NEON PREVENTIVE MAINTENANCE PROCEDURE:

WET DEPOSITION COLLECTOR

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See configuration management system for approval history.

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Change Record

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A	12/08/2016	ECO-04273	Initial release

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1 DESCRIPTION

1.1 Purpose

The National Ecological Observatory Network (NEON) employ terrestrial and aquatic sensors to collect measurements from air, wind, soil, and sun. Regular maintenance of these sensors and their infrastructure is necessary for the continued operation of the observatory, and to preemptively identify problems before they escalate.

This document establishes mandatory procedures and recommend practices for preventive maintenance of the **Wet Deposition Collector (N-CON TM 00-127-07)**.

1.2 Scope

The procedures in this document are strictly preventive. Any corrective maintenance issues uncovered while performing preventive maintenance should be addressed using the corrective maintenance procedure associated with this subsystem. Refer to RD [04] for a list of maintenance procedure document numbers.

2 RELATED DOCUMENTS AND ACRONYMS

2.1 Applicable Documents

Applicable documents contain information that shall be applied in the current document. Examples are higher level requirements documents, standards, rules and regulations. These documents can be found electronically via the NEON project document repository portal.

AD [01]	NEON.DOC.004300	Environmental, Health, Safety And Security (EHSS) Policy, Program And Management Plan
AD [02]	NEON.DOC.004301	EHSS Environmental Protection Manual
AD [03]	NEON.DOC.004316	Operations Field Safety and Security Plan
AD [04]	NEON.DOC.00XXXX	Field Operations Job Instruction Training Plan
AD [05]	NEON.DOC.00XXXX	Overarching Maintenance Document
AD [06]	NEON.DOC.001421	NEON Sensor Command, Control and Configuration – Wet Deposition Collector Assembly

2.2 Reference Documents

Reference documents contain information complementing, explaining, detailing, or otherwise supporting the information included in the current document. These documents can be found electronically via the NEON Document Repository portal.

RD [01]	NEON.DOC.000008	NEON Acronym List
RD [02]	NEON.DOC.000243	NEON Glossary of Terms
RD [03]	NEON.DOC.00XXXX	NEON Training Curriculum Guide
RD [04]	NEON.DOC.00XXXX	NEON Maintenance Document Matrix

2.3 External References

External references contain information pertinent to this document, but are not NEON configuration-controlled. Examples include manuals, brochures, technical notes, and external websites.

ER [01]	N-CON Systems Company, Inc. *Precipitation Sampler MDN 00-125 & TM 00-127 Installation & Operations Manual*, TM-MDN Manual v12-31-2013.pdf SHA1 Checksum: afbf0fdcfc401007b9c619bdc8e9a94ca76f0629
ER [04]	N-CON Systems Company, Inc. (Main Website – Precipitation Samplers) URL: http://www.n-con.com/

2.4 Acronyms

GAW	Global Atmospheric Watch
GNIP	Global Network in Precipitation
IAEA	International Atomic Energy Agency
IRMS	Isotope-Ratio Mass Spectrometry
NADP	National Atmospheric Deposition Program

NTN	National Trends Network
PRT	Platinum Resistance Thermometer
WMO	World Meteorological Organization

2.5 Symbols

$\delta^{2}H$	delta 2 H(ydrogen); aka δD or delta deuterium
$\delta^{18}O$	delta 18 O(xygen)

3 SAFETY AND TRAINING

Personnel working at a NEON site must be compliant with safe field work practices as outlined in the Operations Field Safety and Security Plan (AD [03]) and EHSS Safety Policy and Program Manual (AD [01]). Refer to the site specific EHSS plan(s) via the NEON project document repository portal for electronic copies and conduct the appropriate Job Safety Analysis 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 Field Operations Job Instruction Training Plan (AD [04]).

Two technicians are recommended to complete this preventive maintenance, though can be performed with by one with extensive experience.

4 SENSOR OVERVIEW

4.1 Associated Equipment

4.1.1 External Components

- Environmental Enclosure with Chimneys (see Figure 1, and Figure 3)
- Moving Cover (see Figure 1, Figure 2, and Figure 3)
- Splash Shield (see Figure 2, and Figure 3)
- Precipitation Sensor (see Figure 1, and Figure 4)
- Thermo-electric Chiller Unit (see Figure 1, Figure 2, and Figure 3)
- Thermo-electric Chiller Power Supply (see Figure 1, Figure 2, and Figure 3)
- Concord GRAPE 24V (see Figure 3)

4.1.2 Internal Components

- Temperature Controller – heater set point (see Figure 5a and Figure 8)
- Temperature Controller – chiller set point (see Figure 9)
- Power Box (see Figure 5d)
- Glass Sample Trains (see Figure 5e)
- Circulating Fan (see Figure 5f)
- Glass Sample Bottle for Isotope Analysis (see Figure 5g)
- Glass Sample Bottle for Chemical Analysis (see Figure 5h)
- Platinum Resistance Thermometers (PRT) (see Figure 5i)
- Thermo-electric Chiller/Heater (see Figure 5j)
- Sample bottle tray holder (see Figure 5k)
- Overflow catch basins (if installed) (see Figure 6)
- Funnel strip heater (see Figure 7)

4.2 Description

4.2.1 Wet Deposition Overview

The Wet Deposition Collector (N-CON TM 00-127-07) collects wet atmospheric deposition samples. Atmospheric deposition is defined as a process where solid and liquid airborne particles and gases are deposited on the earth's surface by two general mechanisms: dry deposition and wet deposition. Dry deposition is a mechanism where airborne particles settle to the earth's surface either via impaction, molecular diffusion, interception, turbulence, or gravity. Wet deposition occurs when raindrops, snow, or ice drag these airborne particles with them as they fall to the surface.

NEON is employing best practices from existing environmental and ecological data collection networks, such as the National Atmospheric Deposition Program's (NADP), to monitor precipitation chemistry. NADP obtains wet deposition samples from a combination of the National Trends Network (NTN) and the Global Atmospheric Watch (GAW) program, which are programs of the World Meteorological Organization (WMO). NEON analyzes and archives wet deposition samples (see Section 4.2.4.2) using third party laboratories for chemistry and stable isotopes analysis.

4.2.2 Stable Isotopes Overview

Stable isotopes analysis is an additional form of analysis NEON is conducting on precipitation samples collected from the Wet Deposition Collector. Stable isotopes naturally occur in the environment; natural abundances vary depending on the environmental condition. Common stable isotopes are outlined in Table 1 below. The partitioning or ratios of stable isotopes of a substance may characterize biological, geological, and hydrological processes from the past and present.

Table 1. Common Stable Isotopes

Common Stable Isotopes

Hydrogen	$^{2}H/^{1}H$
Carbon	$^{13}C/^{12}C$
Nitrogen	$^{15}N/^{14}N$
Oxygen	$^{18}O/^{16}O$

NEON is focusing on the stable isotopic signatures of water ($\delta^{18}O$ and $\delta^{2}H$) from precipitation samples, and employing best practice guidelines from the Global Network of Isotopes in Precipitation (GNIP), the International Atomic Energy Agency (IAEA), and the WMO.

4.2.3 Collector Overview

The Wet Deposition Collector, Model N-CON TM 00-127-07, encompasses a white powder coated environmental enclosure with internal insulation and dual sample chimneys at the top of the enclosure to allow for the collection of two simultaneous "wet only" precipitation samples. The collector is an automated, temperature controlled, collector of both liquid (i.e., rain) and frozen (e.g., snow, hail, ice) precipitation. It is designed to only collect samples during precipitation events using a precipitation sensor. When the Collector senses precipitation, a motor driven cover opens to allow for the collection of samples. It closes when precipitation ceases.

The internal temperature range of the enclosure is set at 3°C and 25°C and internal thermostats command and control the thermo-electric chiller unit. An additional five-inch-long Thermometrics PRT independently monitors enclosure temperature and an internal fan circulates air to aid in maintaining the temperature range.

Table 2. Overview of the N-CON TM 00-127-07 Wet Deposition Collector

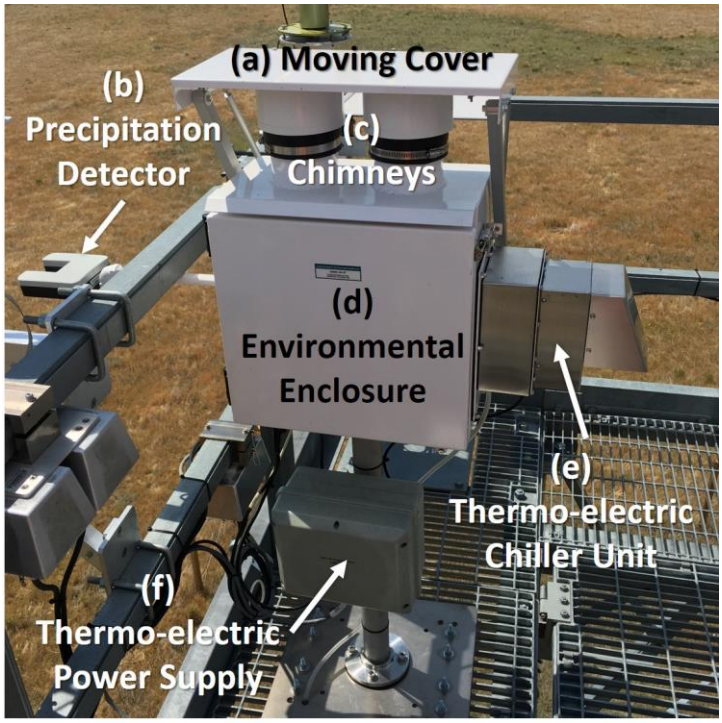


Figure 1. A front view of the main components of the N-CON TM 00-127-07 wet deposition collector. See also Figure 2 and Figure 3.

