, attach the hose and tighten firmly.

Step 4. Attach the other end of the hose to the → **IN** end of the drill pump.

Step 5. Attach the second hose to the **OUT** → end of the drill pump.

Step 6. Attach a drill to the drill pump.

8.5 Safety Data Sheets (SDS)

Please see the embedded PDF documents below, which are only accessible via electronic means through this document.

SDS's can always be accessed via the NEON Project's account on MSDSOnline. Please contact the NEON Safety office for the latest copy or additional guidance pertaining to this SDS.

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

Neon Inc.

Scan to access an MSDS

8.5.1 Isopar M

SDS Isopar M.pdf

8.5.2 Light Renoil White Oils

SDS-Light-Renoil-White-Oils-1-16.pdf

8.5.3 60/40 Methanol/Propylene Glycol Mixture

Methanol 60% Propylene Glycol 40% (CORECHEM Inc.) Safety Data Sheet 2016.01.26.pdf

8.5.4 Tricopolymer Fence-Seal

SDS Tricopolymer Fence-Seal.pdf

8.6 Non-Standard DFIR Height Sites

Several NEON DFIR sites have non-standard fence and gauge heights due to either significant yearly winter snowfall amounts, or areas with drifting snow. **Table 16** has a list of sites with Non-Standard DFIR fence heights.

Table 16. Sites with Non-Standard DFIR Fence Heights.

Domain	Site ID	Site Name
9	WOOD	Woodworth
12	YELL	Yellowstone Northern Range (Frog Rock)
13	NIWO	Niwot Ridge Mountain Research Station
16	WREF	Wind River Experimental Forest
18	TOOL	Toolik
19	BONA	Caribou Creek - Poker Flats Watershed

8.6.1 Domain 09 – Woodworth (WOOD)

The Primary Precipitation Gauge and DFIR fence heights are currently at the standard NEON DFIR heights (see **Figure 16**), a change to these heights and implementation are TBD.

8.6.2 Domain 12 – Yellowstone National Park (Frog Rock) (YELL)

The Primary Precipitation Gauge and DFIR fence heights are currently at the standard NEON DFIR heights (see **Figure 16**), a change to these heights and implementation are TBD.

NOTE: Installation of the Primary Precipitation Gauge and the DFIR are scheduled to be completed in August 2018.

8.6.3 Domain 13 – Niwot Ridge Mountain Research Station (NIWO)

The Primary Precipitation Gauge and DFIR fence heights are currently at the standard NEON DFIR heights (see **Figure 16**), a change to these heights and implementation are TBD.

8.6.4 Domain 16 – Wind River Experimental Forest (WREF)

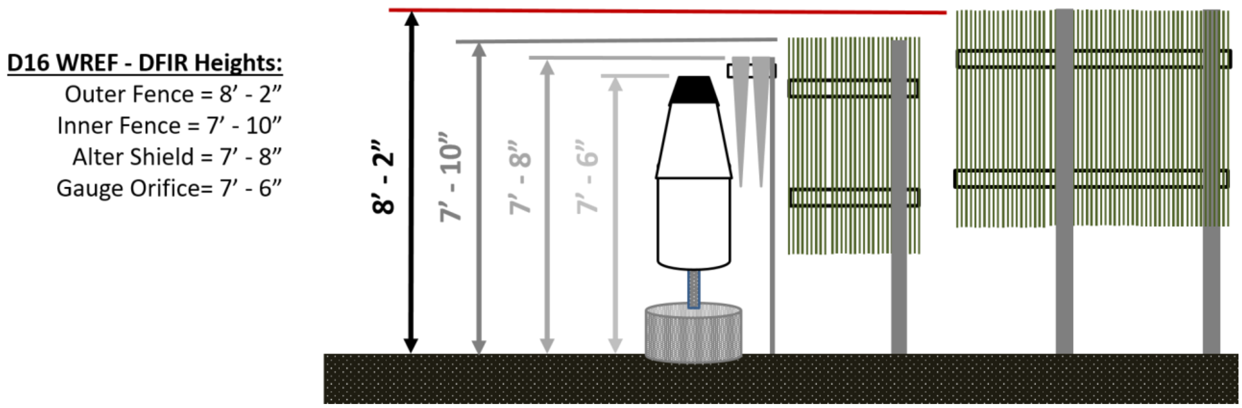


Figure 43. D16 WREF - DFIR Fence Heights.

