

# CAV<sup>®</sup> 4.1

Single-Bath  
Automated  
Kinematic  
Viscometer



*Operation  
Manual*



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## Overview

CANNON<sup>®</sup> CAV 4.1 (see Figure 1) is a fully automated, single-bath, benchtop kinematic viscometer with two 14-position sample handlers for unattended ASTM D445/D446, ISP 3104/3105, and IP 71 testing. Each of the two viscometer tubes covers a 100-fold viscosity range at values between 0.5 mm<sup>2</sup>/s (cSt) and 10,000 mm<sup>2</sup>/s (cSt) from 20 °C to 150 °C (with available options.) The CAV 4.1 combines CANNON quality and reliability with a modern design and unique features to enhance lab productivity, reduce costs, and improve data quality.



**Figure 1 — CAV 4.1**

CANNON CAV 4.1 Single-Bath Benchtop Kinematic Viscometer comes with two 14-position sample carousels, two viscometer tubes, one set of oil viscosity standards, a case of glass vials, a high precision digital thermometer with probe, VISCPRO data storage/management software, and a one-year warranty. Instrument is stand-alone but optional computer (sold separately) is recommended for ease of calibration, connecting to LIMS (laboratory information management system), and maintaining complete audit trail.

## Specifications/Compliances

**Table 1 — Specifications and Compliances**

Specifications	Details
Model	CAV 4.1 Benchtop Kinematic Viscometer
Methodology	ASTM D445/D446, ISO 3104/3105, IP 71
Applications	Formulated oil analysis, hydraulic oil analysis, additive analysis, marine fuel testing, base stock analysis, light and heavy fuel testing, waxes/paraffin, crude oil testing, glycols
Dimensions (W × D × H)	36 cm × 66 cm × 72 cm (14.15 in × 26 in × 28.5 in)
Weight	63 kg (140 lb)
Temperature range & Accuracy	40 °C to +100 °C (± 0.01 °C); Up to 150 °C (± 0.03 °C) Down to 20 °C (± 0.03 °C) with integrated TE bath cooler
Maximum throughput	24 tests per hour
Automated sample capacity	28 positions (2 × 14 positions)
Minimum sample/solvent volume required	8 mL sample/15 mL solvent per test *as little as 3mL with fast run tubes
Viscosity range	0.5 mm <sup>2</sup> /s to 10,000 mm <sup>2</sup> /s in 100-fold increments (depending on viscometer tubes selected). Fast run tubes are also available
Timing resolution	0.01 seconds (timing accuracy to ± 0.001 seconds)
Power requirements	100 VAC, 50/60 Hz, 1200 W 115 VAC, 50/60 Hz, 1200 W 230 VAC, 50/60 Hz, 1200 W
Operating conditions	15 °C to 30 °C, 10% to 75% relative humidity (non-condensing), Installation Category II, Pollution Degree 2
Compliance	CE Mark: EMC Directive (2004/108/EC); Low Voltage Directive (2006/95/EC); ROHS

## Notes/Cautions/Warnings

Notes, caution, and warnings are used in the manual to call an operator's attention to important details prior to performing a procedure or step. Read and follow these important instructions. Failure to observe these instructions may void warranties, compromise operator safety, and/or result in damage to the CAV 4.1.



**Note:** Provides more information about the content that follows.



**Caution:** Alerts the operator to conditions that may damage equipment.



**Warning:** Alerts the operator to conditions that may cause injury.

## Safety Precautions

Please observe the following general safety precautions for proper and safe operation of the CAV 4.1.

- Only qualified personnel should operate the CAV 4.1.
- Make sure that you read and understand all operating instructions and safety precautions listed in this manual before installing or operating your unit. Direct questions regarding instrument operation or documentation to CANNON Instrument Company.
- Do not deviate from the installation, operation, or maintenance procedures described in this manual. Improper use of the CAV 4.1 may result in a hazardous situation and/or void the manufacturer's warranty.
- Handle and transport the unit with care. Sudden jolts or impacts may cause damage to components.
- Observe all warning labels. Never remove warning labels.
- Never operate damaged or leaking equipment.
- Unless procedures specify otherwise, always turn off the unit and disconnect the MAINS cable from the power source before performing service or maintenance procedures, or before moving the unit.
- Refer all service and repairs to qualified personnel.

## Navigating the Manual

Since the CAV 4.1 uses both a touchscreen interface on the instrument and the VISCPRO II computer software application, the instructions are broken into sections for each type of controlling software. The header of each section notes **CAV 4.1 GUI Touchscreen** or **VISCPRO II** so the operator knows whether the procedures apply to the touchscreen instrument software, or the computer-controlled VISCPRO software.

**CAV 4.1 GUI Touchscreen** refers to the instrument touchscreen.

**VISCPRO II** refers to the computer software.



## Getting Started

This chapter covers all steps necessary to set up, calibrate, and run a sample on the CAV 4.1. The procedures are intended to be performed in the order written. These are basic, simplified procedures designed to familiarize an operator with the instrument, with more detailed instructions provided in following sections.

### Unpack and Inspect

Unpack and inspect the complete CANNON CAV 4.1 and all accessories as soon as they are received.



**Caution:** *Many components are fragile. Use caution when moving and handling the CAV 4.1 and accessories.*

1. Carefully unpack the entire contents of the shipment.
2. Refer to the packaging list to verify that all materials are present. See Table 2—Table 4.
3. Inspect materials for defects and shipping damage. Contact your CANNON representative to resolve any issues.

**Table 2 — Packing List (Main Components)**

Description	Part Number
CAV 4.1	68.1025
Bath Fluid	9726-L37
Sample carousel (2)	68.1047 for use with glass vials 68.1115 for use with metal sleeves
MAINS AC power cable	Varies by locale
USB Drive (Operation Manual, VISCRO software)	N/A

**Table 3 — Packing List (installation)**

	Description	Part Number
Solvent	1/8" blue FEP tubing (25 ft)	81.2185
	Brass tee fittings (2)	81.0007
	Bottle caps for GL-38 bottles (3)	65.3201
	20 micron filters (3)	65.0047
Waste	1/2" white nylon tubing (15 ft)	62.1500.3
	1/2" white nylon elbows (2)	62.1500.2
	1/2" white nylon tees (2)	62.1500.4

**Table 4 — Packing List (Tools)**

Description	Part Number
Rubber stoppers (3)	11.3115
Tubing cutter	81.1074
Yellow Tygon tubing (2 ft)	71.4.16
1/4" wrench	----

## Setup

Initial setup of the CAV 4.1 involves connecting the hoses and cables and filling the bath with silicone bath fluid. See Figure 2 for overview of final setup and Table 5 for tools and materials required.