(a) Moving cover

(b) Precipitation detector

(c) Two collection chimneys

(d) Environmental enclosure

(e) Thermo-electric chiller unit

(f) Thermo-electric power supply

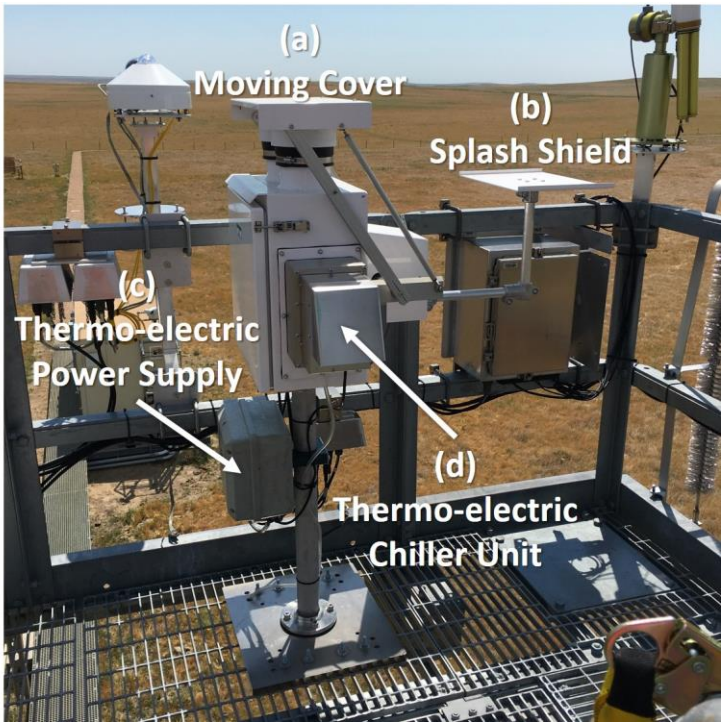


Figure 2. A side view of the main components of the N-CON TM 00-127-07 wet deposition collector. See also Figure 1 and Figure 3.

(a) Moving cover

(b) Splash shield

(c) Thermo-electric power supply

(d) Thermo-electric chiller unit

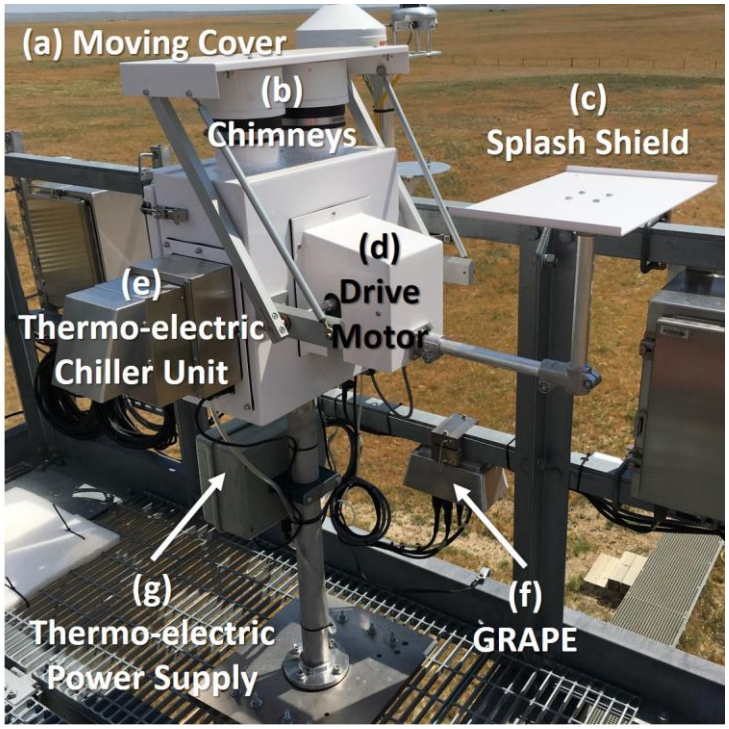


Figure 3. A rear view of the main components of the N-CON TM 00-127-07 wet deposition collector. See also Figure 1 and Figure 2.

(a) Moving cover

(b) Two collection chimneys

(c) Splash shield

(d) Drive motor

(e) Thermo-electric chiller unit

(f) Associated Grape

(g) Thermo-electric power supply

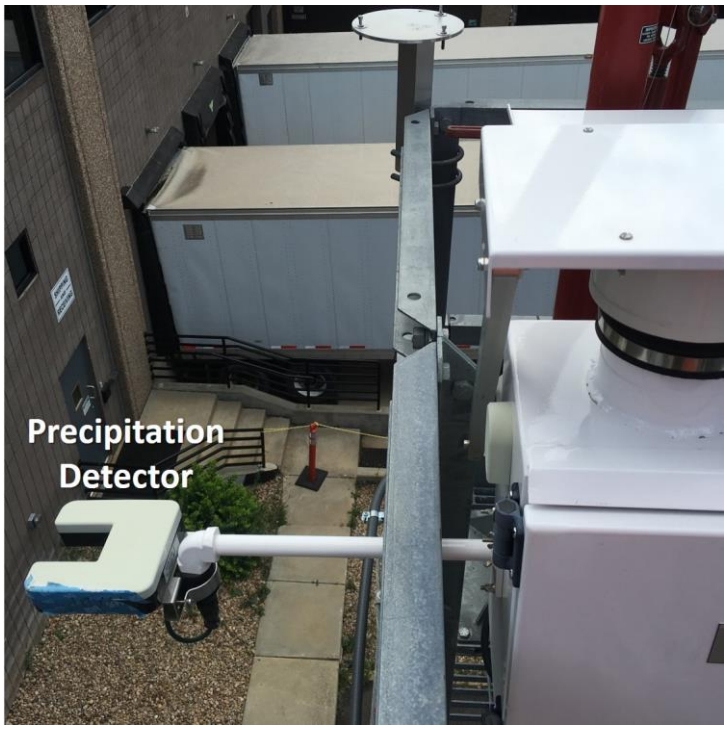


Figure 4. A view of the precipitation detector. This unit is typically located on an extension arm projecting from the environmental enclosure.

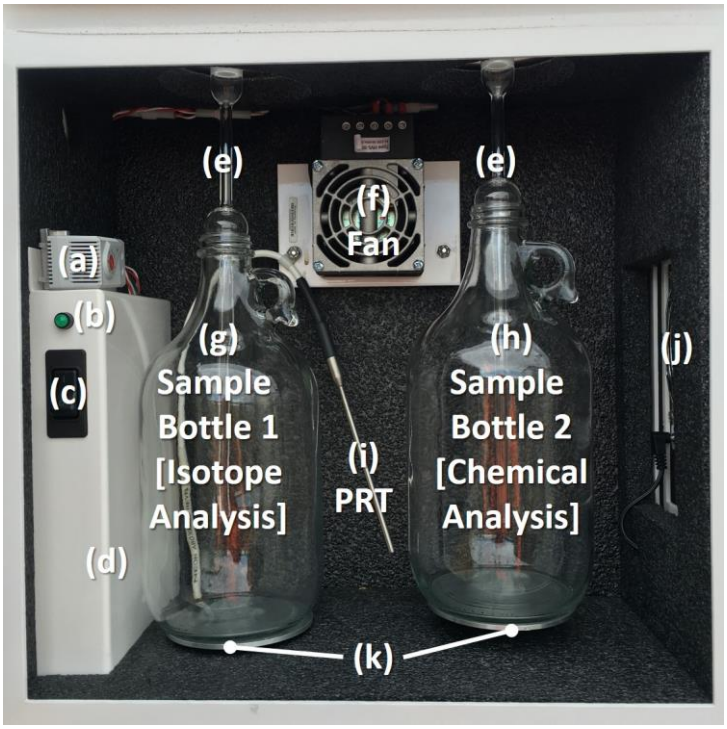


Figure 5. The inside view of the environmental enclosure.

(a) Temperature Controller

(b) Power on LED

(c) Power Switch

(d) Power Supply

(e) Glass Sample Train

(f) Fan

(g) Sample Bottle 1 – for Isotope Analysis

(h) Sample Bottle 2 – for Chemical Analysis

(i) PRT

(j) Thermo-electric Chiller Unit

(k) Sample Bottle Tray Holder

Figure 6. Overflow catch basins placement.

NOTE: Domains 03, 04, 08, and 20 may require the installation of overflow catch basins to accommodate overflow during heavy rainfall events (e.g., hurricane season).

NOTE: The overflow catch basins have an overflow capacity of 2L (67 oz.).

See Table 3 for details of the overflow catch basins.

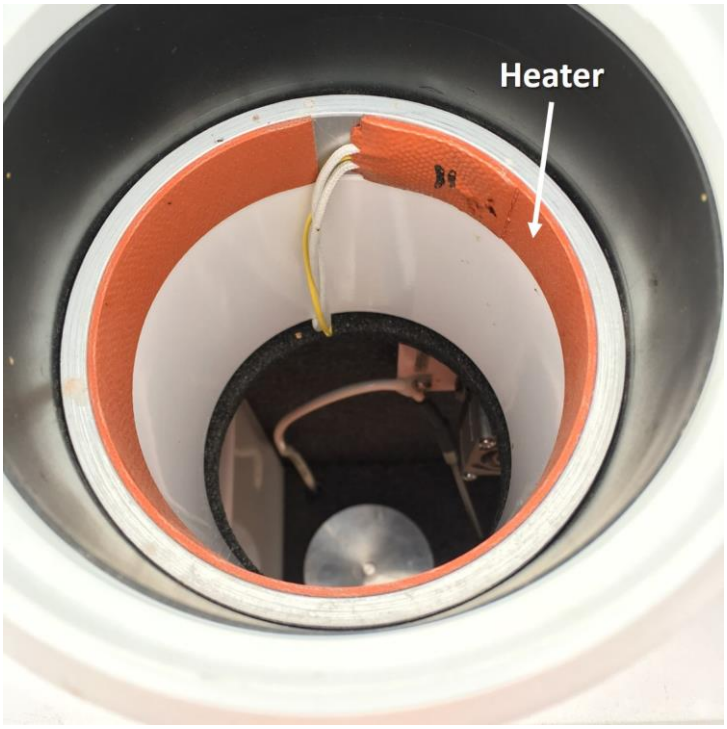


Figure 7. Inside each chimney is an automated silicon strip heater. This heater melts snow accumulation within the glass funnel.