8.6.5 Domain 18 – Toolik (TOOL)

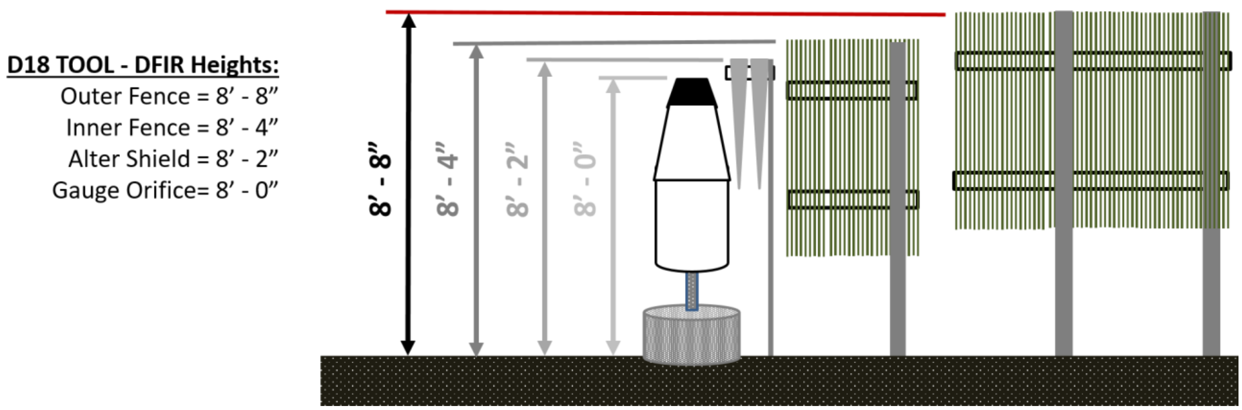


Figure 44. D18 TOOL - DFIR Fence Heights.