**Figure 2 — Complete CAV 4.1 System Setup**

**Table 5 — Tools and Materials Required**

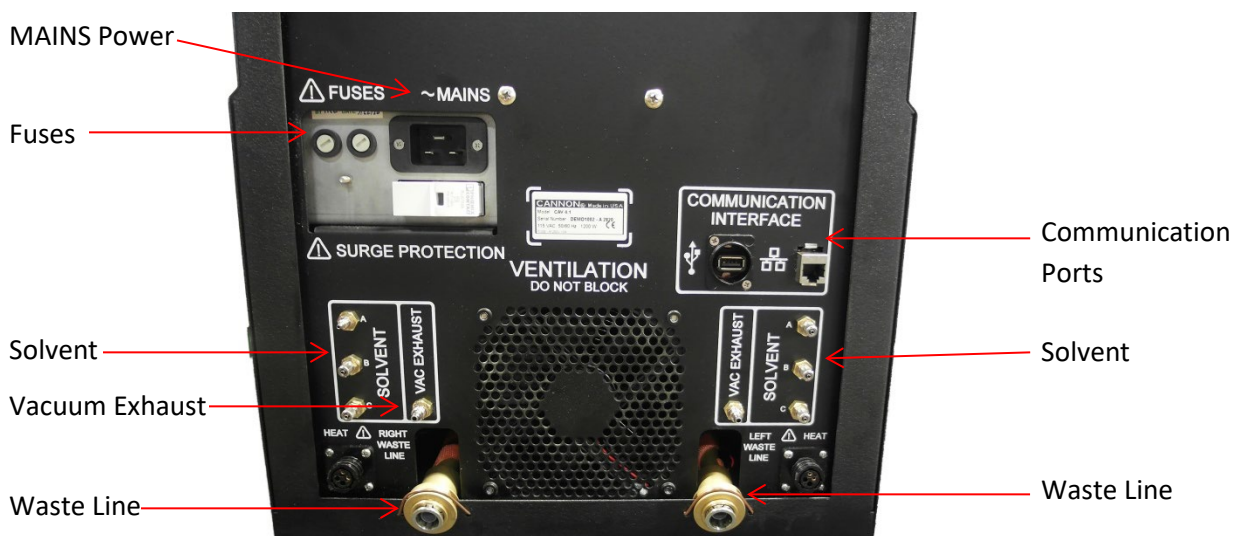
Description	Hose connections
Complete CAV 4.1	1/8" blue FEP tubing (25 ft)
MAINS AC power cable	1/2" white nylon tubing (15 ft)
Waste receiver	Bottle caps for GL-38 bottles (4)
Solvent	20 micron filters (4)
Silicone bath fluid (2 L)	Rubber stopper
Glass vials (and metal sleeves if applicable)	Tubing cutter
Networking	Optional
CAT cables, red (2)	Brass tee fittings (2)
USB to ethernet adapter	Brass elbow
8-port network switch	1/2" white elbows (2)
	1/2" white tees (2)
	6 mm blue FEP tubing (15 ft)

## Connect Hoses, Standard Setup (most common)



**Note:** For hose connections with External Waste Receiver Option, follow directions under Connect Hoses, External Waste Receiver Option (least common).

Assemble the CAV 4.1 on a secure surface with sufficient room behind the instrument to maintain a clear airflow and allow for unimpeded connection of the solvent inlet and waste outlet tubing. See Figure 3.



**Figure 3 — Tubing Connections (Rear Close Up)**

1. Place the CAV 4.1 on a solid, level workbench located near a MAINS AC power connection capable of providing sufficient current (10 A at 115 VAC) to the CAV 4.1. Depending on the materials tested, solvent used, and laboratory regulations, the work area may also need to be equipped with a ventilation system.
2. Place the waste receiver beneath the CAV 4.1. In order to promote proper gravity drainage, the top of the waste receiver must be lower than the waste outlets on the back of the instrument.
3. Place the solvent bottles alongside or beneath the CAV 4.1.
4. Measure and cut the  $\frac{1}{8}$ " blue FEP tubing to use as the solvent tubing. Each piece of tubing must run from the solvent inlet well to the bottom of a solvent bottle.
5. Connect the solvent tubing to the CAV 4.1:
  - a. Remove the cover plate from the solvent inlet well.
  - b. Thread the tubing through the solvent inlets on the back of the lid.
  - c. Unscrew the appropriate compression connector and slide it onto the tubing.
  - d. Slide the tubing onto the flared inlet pipe and hand tighten the compression connector.
6. Insert the solvent tubing into the solvent bottle:
  - a. Thread the tubing through the bottle cap.

- b. Screw a 20-micron filter onto the end of the tubing.
  - c. Screw the bottle cap onto the solvent bottle.
7. Repeat steps 4 through 6 for each piece of solvent tubing.



**Note:** Each piece of tubing must run from the middle of the CAV 4.1 into the waste receiver.  $\frac{1}{2}$ " white nylon elbows and tees are provided to enable combining both waste tubes into one tube before entering the waste receiver. A brass elbow is also provided to connect the waste tubing to the waste receiver.

8. Measure and cut the  $\frac{1}{2}$ " white nylon tubing to use as the waste tubing.



**Caution:** Do not overtighten the waste outlet compression nut.

9. Connect the bath waste tubing to the CAV 4.1:
  - a. Fully insert tubing into push to lock fitting.
10. Connect the waste tubing to the waste receiver.
11. Measure, cut, and install the 6 mm blue FEP tubing as exhaust tubing.
12. Next step, Fill Bath.

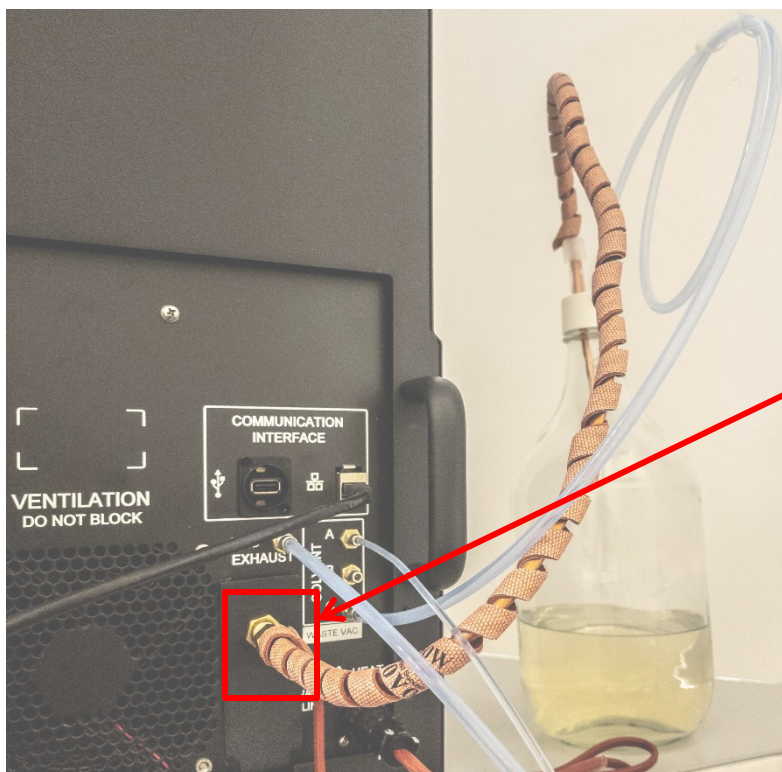
### Connect Hoses, External Waste Receiver Option (least common)

Assemble the CAV 4.1 on a secure surface with sufficient room behind the instrument to maintain a clear airflow and allow for unimpeded connection of the solvent inlet and waste outlet tubing. See Figure 3.