Figure 8. A view of one of the internal Temperature Controllers. See Figure 5 for the location of this Temperature Controller.

This temperature controller has the set point temperature for heater activation.

The temperature scale here is measured in Fahrenheit (°F).

Figure 9. View of the Thermo-electric chiller unit from inside the enclosure (see Figure 5j for its location).

Notice there is a Temperature Controller in the lower right. This Temperature Controller has the set point temperature for when the chiller is to be activated.

The temperature scale here is measured in °F.

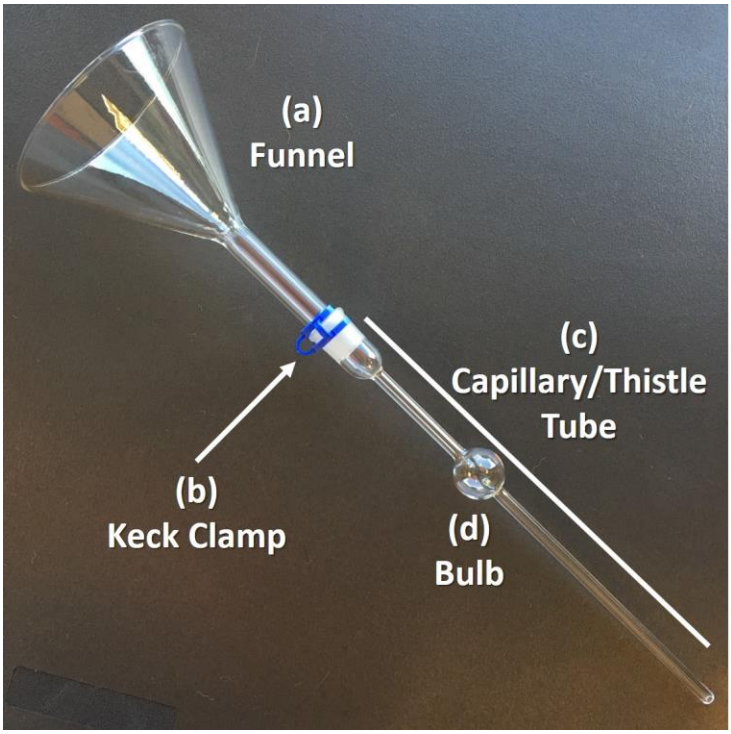


Figure 10. A fully assembled glass sample train includes:

(a) Funnel

(b) 19/22 Keck Clamp

(c) Capillary/Thistle Tube (hereafter referred to only as capillary tube)

The funnel and capillary tube have frosted glass ends that mate together, which are held together by the Keck Clamp.

The 19/22 signifies the joint size of the Keck Clamp.

The sample train should come from the lab cleaned and fully assembled. See also **Figure 11**.

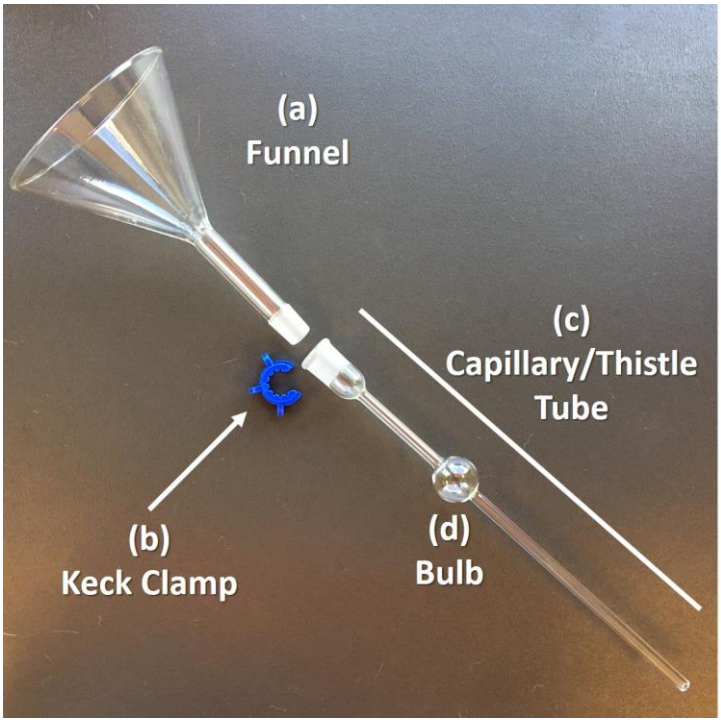


Figure 11. The glass sample disassembled.

(a) Funnel

(b) 19/22 Keck Clamp

(c) Capillary/Thistle Tube

See also **Figure 10** for a fully assembled glass sample train.

4.2.4 Sample Overview

The collection of two samples occur during each precipitation event. Samples from the left sample bottle (see **Figure 5**) are sub-sampled and sent to a contract laboratory for isotopic analysis (see Section 4.2.4.1 Isotope Analysis). Samples from the right sample bottle (see **Figure 5**) are sent to a second contract lab for chemical analysis (see Section 4.2.4.2 Chemical Analysis).

4.2.4.1 Isotope Analysis

Analysis is performed on a sub-sampling of a wet deposition sample using isotope-ratio mass spectrometry (IRMS) for the stable isotopes of ^{2}H and ^{18}O in water.

4.2.4.2 Chemical Analysis

Several types of chemical analyses of a wet deposition sample are performed, depending on the amount of available sample:

- Precipitation sample volume ≤ 8.0 mL:
  pH Conductivity
- Precipitation sample volume 8 to 30.5 mL. Total dissolved chemical ion concentrations of:
  SO_4^{2-} NO_3^{-} Cl^{-} Br^{-} NH_4^{+}
  PO_4^{3-} Ca^{2+} Mg^{2+} K^{+} Na^{+}

pH Conductivity

- Precipitation sample volume ≥ 30.5 mL includes the same analysis as above, in addition to any precipitation sample left over is archived.

4.3 Sensor Specific Handling Precautions

⚠**IMPORTANT:** To avoid contamination of the samples, clean nitrile gloves **must** be worn at all times (specifically when conducting maintenance on the unit, and/or handling of the sample train or sample bottles). Avoid touching the inside of the sample train funnel, the inside of the bottle, or the inside of the bottle cap. Avoid handling the end of the capillary tube below the bulb.

4.4 Operation

When there are at least five drops of precipitation by the unit's infra-red precipitation sensor, the internal drive motor moves the cover and exposes the two sampling chimneys.

The collection of precipitation that falls into the two sampling chimneys occurs via two glass sample trains, and two glass 60 oz. bottles. A heater resides within the chimney stacks to assist in melting any frozen precipitation accumulation.

The sensor closes the cover after 25 seconds of sensing no precipitation.

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 and the cover of the collector closes before proceeding. If precipitation is imminent and likely to start while performing maintenance on this system, stop and conduct maintenance at a time that it could be performed 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

The sequence for routine preventative maintenance of the Wet Deposition Collector is, as follows:

1. Preparation for the site visit.
    a. Inspect glassware (Section 5.2.1)
    b. Assemble supplies and consumables (Section 5.2.2)
2. Initial Inspection (Section 5.5.1)
3. Verify operation of the Moving Cover (Section 5.5.2)
4. Inspect the Thermo-Electric Chiller Unit (Section 5.5.3)
5. Cross-check internal enclosure temperature (Section 5.5.4)
6. Remove sample bottles and sample trains (Section 5.5.5)
    a. Sub-sampling for water isotope analysis
7. Verify temperature set points (Section 5.5.6)
8. Clean the collector (Section 5.5.7)
9. Deploy new sample bottles and sample trains (Section 5.5.8)
10. Restart the collector (Section 5.5.9)

5.2 Preparation for Site Visit

5.2.1 Inspect Glassware

An external laboratory cleans and delivers pre-cleaned and pre-packaged sample bottles and pre-cleaned, pre-assembled, and pre-packaged glass sample trains. Each set of glassware should have their own shipping container with two of each piece of glassware.

5.2.1.1 Glass Sample Trains

1. Open the shipping container holding the pre-cleaned and pre-assembled glass sample trains.
    a. Verify there are two fully assembled sample trains.
        i. Each sample train is in plastic packaging.
    b. Verify there is a receipt/paper indicating the glassware is clean.

2. Put on a new and clean pair of powder-free nitrile gloves *BEFORE PROCEEDING.*
3. **Do not remove the glass sample train from their plastic packaging!** Remove and inspect each sample train for missing pieces, cracks and/or breaks in the glassware.
4. Return inspected glass sample trains back into their shipping container and stage with equipment for the site.
5. Ensure two spare 19/22 Keck Clips are available as backup.
6. Repeat steps 1-4 above for the second set of glassware (backup set).

NOTE: Due to the delicate nature of glass sample trains, and the possibility of glass contamination during maintenance, ensure two full sets of clean glass sample trains are brought to each site visit.