8.6.6 Domain 19 – Caribou Creek - Poker Flats Watershed (BONA)

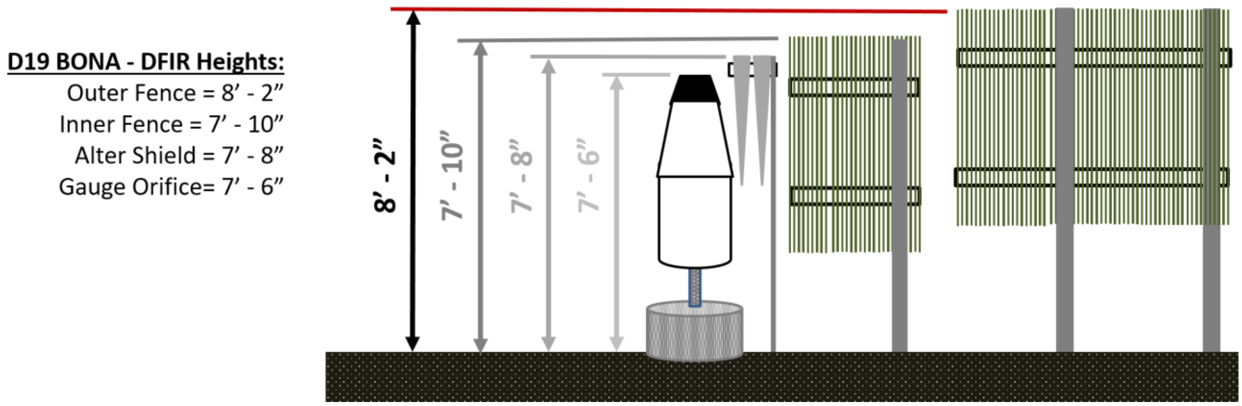


Figure 45. D19 BONA - DFIR Fence Heights

8.7 Installing the Belfort LC Check Program

8.7.1 Install the LabVIEW Run-Time Engine

1. Go to N:\Common\CVL\Field_Calibration\Labview Runtime

   a. Double-click the executable, **LVRTE2015_f3Patchstd.exe**

      - Follow the instructions and prompts for installation. Accept the defaults.
      - When prompted, restart the computer.

8.7.2 Install the LabVIEW NI-VISA Runtime

1. Go to N:\Common\CVL\Field_Calibration\Labview Runtime

   a. Double-click the executable, **NIVISA1600runtime.exe**

      - Follow the instructions and prompts for installation. Accept the defaults.
      - When prompted, restart the computer.

8.7.3 Create Required Directory and Copy Required Files

1. On the root (C:) drive, create a folder with the title **"Test_Data"**.

   a. Directory is now **C:\Test_Data**.

2. Go to N:\Common\CVL\Field_Calibration\Required Directory\Test_Data

   a. Copy the contents of this folder to **C:\Test_Data**.

8.7.4 Verify Contents of Copied Directories

1. Open C:\Test_Data\Current_Executables

a. Verify the L1P1000000 Belfort LC Check is present (see side (a) of **Figure 46**).

2. Open C:\Test_Data\Current Executables\L1P1000000 Belfort LC Check

    a. Verify the three Belfort LC Check files are present (see side (b) of **Figure 46**).

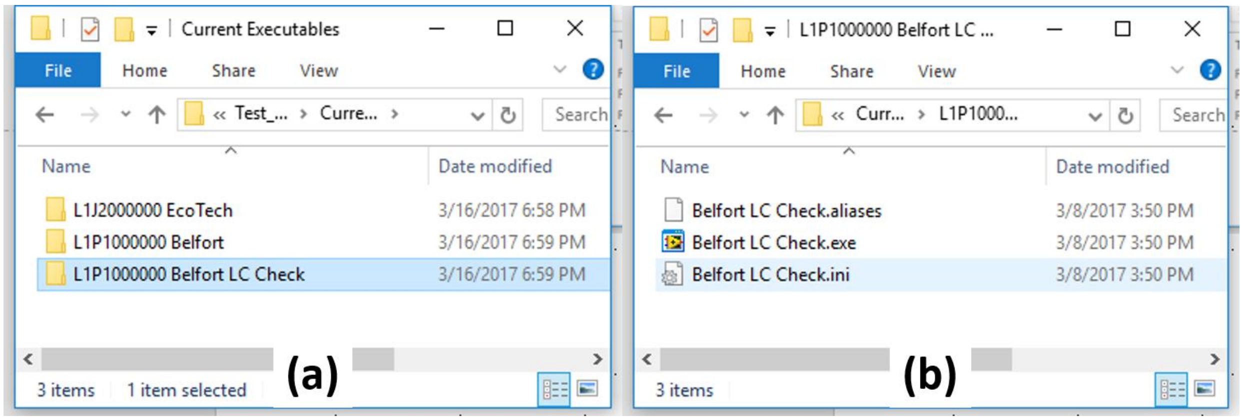


Figure 46. Verify Files within L1P1000000 Belfort LC Check Directory.

8.7.5 Verify Program Has Firewall Access

1. Open C:\Test_Data\Current Executables\L1P1000000 Belfort LC Check

    a. Double-click the executable, **Belfort LC Check.exe**

        - The program window will appear (see **Figure 47**).
        - Wait a while until a Windows Security Alert pops up. This pop-up window allows the Belfort LC Check program access through the Windows Firewall.