1. Place the CAV 4.1 on a solid, level workbench located near a MAINS AC power connection capable of providing sufficient current (10 A at 115 VAC) to the CAV 4.1. Depending on the materials tested, solvent used, and laboratory regulations, the work area may also need to be equipped with a ventilation system.
2. Place the solvent bottles alongside or beneath CAV 4.1.
3. Measure and cut the  $\frac{1}{8}$ " blue FEP tubing to use as the solvent tubing. Each piece of tubing must run from the solvent inlet well to the bottom of a solvent bottle.
4. Connect the solvent tubing to the CAV 4.1:
  - b. Remove the cover plate from the solvent inlet well.
  - c. Thread the tubing through the solvent inlets on the back of the lid.
  - d. Unscrew the appropriate compression connector and slide it onto the tubing.
  - e. Slide the tubing onto the flared inlet pipe and hand tighten the compression connector.
5. Insert the solvent tubing into the solvent bottle:
  - a. Thread the tubing through the bottle cap.



- b. Screw a 20-micron filter onto the end of the tubing.
  - c. Screw the bottle cap onto the solvent bottle.
- 6. Repeat steps 4 through 6 for each piece of solvent tubing.
  - 7. Measure, cut, and install the 6 mm blue FEP tubing as exhaust tubing.
  - 8. Connect copper tube to waste line port. See Figure 4.



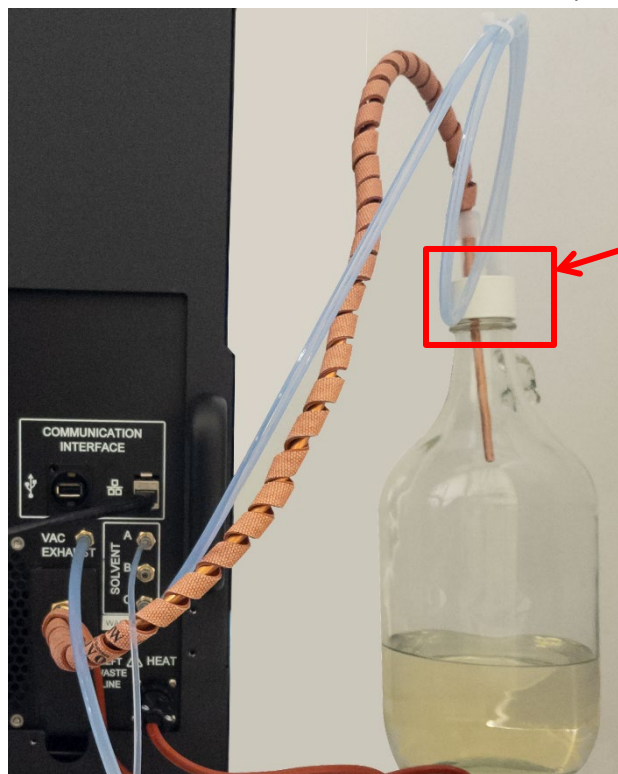
**Figure 4 — Waste Line Port Connection**

- 9. Connect the 6 mm tube to waste vac port. See Figure 5.



**Figure 5 — Waste Vac Port**

10. Connect copper line and 6 mm tube to waste container and ensure cap is tight. See Figure 6.



**Figure 6 — Vacuum Waste Container Cap**

11. Next step, Fill Bath.

## Fill Bath

The temperature bath must be filled with the appropriate silicone fluid prior to operation. The viscosity of the fluid depends upon the temperature of the bath during most operations. Refer to Table 6 for proper bath fluid selection.

**Table 6 — Silicone Bath Fluid Selection**

Bath operating range	Recommended bath fluid viscosity
20 °C to 100 °C	10 cSt
101 °C to 150 °C	20 cSt



**Warning:** Follow all lab policies regarding the safe handling and disposal of all hazardous materials.

## Tools/Materials Required (Bath Fill & Bath Drain)

Refer to Table 7 for tools and materials required to fill and drain bath.

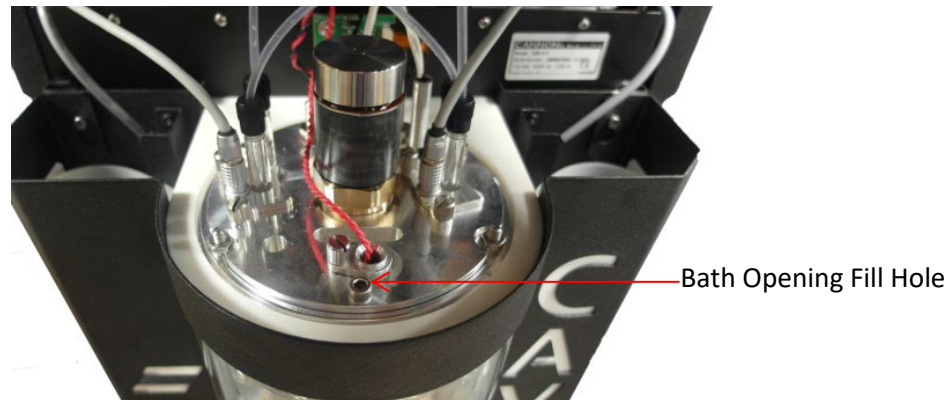
**Table 7 — Tools/Materials for Bath Fill and Bath Drain**

¼" Open End Wrench	Yellow Tubing
Silicone Bath Fluid	Bath Drainage Receptacle

## Procedure

1. Turn off power to the CAV 4.1 instrument and let the bath cool to room temperature.
2. Lift the hood to access the top of the bath.

3. Remove the float from the top of the bath and set aside. This provides the opening to fill the bath. Refer to Figure 7.