5.2.1.2 Sample Bottles

1. Open the shipping container holding the pre-cleaned and pre-assembled glass sample trains.
    a. Verify there are two 60 oz. glass sample bottles with lids.
        i. Each sample bottle is in plastic packing.
    b. Verify there is a receipt/paper indicating the glassware clean.
2. Again, **do not remove the glass sample bottles from their plastic packaging**! Remove and inspect each sample bottle for cracks and/or breaks in the glassware.
3. Put on a new clean pair of powder-free nitrile gloves *BEFORE PROCEEDING.*
4. Remove the glass sample bottle from the plastic packaging, and remove the cap.
    a. Place the cap face-up in a clean location.
5. Weigh the bottle (without the cap) and make a note of its weight into a field notebook, or mobile recording app.

NOTE: For consistency, use the same scale as the field measurement.

6. Re-cap the bottle.
7. Write the bottle weight on the outside of the bottle (e.g., Tare: 1015.2 g).
8. Place the bottle back inside its plastic bag and reseal.
9. Return inspected sample bottles back into their shipping container and stage with other equipment for the site.
10. Repeat steps 1-4 above for the second set of glassware (backup set), if necessary.

NOTE: The 60 oz. glass sample bottles are made of thick, robust glass. A backup set of these bottles may not be necessary; however, for inexperienced technicians and/or during high winds, a backup set is necessary.

5.2.2 Assemble Supplies and Consumables

This maintenance procedure requires the use of several items and consumables. See Section 5.3 Equipment for a list of items.

5.3 Equipment

Table 3. Tools, Consumables, and Resource Lists for Preventive Maintenance

Item No.	Description	Quantity
	Tools	
1	19/22 Keck Clip (backup) [Maximo: MX??????]	2
2	Laptop with Network Connection & Data Monitoring Software	
	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	5-6 pairs
5	4" x 6", 4 mil[1], Clear Reclosable Plastic Bag [Maximo: MX111032]	1
6	12" x 15", 4 mil, Clear Reclosable Plastic Bag [Maximo: MX109419]	6
7	16 milliliter (mL) Clear Glass Vial with Black Phenolic Cap and 14B Liner [Maximo: MX108274]	2
8	60 mL syringes, with Luer-Lok tip, 1 mL graduations [Maximo: MX100554]	2
9	Syringe Filter, Nonsterile, Nylon, 0.20µm, Diameter: 33 millimeter (mm) [Maximo: MX109591]	4
10	Paraffin Film	A/R
	Resources	
1	Portable Digital Scale (5 kilogram (kg) capacity) OHAUS CS Series Compact Scale, Model CS5000	1
2	Handheld IR Thermometer Fluke 62 MAX Infrared Thermometer	1
3	60 oz. Glass Sampling Bottle [Maximo: MX??????]	2
4	Assembled Glass Sample Trains [Maximo: MX??????]	2
5	Overflow Catch Basins[2]	2

[1] Mil represents one thousandth of an inch; a form of measurement to measure thickness of an object.
[2] For use at select Domains that may incur heavy precipitation.

	1 Gallon Epoxy Lined Empty Paint Can	
Shipping Containers		
1	Bel-Air ReadyCase Shipping Case, 20.7” x 10.8” x 6.7” (Holds two Assembled Glass Sample Trains)	1
2	Bel- Air ReadyCase Shipping Case, 17.6” x 13.5” x 7.3” (Holds two 60 oz. Glass Sample Bottles)	1

5.4 Subsystem Location and Access

The subsystem is located at the top of the tower at terrestrial instrumentation sites.

5.5 Maintenance Procedure

See AD [05] for a comprehensive table of required and recommended preventive maintenance schedules.

5.5.1 Initial Inspection

1. Observe the immediate area surrounding the collector if any conditions are found that may affect the integrity of the samples (e.g., insect or bird nests nearby, fire in the vicinity, wind storm, vandalism, dirt, or debris accumulation).
    a. Record these observations on the datasheet (see Section 7).
2. Inspect the exterior for any damage.
    a. Record damage on the datasheet and/or the mobile recording app.
3. Inspect connections and ensure they are secure.
    a. Use caution for electrical connections: power down the sensor via removing the Ethernet cable from the Concord Grape to de-energize the Grape to mitigate damage to the equipment or switch off the communications box in the tower top breaker, then power down the sensor and check connections to Grape or Sensor for corrosion at connection site, over-heating, dust and/or debris.
    b. Remove dust by dabbing electrical areas with a lint free cloth. Wiping may cause static, which imposes a risk in the event the power is not off.
    c. Do not use compressed air around power supply units or breaker terminals.
4. If there is snow accumulation on the instrument, use a clean soft bristle brush to sweep away the snow from:
    a. Splash Shield
    b. Moving Cover
    c. Top of the Precipitation Detector
    d. Area around the dual chimneys
5. Inspect the arms of the Moving Cover and ensure there is no debris blocking its operation.
6. Inspect the internal PRT and make sure it is not touching the enclosure foam, the glass sample bottles, or (if installed) the overflow catch basins.

5.5.2 Verify Operation of the Moving Cover

Table 4. Procedure for Verifying the Operation of the Moving Cover

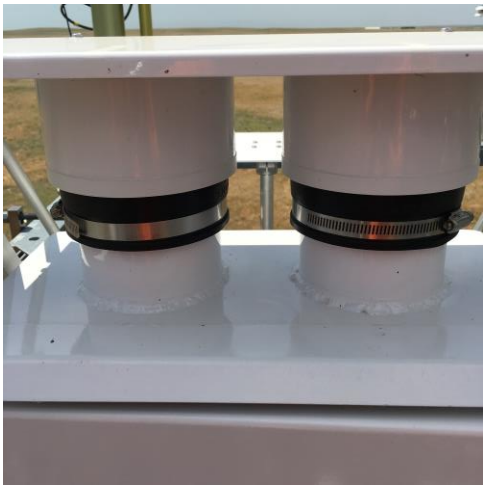
Step 1. Wave fingers or hand slowly vertically in-and-out of the Precipitation Detector until the Moving Cover begins to open.

Moving a hand vertically in-and-out of the detector simulates a precipitation event, and opens the Moving Cover.

Step 2. As the Moving Cover opens, observe its full range of motion. Movement should be smooth and consistent.

The Moving Cover should move all the way to the Splash Shield without touching it.

NOTE: If no precipitation occurs within 25 seconds, the sensor starts to close, so additional hand movements may be needed to have the lid open fully.



Step 3. Observe the Moving Cover as it closes. Again, the movement should be smooth and consistent. If it is not, record it on the datasheet/submit a ticket via the issue reporting system.

The Moving Cover stops on top of the two sample chimneys when fully closed.

Step 4. Inspect the seal between the bottom of the Moving Cover and the top of the two chimneys.

The bottom of the seal should rest snugly on top of the two chimneys without a gap.

Step 5. Inspect the black rubber gasket and the hose clamp.

Ensure the rubber is not cracked or ripped, and the hose clamp holds the rubber gasket snugly to the chimney.

If there are issues with the Moving Cover and/or the operation of the drive motor, please make a note and

submit a ticket via the issue reporting system.

5.5.3 Inspect the Thermo-Electric Chiller Unit

Table 5. Procedure to Inspect the Thermo-Electric Chiller Unit

Step 1. Look underneath the shroud of the thermo-electric chiller unit. Inspect the fan and heatsink fins.

Remove obstructions, if present.

5.5.4 Cross-Check Internal Enclosure Temperature

Cross-check internal PRT temperature of the environmental enclosure against the outside temperature via an external, independent temperature sensor. Monitor the internal PRT using a laptop with Network connection and active data monitoring software.

Table 6. Procedure to Cross-check the Internal Enclosure Temperature

Step 2. Connect laptop to the internal network, and using your data monitoring software, call up the PRT temperature from the Wet Deposition Collector.

Record the internal PRT temperature via a datasheet and/or mobile recording app.

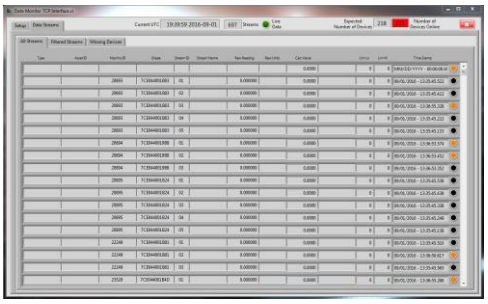
NOTE: Keep the data monitoring software open, as you may need to refer back to this temperature.

Step 3. Unlatch the two latches on the closed door and open the door.

Step 4. Using a handheld infrared (IR) thermometer, measure the black insulation right next to the center area of the PRT.

Record this temperature in Celsius (°C).

NOTE: If direct sunlight is hitting the area around the PRT, throw some shade on the measurement area.



Step 5. Determine the temperature differential between the internal PRT and the temperature via the IR thermometer.

If the temperature differential is > 3°C, submit a ticket via the NEON project's issue reporting system.

5.5.5 Remove Sample Bottles and Sample Trains

Two identically configured glass sampling trains and bottles are employed in the Wet Deposition Collector. The preventive maintenance procedure below is the same for both. For consistency, conduct these procedures from right to left. This will align with the instructions in Table 7.

Table 7. Procedure for Removing Glass Sample Bottles and Sample Trains

Step 1. Unlatch the two latches holding the closed door and open the door.

Locate the power switch (see **Figure 5**) and power down the sensor for these next steps.

Step 2. Inspect the condition of two sample bottles. Make a note on each separate sample, or both if their conditions are the same.

Noteworthy considerations:

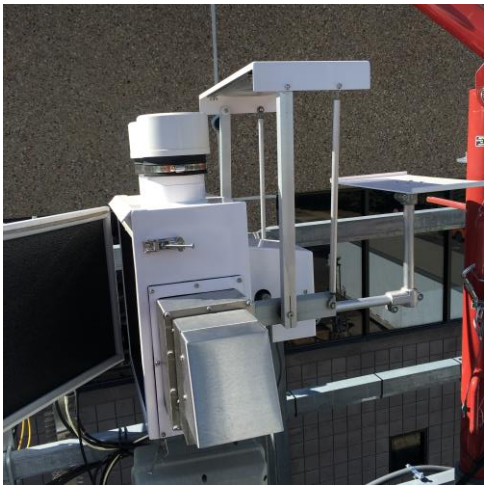
1. Do the samples display contamination in any way?
2. Do the sample bottles show evidence of overflow?