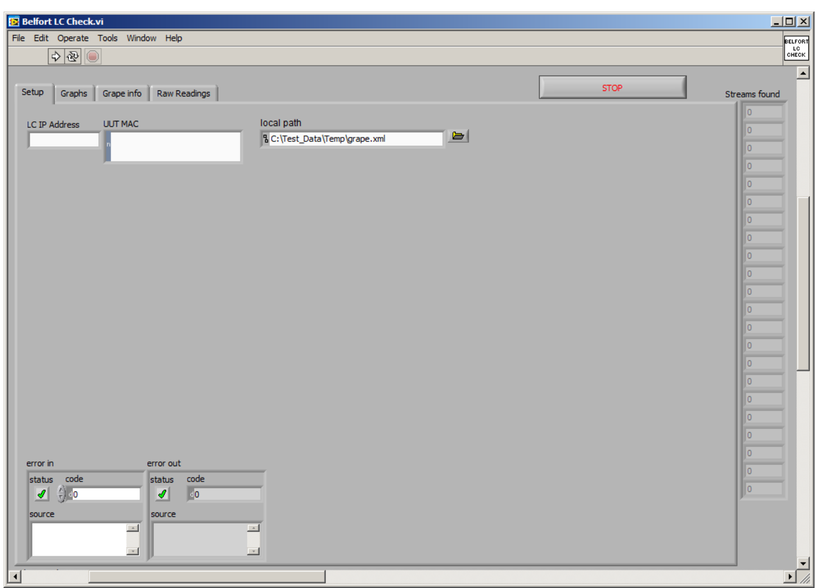


Figure 47. Belfort LC Check.exe Program Window.

b. Once the Windows Security Alert shows up, conduct the following actions:

- Select all the check boxes (see **Figure 48**).
- Select Allow Access.

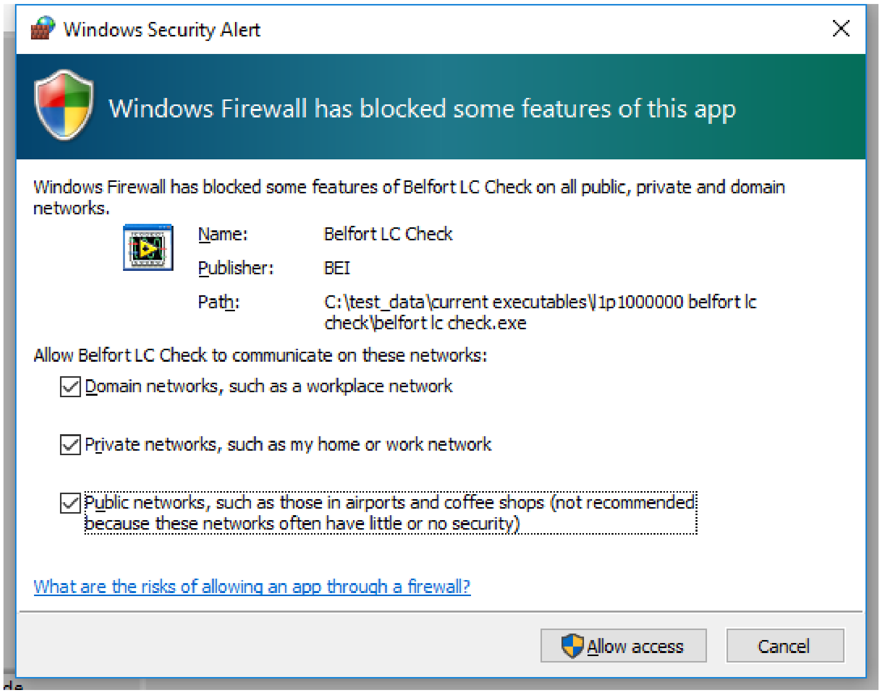


Figure 48. Select All the Check Boxes in the Windows Security Alert.

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