**Figure 7 — Remove Float from Top of Bath to Reveal Opening**

4. Insert funnel into the hole now available by the removed Float. Refer to Figure 8.

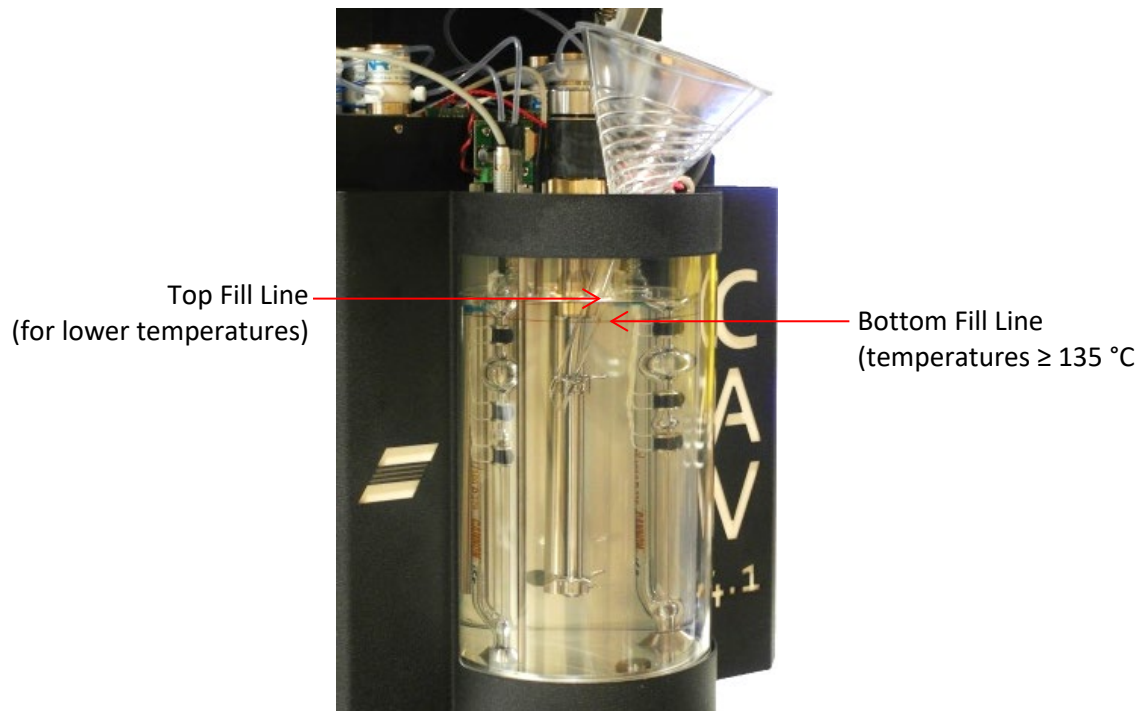


**Figure 8 — Funnel Inserted into Bath Opening**

5. Using the funnel, fill bath with the appropriate silicone bath fluid to the applicable fill line on the bath. The top line is for lower temperatures (100 °C) and the bottom line is for higher temperatures (135 °C and above). Refer to Figure 9 and Figure 10.



**Figure 9 — Filling Bath with 10 cSt Silicone Fluid**



**Figure 10 — Bath Filled to Top Fill Line**

6. Remove funnel and replace float into top of bath. The CAV 4.1 bath is now filled.

## Drain the Bath

It may be necessary to periodically drain the bath. Follow the instructions in this section and use caution to avoid exposure to hot bath fluid. See Table 7 for tools and material required.

1. Turn off power to the CAV 4.1 instrument and allow bath to cool to room temperature.



**Warning:** *When working with the bath in any capacity, and especially when emptying the fluid, make sure the bath is completely cooled (ambient temperature) prior to working or emptying bath fluid.*

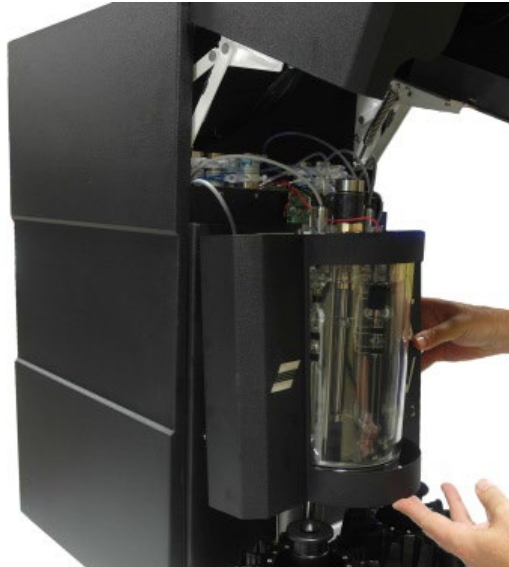
2. Lift the CAV 4.1 hood to access the bath. It flips up, as shown in Figure 11.



**Figure 11 — Lift the CAV 4.1 Hood**

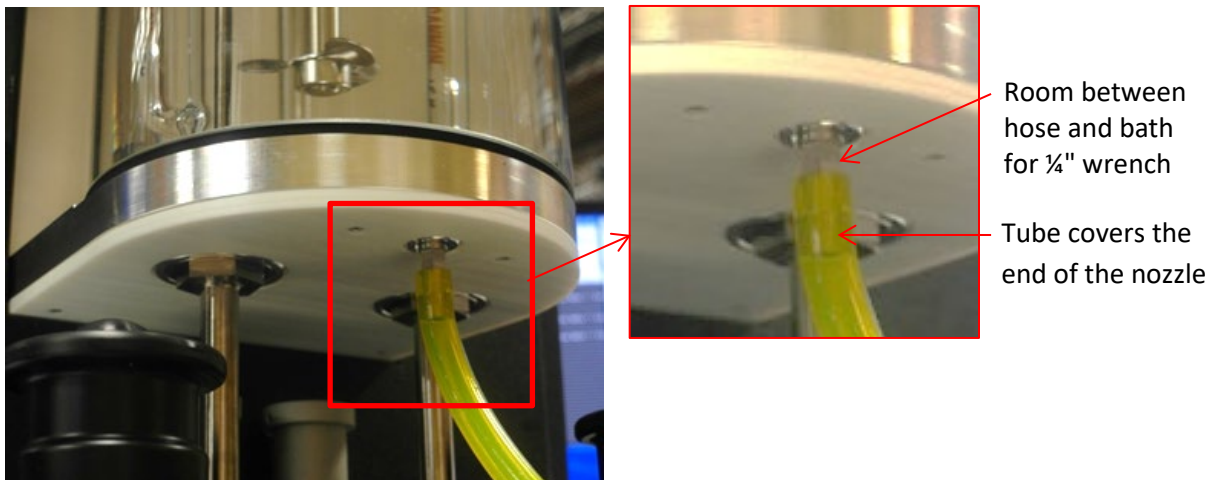


3. Remove the front panel of the CAV 4.1 by gently pulling it away from the front of the instrument, as shown in Figure 12. Set the front panel aside.



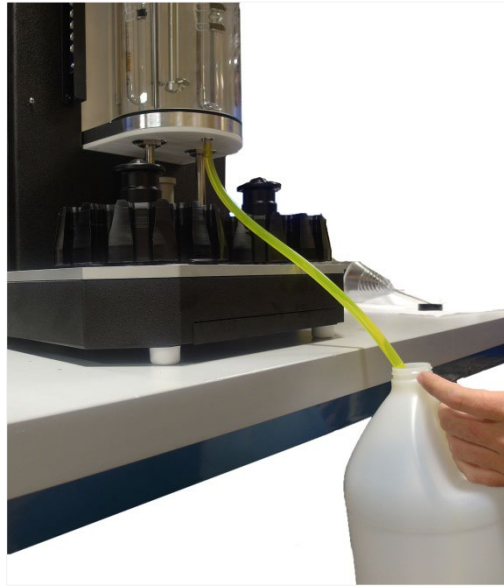
**Figure 12 — Remove Front Panel and Set Aside**

4. Insert one end of the yellow tubing onto bath drain, leaving at least  $\frac{1}{4}$ " above the hose on the nozzle. The hose must cover the large end of the nozzle, without making contact with the bath itself. There must be adequate room above the hose to access the nozzle with the  $\frac{1}{4}$ " open end wrench that opens the drain. Do not let the hose cover the entire drainage tube. Refer to Figure 13.