Step 3. If using overflow catch basins, and evidence of overflow on the sample bottles exist, ensure the overflow basin did not overflow, as well.

If the overflow basins appear overflowed, make a note and submit a ticket via the issue reporting system.

NOTE: Discard any water in the overflow basin. Water within basins are not samples for analysis.

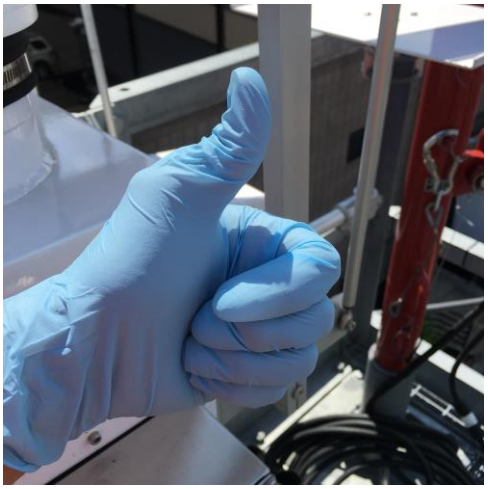
Step 4. Wave a hand slowly vertically in-and-out of the Precipitation Detector until the Moving Cover begins to open.



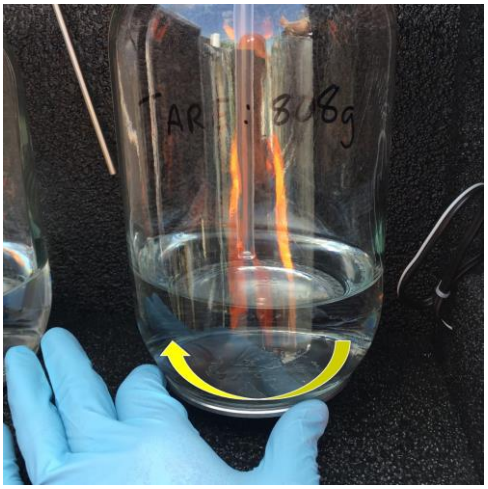
Step 5. Allow the Moving Cover to open until it is about half-way to fully open, or until the lid is vertical, and flip the power switch (see **Figure 5**) to the off position.

Turning the power off stops the Moving Cover in place.

NOTE: The Moving Cover must provide enough clearance to not hinder the removal of the glass sample trains.



Step 6. Put on a new pair of powder-free nitrile gloves.



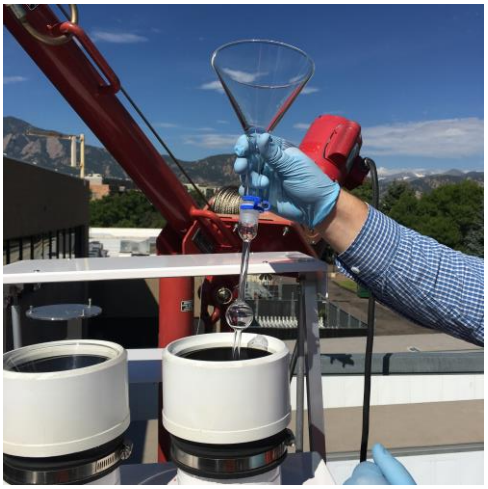
Step 7. Lower the glass sample bottle by rotating the metal bottle holder tray **clockwise** until the bottom of the bulb of the capillary tube clears the opening of the sample bottle.

Step 8. Carefully grasp and lift the capillary tube up.

Lift it high enough to safely grab the outside of the funnel from of the top of the chimney.

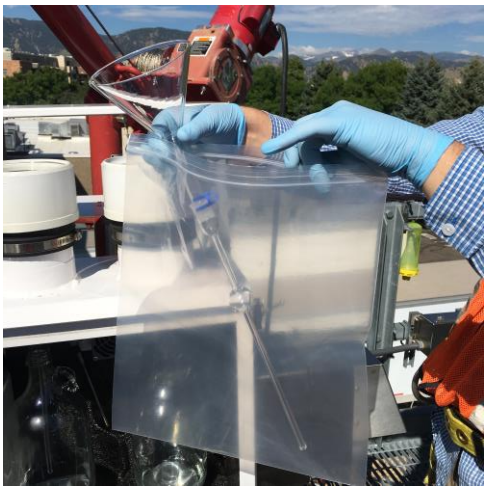
Step 9. With the other hand, grasp the outside of the funnel.

NOTE: Make it a habit to never touch the inside of the funnel. Only handle the glass sample train from its outside surfaces.



Step 10. Lift out the entire glass sample train from the chimney.

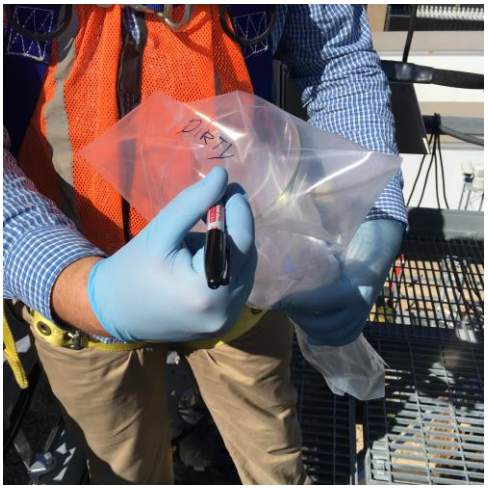
NOTE: Try to pull the sample train as straight as possible to avoid hitting the sides of the sample bottle, and the insides of the chimney.



Step 11. Place the entire glass sample train into a 13” x 15”, 4 mil, reclosable plastic bag.

Place the capillary tube in first.

Step 12. Place another 13” x 15”, 4 mil, reclosable plastic bag over the exposed top portion of the glass sample train.



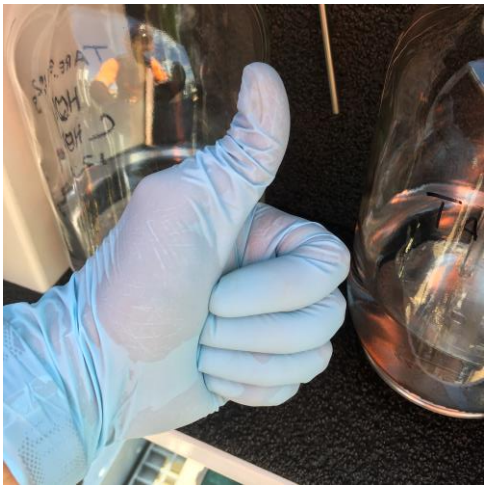
Step 13. Label the plastic bag, or use some other form of mark or tag (e.g. tape, flagging) to indicate the glass sample train is dirty or used.

Set the plastic bag aside in a safe place and secure place until they are packed into their respective shipping containers.

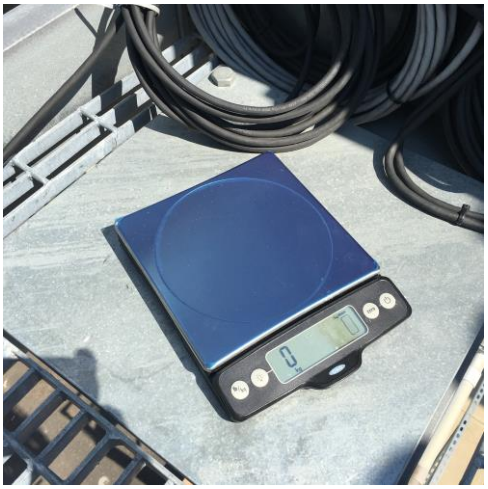
Immediate labeling of the plastic bags mitigates confusion between clean glass sample trains.

IMPORTANT:

- If the procedure was initiated with the sample bottle located on the right (chemical analysis), then proceed to the next steps.
- If the procedure was initiated with the sample bottle located on the left (isotope analysis), then continue to **Section 5.5.5.1** for instructions on sub-sampling and filtering the sample.



Step 14. Put on a new pair of powder-free nitrile gloves.



Step 15. Remove the field scale from its travel case and turn on. Place in a stable, flat and level location.

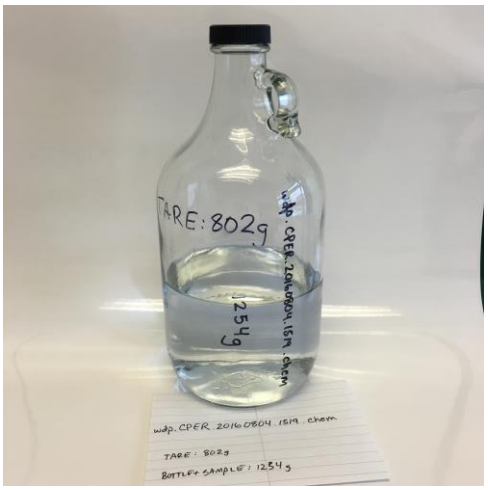
Step 16. Place the sample bottle on the scale and record the weight.

Using the tare weight already existing on the bottle (tare weight from Section 5.2.1.2), determine and record the sample-only weight.

NOTE: The mouth of the sample bottle is now exposed, use care to avoid contamination. Do not touch or allow anything to come into contact with the open mouth of the sample bottle.

Step 17. Remove a clean bottle cap from its plastic bag.

Step 18. Cap and tighten the bottle.