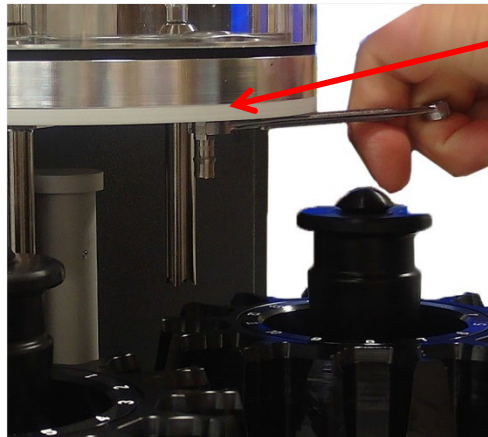
**Figure 13 — Hose Inserted Properly onto Bath Drain (with Close Up)**

5. Insert the other end of hose into a silicone fluid bottle or appropriate bath drainage container. Refer to Figure 14.



**Figure 14 — Hose Draining into Fluid Container**

6. Use the ¼" Open End wrench to gently open the drain by turning the exposed portion counter-clockwise. Refer to Figure 15.

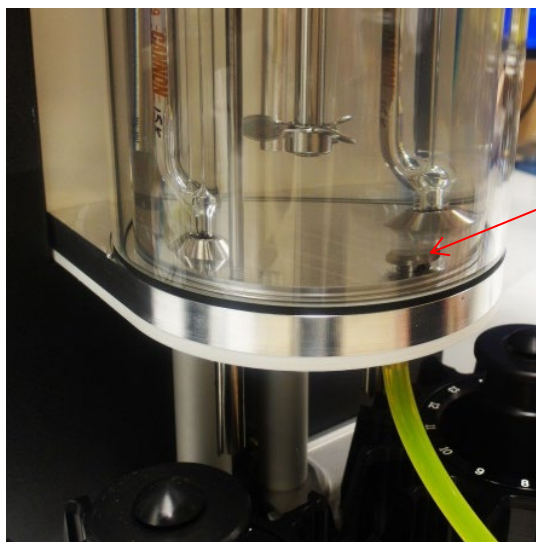


¼" Open End wrench  
applied to exposed  
drain to open

**Figure 15 — Open Drain with Allen Wrench**

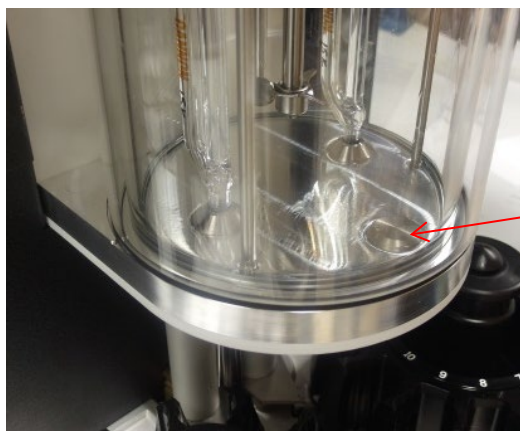


7. When the bath drain is completely open, the drain plug will rise out of the bottom of bath, no longer flush with the bottom of bath. Refer to Figure 16.



**Figure 16 — Open Bath Drain**

8. Drain entire contents of bath. Remove the hose and close the drain plug by turning it clockwise until it is flush with the bottom of the bath. Refer to Figure 17.



**Figure 17 — Fully Closed Bath Drain Plug**

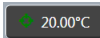
9. Now that bath is empty, return the hood and panel to their original positions, reversing previous steps to remove them. Procedure is complete.

### **Connect Cables**

1. Connect the MAINS AC power cord to the CAV 4.1.
2. Plug the power cord into the MAINS AC outlet at the workstation.
3. (optional) Connect the CAV 4.1 to the network switch with one CAT cable.
4. (optional) Connect the network switch to the PC with a CAT cable and USB adapter.

## Set Bath Temperature (Touchscreen)

Set the temperature of the bath before calibrating the instrument. This section specifies procedures for the Graphical User Interface, or **GUI**, located on the instrument's touchscreen.

1. From the main screen, click the target temperature button  for the bath. This opens the temperature settings screen. Refer to Figure 18.

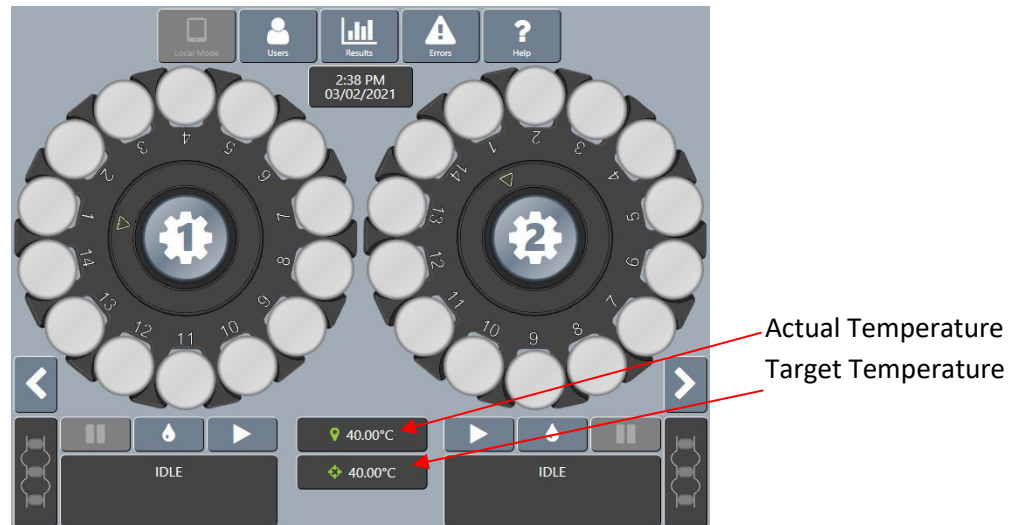


Figure 18 — Main CAV 4.1 Screen

2. Select **Target Temperature** button. This opens the Enter Target Temperature screen. Refer to Figure 19.

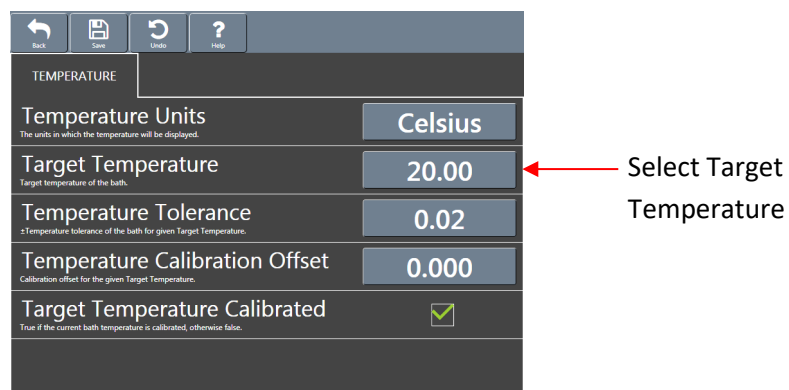
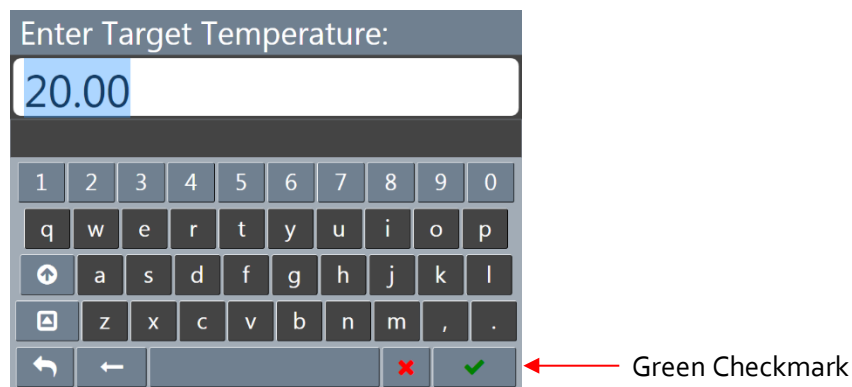