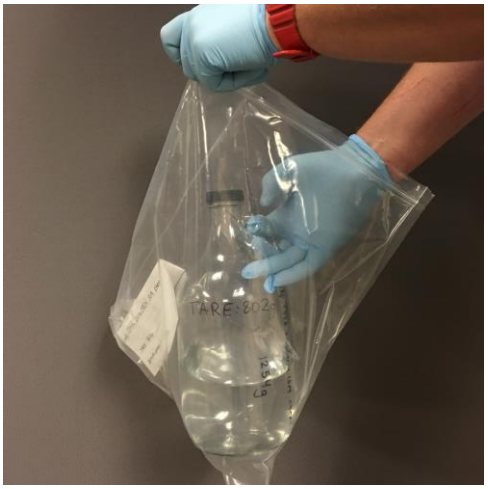
Step 19. Label the bottle and a separate sheet of paper with the following information:

Tare weight
Bottle+Sample weight

Sample ID:
wdp.XXXX.YYYYMMDD.HHMM.zzzz

wdp = wet deposition
XXXX = Site ID
YYYY = Year
MM = Month
DD = Day
HH = Hour (24 hour clock)

MM = Minute
zzzz = iso or chem
iso = isotope, chem = chemistry



Step 20. Place the label and sealed glass sample bottle into a 12" x 15", 4 mil, reclosable plastic bag and seal.

Set aside in a safe place and secure place until they are packed into their respective shipping containers.

Step 21. Repeat **Step 6** through **Step 13** above for the second sample bottle.

IMPORTANT:

- If the procedure was initiated with the sample bottle located on the right (chemical analysis), proceed to **Step 22**.
- If the procedure was initiated with the sample bottle located on the left (isotope analysis), then repeat **Step 6** through **Step 13** above for the second sample bottle.

Step 22. Carefully place the glass sample trains and the glass sample bottles into their respective shipping cases. Secure the cases.

The glassware and the samples are shipped to external laboratories for separate analysis from the Domain office.

The glassware is returned to the Domain office *clean* to continue the collection of precipitation samples. The NEON project HQ will provide FOPS and the Domain Manager the address to these laboratories.

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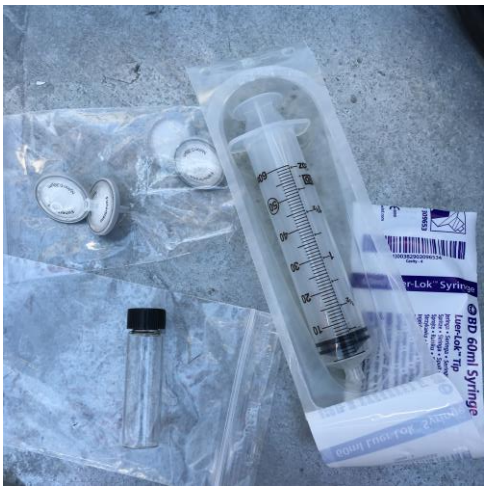
5.5.5.1 Sub-sampling for Water Isotope Analysis

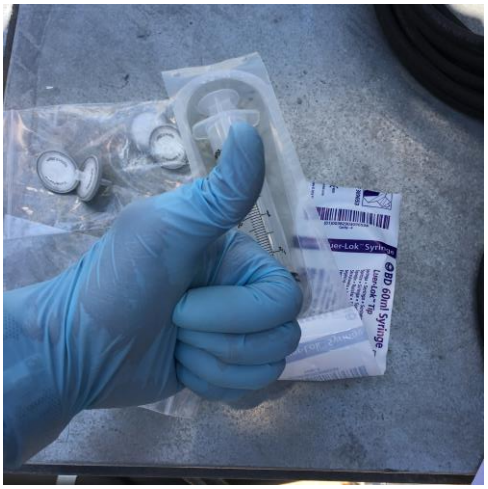
Table 8. Sub-sampling Procedure for Water Isotope Analysis



Step 1. Locate and stage the 20 mL glass sample vial, 60 mL syringe, and a couple of the 0.2 µm filters in a clean location.

To avoid handling contamination, keep each item in their sealed containers until ready for use.

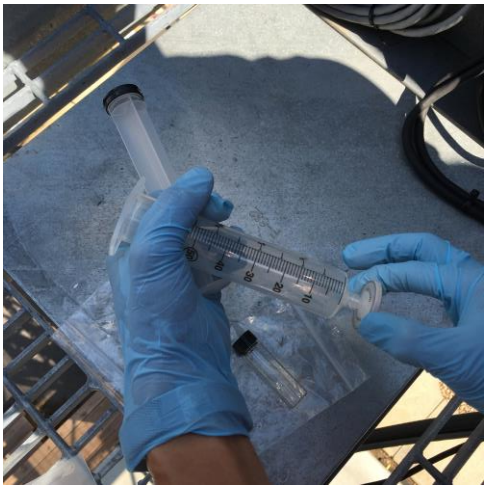
NOTE: Depending on the condition of the sample (clean versus contaminated), more than one filter may be necessary. Bring extra filters, just in case.



Step 2. Put on a new pair of powder-free nitrile gloves.

Step 3. Remove the 60 mL syringe from its packaging and pull the plunger out by pulling firmly. Hold the syringe plunger in the same hand as the syringe.

NOTE: Use to care; do not allow the plunger or the tip of the syringe to touch anything. Avoid touching the inside of the syringe.



Step 4. Attached the 0.2 µm filter and secure to the Luer-Lok tip at the end of the syringe. Continued holding the syringe plunger in the same hand.

Step 5. Using the other hand, grab the open glass sample bottle and pour the water sample into the syringe. Fill the syringe to the 30 mL mark. If there is not enough of the collected sample to fill to the 30 mL mark, pour in the entire sample.

NOTE: The glass sample bottle may be full or too heavy to manage with the opposite hand. In this case, plan or acquire help from a fellow technician. If help is not available, tip the glass sample bottle from its location in the enclosure to aid in filling (see picture to the left).

Step 6. Place the plunger back on to the syringe.

Step 7. Tip the syringe up and push on the plunger to squeeze out excess air.

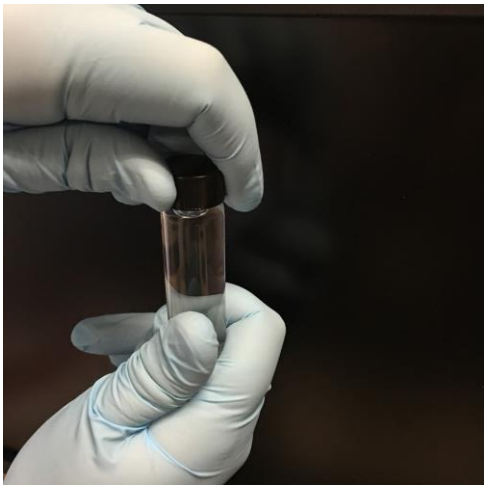
NOTE: Less air in the syringe enables easier filtering of the sample; it also reduces the extension of the plunger for easier handling.

Step 8. Open the cap of the 16 mL glass vial, and set the cap aside.

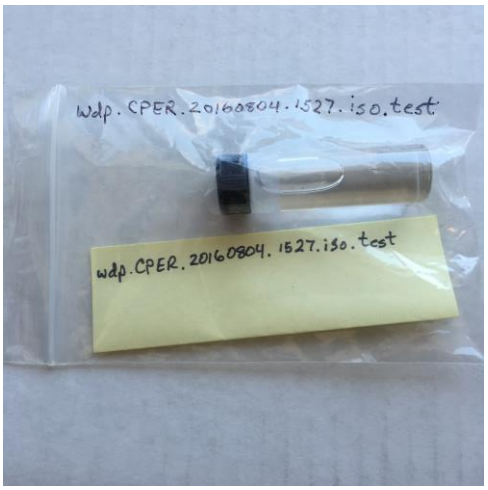
Step 9. Apply even pressure plunging the sample through the filter into the 16 mL glass vial.

Step 10. Fill the bottle so there is ~5% of head space.

NOTE: Minimizing the head space is important to reduce additional isotopic fractionation of the water. Also, having ~5% of head space available accommodates for thermal expansion that may occur during shipping.



Step 11. Tighten the vial's cap and wrap the cap and area surrounding with paraffin film.



Step 12. Place the vial in a small 4"x 6" reclosable plastic bag. Label the bottle and a separate sheet of paper with the following information:

Sample ID:

wdp.XXXX.YYYYMMDD.HHMM.iso.test

wdp = wet deposition
XXXX = Site ID
YYYY = Year
MM = Month
DD = Day
HH = Hour (24 hour clock)
MM = Minute

zzz = iso or chem

iso = isotope, chem = chemistry

test = identifier for the sub-sample

Step 13. Discard the used filter, syringe, and gloves.

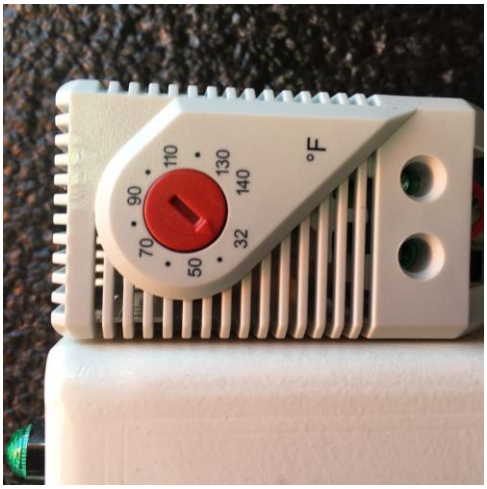
Step 14. Go to Section 5.5.4 and start from **Step 14** to complete the handling and packing of the isotope sampling bottle.