Figure 19 — Temperature Settings Screen

3. Enter the target temperature. Then click the green checkmark to submit entry and return to the temperature settings screen. Refer to Figure 20.



**Figure 20 — Target Temperature Entry Screen**

4. Click **Save**. Then click **Back** to return to the main screen.
5. Wait for the current temperature to match the target temperature.

## Calibrate Temperature (Touchscreen)

The temperature calibration must be verified any time the instrument is moved, the bath fluid is refilled, or a new operating temperature is used. The instrument is calibrated by inserting the thermometer through an access hole in the display hood, measuring the actual temperature of the bath fluid, and entering that temperature into the CAV 4.1 software. Refer to Table 8 for necessary tools and materials.


**Table 8 — Tools and Materials Required**

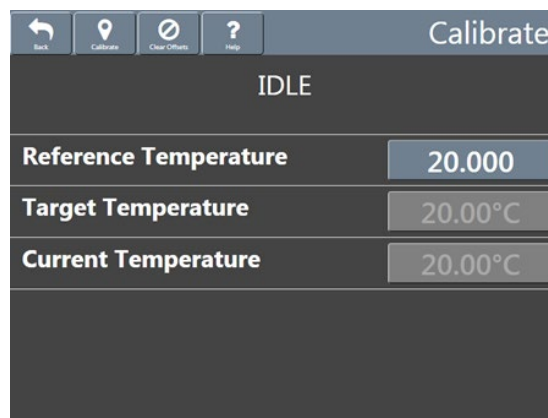
Description	Part Number
Assembled CAV 4.1	68.0229
Dostmann digital thermometer	61.5600
Thermometer probe	61.5601

1. If raised, lower the display hood and plumbing lid.
2. Carefully insert a thermometer through the access hole in the display hood and into the bath until the tip of the thermometer is in the middle of the capillary portion of the viscometer tube. The thermometer passes through the same hole in the top of the bath that is used to fill the unit with fluid. Refer to Figure 21.



**Figure 21 — Insert Thermometer**

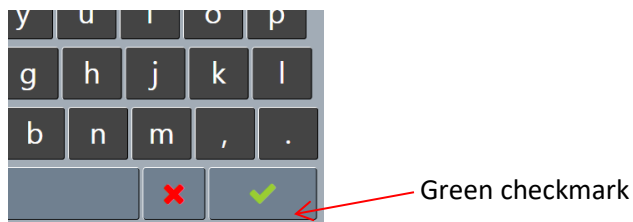
3. Wait for the thermometer to adjust to the temperature of the bath fluid. Read the reference temperature.
4. From the main screen, click the current bath temperature button  for the bath. This opens the **Temperature Calibration** screen, as shown in Figure 22.



**Figure 22 — Temperature Calibration Screen**

5. Click the **Reference Temperature** field. A field entry screen opens.

6. Enter the reference temperature measured in step 3. Then, click the green checkmark to submit the entry and return to the **Temperature Calibration** screen, as shown in Figure 23



**Figure 23 — Green Checkmark for Entry Submission**

7. Select **Calibrate**, wait for the system to save the adjustment, and then click **Back** to return to the main screen.
8. Remove and clean the thermometer, and then store safely.

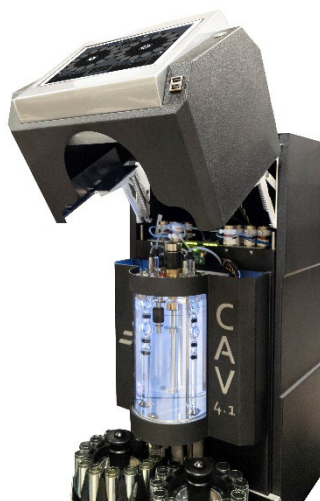
## Set Vacuum and Pressure (Components)

Set the vacuum and pressure of the CAV 4.1 before running the instrument. Use the following procedure to access the vacuum and pressure knobs within the instrument.

**Table 9 — Tools and Materials Required**

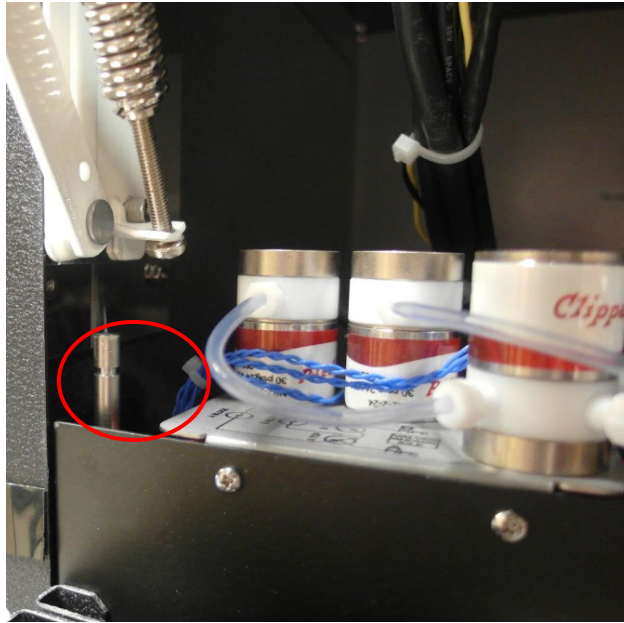
Description	Part Number
Assembled CAV 4.1	68.0229
Rubber stoppers (3)	11.3115

1. Lift the CAV 4.1 Hood. See Figure 24.



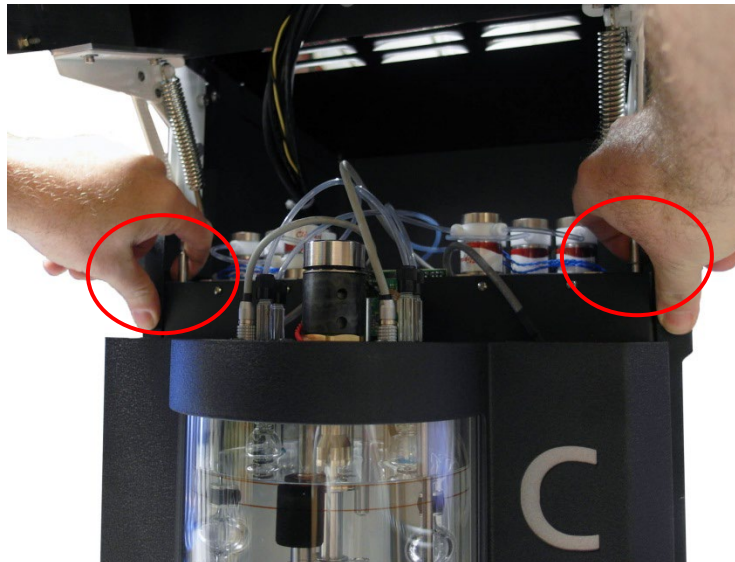
**Figure 24 — CAV 4.1 with Hood Lifted**

2. Pull up the two access pins on either side of the top of the bath and rotate to lock into the up position. Refer to Figure 25.