5.5.6 Verify Temperature Set Points

The temperature range within the environmental enclosure is set to 3°C (37.4°F) and 25°C (77°F). Two Temperature Controllers are located within the environmental enclosure to control this temperature range. One is located on top of the power supply (see **Figure 5**), which controls for the temperature set point to active the heaters. The other is located on the Thermo-electric chiller unit (see **Figure 5**, and **Figure 9**).

The temperature set points are typically set by SI&V during the time of installation of the unit, Verifying the temperature during each maintenance interval ensures accurate set points and mitigates any accidental changes (particularly, the temperature controller on the Thermo-electric chiller unit).

Table 9. Procedure for Verifying the Temperature Set Points



Step 1. Verify the set point is ~37 °F via the Temperature Controller on top of the power supply (see **Figure 5**).

Step 1. Verify the set point is ~77 °F on the Temperature Controller on the Thermo-electric chiller (see **Figure 5** and **Figure 9**).

5.5.7 Cleaning the Collector

Once the samples and glassware are removed, access to the main components of the collector are ready for cleaning. The external surfaces of the collector may be cleaned with a multi-surface cleaner (e.g., Formula 409); however, surfaces that may lead to the potential contamination of samples/sample areas, please use distilled/deionized water.

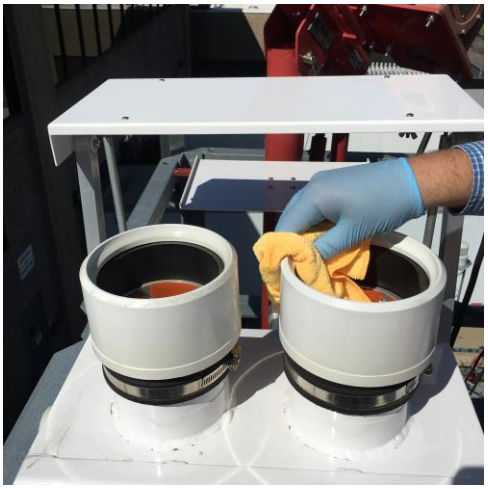
Always spray 409 cleaner and/or distilled/deionized water directly onto a cloth and **not** onto the surface of the collector. Multiple changes of powder-free nitrile gloves and frequent discarding of lint-free cloths are necessary to conduct the next set of procedures; ensure an ample supply of these items are available.

Table 10. Procedure for Cleaning the Sensor Body and Associated Components

Step 1. Put on a new pair of powder-free nitrile free gloves.

Step 2. Spray the Formula 409 Multi-Surface Cleaner on to a clean lint-free cloth.

NOTE: Considerable buildup of dirt may occur on the external surfaces of the collector. If the lint-free cloth becomes excessively dirty, please exchange the cloth for a new one and repeat as necessary.

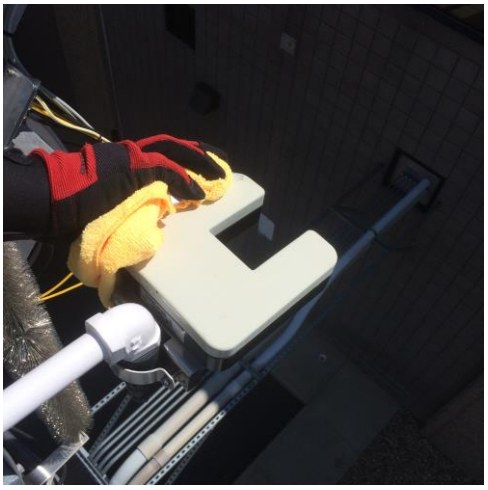


Step 3. Clean both of the white chimney caps by wiping down the neck of the chimneys. Start from the top of the chimney down. Re-apply cleaner to the lint-free cloth, if necessary.

Step 4. Clean the top surface of the body of the collector, and wipe down the sides, as well. Re-apply cleaner to the lint-free cloth, if necessary.

Step 5. Clean the top surface of the Moving Cover.

Step 6. Clean the top surface of the Splash Shield.



Step 7. Clean Precipitation sensor.

Step 8. Discard all dirty and used lint-free cloths, and gloves.

Step 9. Put on a new pair of powder-free nitrile free gloves and ready a fresh lint-free cloth.

Step 10. Spray/squeeze distilled/deionized water onto the lint-free cloth.

NOTE: The cloth pictured may look dirty, but is not. It is just a murky gray colored cloth.

Step 11. Clean the underside of the seal on the Moveable Cover with the distilled/deionized water.

While cleaning, inspect the condition of the seal material for cracks and/or tears.

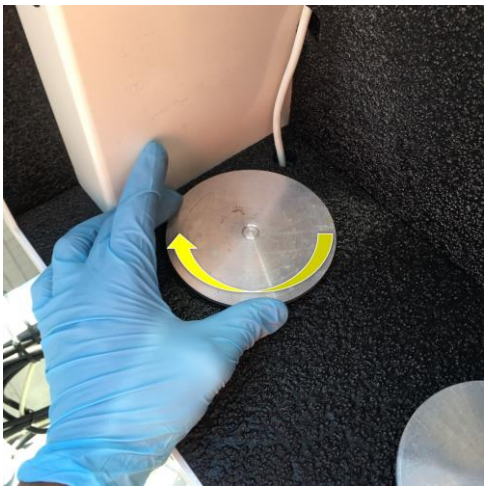
If there are issues with the seal, please make a note and submit a ticket via the issue reporting system.

5.5.8 Deploying New Sample Bottles and Sample Trains

The next step following the removal of the samples and glassware, and the cleaning of the detector body and associated components is the installation of the new glass sample bottles and glass sample trains. Start with deploying the sample bottle located on the right and do not move on to the left until each component to the right are installed (the glass sample train). Repeat the process on the left. This aligns with the procedures outlined below.

Table 11. Procedures to Deploy New Sample Bottles & Sample Trains

Step 1. Put on a new pair of powder-free nitrile free gloves.



Step 2. Lower the sample bottle holder by turning it clockwise until it is all the way down.

Step 3. Remove a clean glass sample bottle from the container and place it on the bottle holder.

Step 4. Remove a clean glass sample train assembly from the container and remove the top plastic bag.

NOTE: Never touch the inside of the funnel. Only handle the glass sample train from its outside surfaces.

Step 5. Carefully hold the glass sample train by the funnel and remove the bottom plastic bag.

Step 6. Gently place the sample train into the same chimney that the sample bottle is in.

NOTE: Try to insert the sample train in as straight as possible. Avoid hitting/bumping the sides of the chimney or the outside of the glass sample train.

Step 7. Guide the capillary tube into the sample bottle and help settle the funnel into the chimney.

NOTE: Only handle the capillary tube above the bulb. This will help prevent sample contamination.

Step 8. Turn the bottle holder counter-clockwise to raise the bottle until the mouth of the bottle touches the capillary bulb.

Ensure the top of the sample bottle is touching the capillary bulb – **not** lifting the capillary tube up.

Step 9. The capillary bulb should be resting snugly within the opening of the glass sample bottle.

Ensure the top of the sample bottle is touching the capillary bulb – **not** lifting the capillary tube up.

Step 10. Ensure the top of the funnel is below the top of the chimney sides as displayed in the corresponding photo.

NOTE: The funnel must be resting within the chimney – **not** above the sides of the chimney.

If the funnel is above the chimney sides, it may interfere with the closing of the Moving Cover and damage the funnel or sample train.

Step 11. Repeat **Step 3** through **Step 10** for the second sample bottle and second sample train.

5.5.9 Restarting the Collector

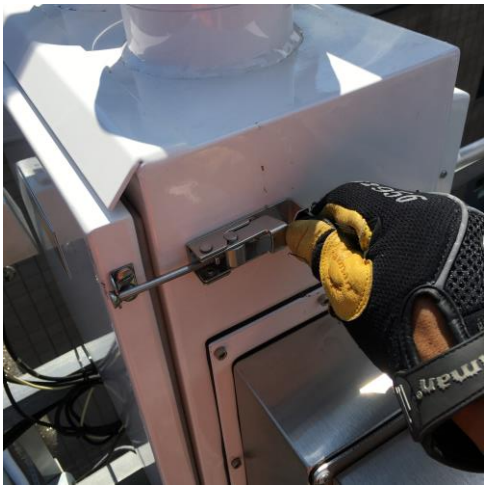
Table 12. Procedure for Restarting the Collector

Step 1. Turn the power back on.

This will cause the Moving Cover to close.

Step 2. Check the seal between the Moving Cover and the top of the chimneys once more.

Ensure the seal is complete and snug.



Step 3. Close and secure the door to the collector.

Record the date and time of the installation/deployment of the new sample glassware on the datasheet and/or the mobile recording app.

6 REMOVAL AND REPLACEMENT (SUBSYSTEM ONLY)

6.1 Equipment

Table 13. Tools, consumables, and resource lists for removal and replacement of the collector.

Item No.	Description	Quantity
Tools		
1	Screw Driver (specifically a ¼" straight blade)	1
2	Allen Wrench set (including 3/16th & 1/8th)	1
3	Magnetic Tray	1
Consumable items		
1	Powder-free Nitrile Gloves	2
2	Lint-free Cloths/KimTech Wipes 4.5" x 8.5"	A/R (3+)
3	Distilled/Deionized Water	A/R
4	Multi-surface Cleaner (e.g., 409)	1
5	Screws	2
6	Wing Nuts	A/R
7	Lid Seal (N-Con)	2
Resources		
1	Glass funnel, glass anti-evaporation capillary tube, glass sample bottle (2 liter)	A/R
2	Cable, PRT Submersible, 6 Feet, NADP	A/R

Note: Carry back-up tools and consumables up the tower in the event of dropping the original tools/consumables.

The heavy duty motor for the Moving Cover is rated for 20 years of typical service. All parts are easy to replace without special tools. If the sensor subsystem is found inoperable due to unforeseen circumstances, document and report the incident via the NEON project Issue Management System for specific corrective action procedures.

6.2 Removal and Replacement Procedure

The Field Operations Domain Manager is responsible for managing the removal and replacement of the sensors on site. The NEON project Calibration, Validation and Audit Laboratory (CVAL) is responsible for the calibration and validation of sensors, as required.

No routine or scheduled calibration and validation requirements are necessary for the Wet Deposition Collector and PRT after initial installation.

Other Removal and Replacement Considerations and/or Instructions

WARNING: Prior to connecting or disconnecting sensor cables at the Grape, ensure the GRAPE is de-energized by opening the breaker inside the associated tower power box (See Figure 12 below) or disconnect the Ethernet connection to the Grape. Plug the Ethernet cable in LAST (after all sensor connections are secure at the Grape). **FAILURE TO DISCONNECT POWER BEFORE PLUGGING OR UNPLUGGING SENSOR CABLES CAN PERMANENTLY DAMAGE THE EQUIPMENT.**

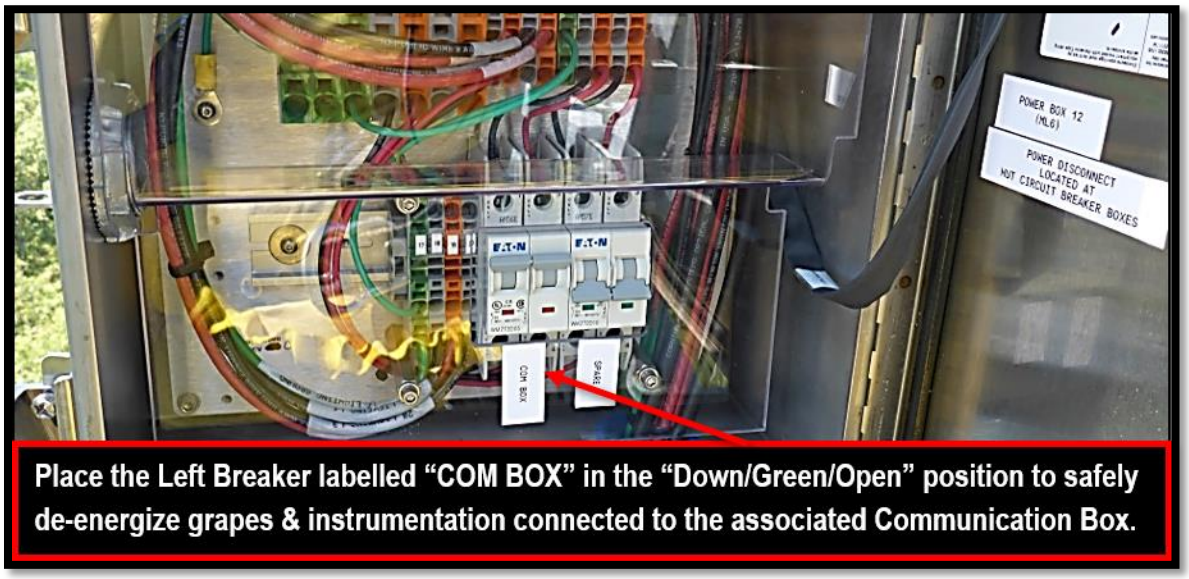


Figure 12. De-energize the GRAPE before disconnecting the sensor cables

6.2.1 Removal and Replacement of the Lid Seal

1. Open sampler about half way and turn off power.
2. Loosen, but do not remove, wing nuts on one side of lid seal clamp and pull out one side of lid seal.
3. Loosen and remove wing nuts on other side and remove lid seal.
4. Smooth out new lid seal and secure with clamp on one side.
5. Tighten wing nuts.
6. Press the lid seal toward other side and push edge under clamp until seal is smooth.
7. Tighten all wing nuts.
8. Clean the new lid seal with a clean lint-free cloth and deionized water and dry.
9. Turn on the power and allow sampler to close on top of funnel.
10. Check that lid seal rests evenly on funnel(s).

NOTE: The lid seal should be replaced twice a year.

6.2.2 Replacement Installation Instructions (As Appropriate)

6.2.2.1 Sensor Installation

1. Remove the 4 wing nuts on the side of the sampler that will be used to install the precipitation sensor.
2. Hold sensor up to mounting studs and connect the keyed Molex connector to the Molex connector. Push the connected Molex assembly back into the housing.
3. Align the holes in the sensor mounting with the studs on the housing and secure the mounting to the housing with the 4 wing nuts provided.
4. Tighten firmly.

6.2.2.2 Recorder/Data Logger Output Cable Installation

1. Connect the output cable to fitting on underside of the sampler.
2. Black and white wires provide an unpowered contact while the sampler is open, and second unpowered pair, red and green indicates that power is on.

6.2.2.3 Splash Shield Alignment

1. If the unit is off, turn the unit on (power switch located inside housing). Allow at least one minute for sensor to warm up. If the unit is on, move on to the next step.
2. Open the sampler Moving Cover by waving fingers between sensor heads. (Movement is required. Stationary object will not open sampler cover.) The Moving Cover opens after approximately 25 seconds. Allow the Moving Cover to come to a stop at a fully open position.
3. Turn off the system so that the cover remains open (and will not automatically close when it does not sense precipitation).
4. Adjust the Splash Shield to a level just below the Moving Cover (no contact).
5. Ensure that the shield is level and tightened completely to prevent rotation.
6. Power the unit on and to return the Moving Cover to its normally closed position.

6.2.2.4 Sample Train Installation

1. Follow instructions in Section 5.5.8, Deploying New Sample Bottles and Sample Trains.

6.2.2.5 Alignment of Moving Cover

1. Turn on power and check that moving cover seats properly. Funnel(s) should rest evenly on the white chimney supports.

2. Lid seal should completely and evenly seat on the chimney(s).

6.2.2.6 Close and Latch Sampler

1. Close and latch unit.
2. Two chimney units have two latches to insure even seal. Be sure to close latch on underside of unit.

6.2.2.7 Final Check Out

- ☐ Ensure the power cord is connected and secured to underside of sampler or stanchion
- ☐ Ensure the System switch is turned on. (System LED will be on.)
- ☐ Wave your fingers between sensor heads to simulate precipitation.
- ☐ Observe cover opening and resting evenly just above splash shield.
- ☐ In about 2 minutes, the cover should return to the closed position.
- ☐ Check that the cover seats uniformly on the chimney(s) and seal is complete.

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). In the event the Wet Deposition sensor requires maintenance, remove any external dirt/debris and follow section **5.5.7 Cleaning the Collector**, **Table 9. Procedure and pictures for cleaning the detector body and associated components procedures**. For the PRT, maintain original packaging. The ID chip in the PRT that collects the temperature data is static sensitive; use caution and employ ESD (electrostatic discharge) handling procedures.

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
1685 38TH STREET, SUITE 100
BOULDER, CO 80301

7 ISSUE REPORTING OUTPUTS

Table 14: Metadata Output Checklist

Issue Reporting Datasheet		
Datasheet field	**Entry**	
NEON Site Code		
Maintenance Date		
Maintenance Technician		
Preventive Maintenance	**Issue Noted**	**Issue Summary**
Environmental Information Surrounding Area Check	☐	
Exterior Damage	☐	
Cables & Connectors Condition Check	☐	
Snow/Ice Accumulation	☐	
Funnel Heater	☐	
Moving Cover Operation	☐	
Moving Cover Seal	☐	
Thermo-Electric Chiller Unit	☐	
Cross-check Internal Temperature	☐	Internal PRT Temperature: _____ Handheld IR Temperature: _____ Temperature Differential: _____
Sample Present	☐	☐ Yes ☐ No
Sample Condition	☐	☐ Bird droppings ☐ Cloudy or discolored ☐ Soot/ash/dirt particles ☐ Insects/animal matter ☐ Leaves/twigs/pollen/plant matter ☐ Handling contamination
Chemical Analysis Sample Bottle	☐	Bottle Tare Weight: _____ Sample + Bottle Weight: _____ Sample Only Weight: _____

Issue Reporting Datasheet		
Chemical Analysis Sample ID	wdp._____._____._____.chem	
Isotope Analysis Sample Bottle	☐	Bottle Tare Weight: _____ Sample + Bottle Weight: _____ Sample Only Weight: _____
Isotope Analysis Sample ID	wdp._____._____._____.iso	
Isotope Analysis Sub-Sample ID	wdp._____._____._____.iso.test	

Notes

8 APPENDIX

- 8.1 - Glassware and Shipping Container Requirements per Domain

8.1 Glassware and Shipping Container Requirements per Domain

- (4) sets* of complete sample trains
    - (1) active set – inside collector
    - (1) swap set – set that will be swapped at maintenance
    - (1) back-up set –in case of any breakage/contamination during maintenance
    - (1) next deployment set – in case there is a delay in the return of a glassware set from the contract laboratory
- (3) sets* of 60 oz. sample bottles
    - (1) active set – inside collector
    - (1) swap set – set that will be swapped at maintenance
    - (1) back-up & next deployment set – back-up in case of any breakage/contamination during maintenance, or in case there is a delay in the return of glassware set from the contract laboratory
        - 60 oz. glass sample bottles are rather robust and difficult to break, so can get by with one back-up and next deployment set
- (4) shipping containers for the assembled sample trains
    - Bel-Air ReadyCase™ Shipping Case, 20.7” x 10.8” x 6.7”
        - (holds two Assembled Glass Sample Trains)
- (3) shipping containers for the 60 oz. sample bottles
    - Bel- Air ReadyCase™ Shipping Case, 17.6” x 13.5” x 7.3”
        - (holds two 60 oz. Glass Sample Bottles)

**A set is two of each item.*