**Figure 25 — Access Pin on One Side**

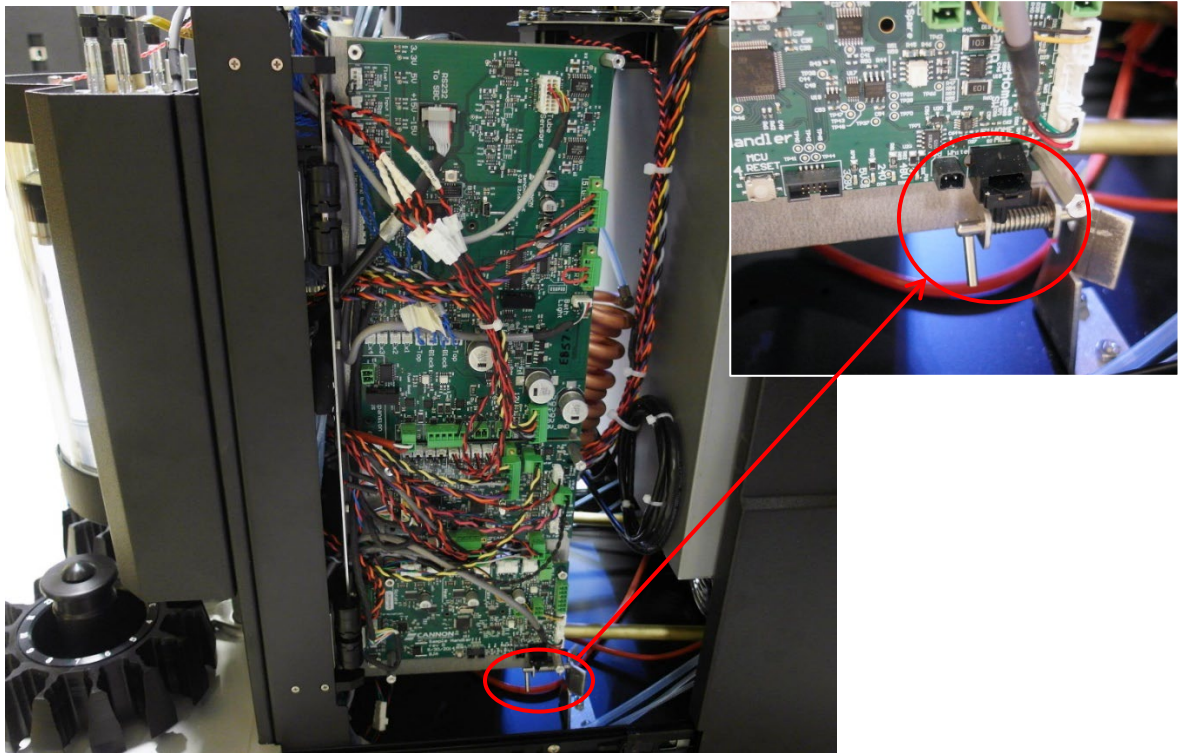
3. Gripping the access pins, push against the outer chassis to pull out the inner chassis. Refer to Figure 26.



**Figure 26 — Pull Out Chassis while Pulling Up Both Access Pins**

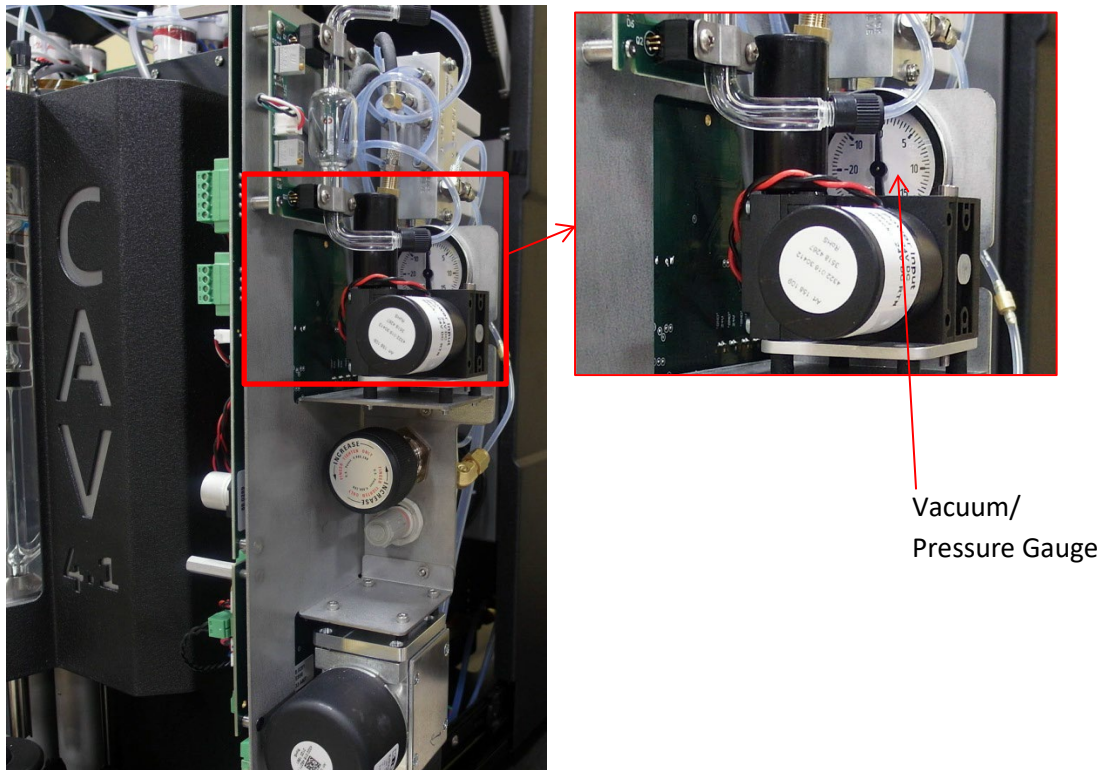


4. Pull latch on side panel to open the right bath control wing. When the latch is open, the bath control wing swings out. Refer to Figure 27.

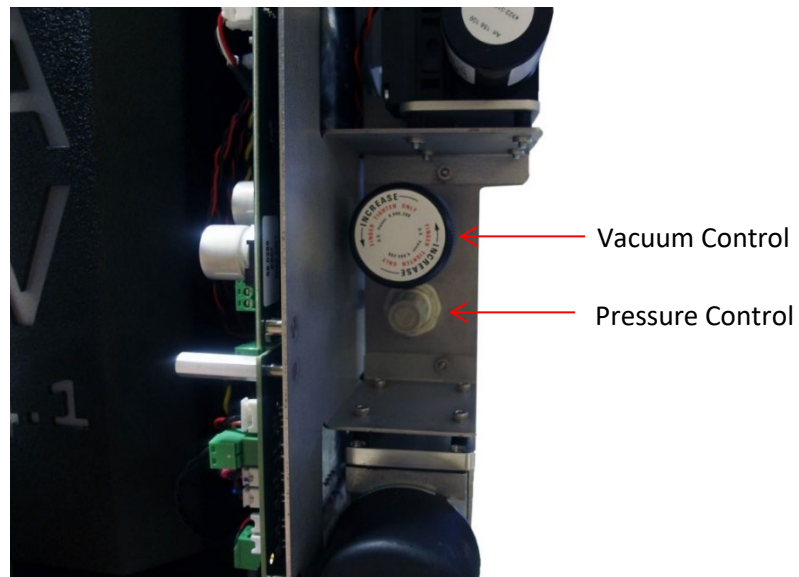


**Figure 27 — Side of Chassis with Latch, with Close up of Latch**

5. As the bath control wing swings out it allows access to the Vacuum and Pressure knobs. Adjust as necessary. Figure 28 shows the gauge, Figure 29 displays the knobs for adjusting vacuum and pressure.



**Figure 28 — Vacuum/Pressure Gauge**



**Figure 29 — Front View of Bath Control Wing with Vacuum and Pressure Knobs**

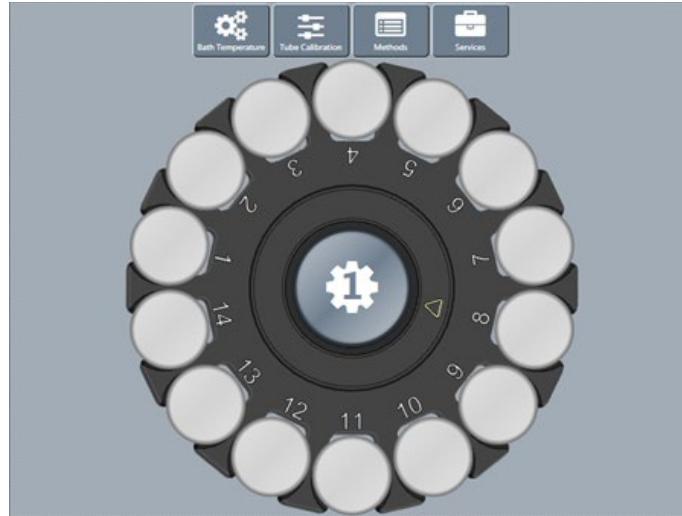
6. Repeat the steps in reverse order to slide the chassis back into place and commence operation.



## Set Vacuum and Pressure (Touchscreen)

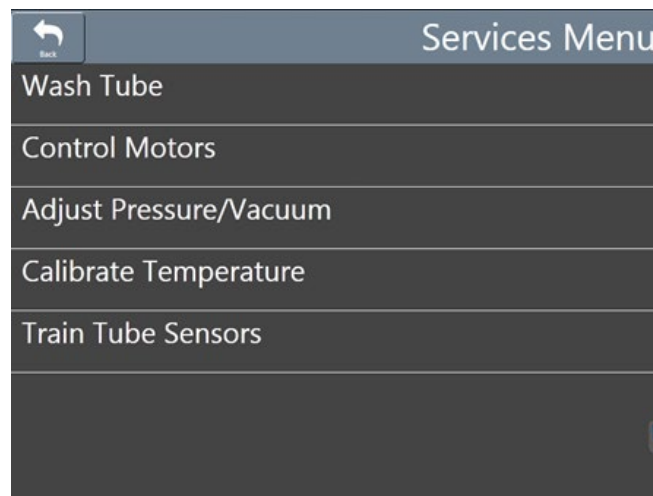
Once the components are in order and the instrument is put back together, use the **GUI Touchscreen** to adjust the vacuum and pressure settings.

1. From the main screen, select **Bath** to open the bath screen options. Refer to Figure 30.



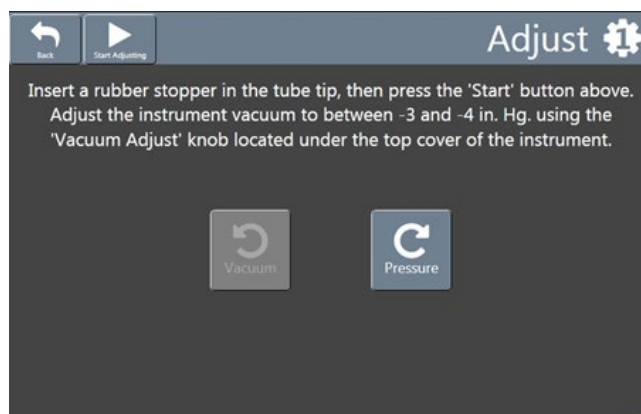
**Figure 30 — Bath Screen**

2. From the bath screen, click the **Service** button. This opens the **Service** menu options. Refer to Figure 31.



**Figure 31 — Services Menu**

3. Click **Adjust Pressure/Vacuum**. Follow the on-screen prompts, as shown in Figure 32.



**Figure 32 — Pressure/Vacuum Adjustment Screen**

4. After completing the steps as prompted in the **Adjust** screen, click **Back** to return to the bath screen.

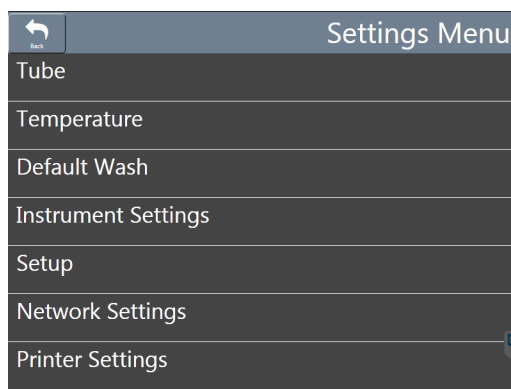
## Adjust the Default Wash Settings (Touchscreen)

Verify and adjust the default wash settings prior to running a wash for the first time.



**Note:** The CAV 4.1 wash settings are defined in the method settings of the last run test. When starting the CAV 4.1 from a complete shutdown, it does not reference the last run test, instead using the **default** wash settings.

1. From the main screen, select **Bath** to open the bath options window.
2. From the bath screen, click the **Settings** button. This opens the settings menu window. Refer to Figure 33.



**Figure 33 — Settings Menu**

- Click **Default Wash**. The **Wash** screen opens as shown in Figure 34.



The Wash screen displays a list of wash settings for two bulbs. At the top, there are icons for Back, Save, and Undo, along with a settings gear icon. The settings are as follows:


WASH	
Bulb1 Solvent A Washes	5
<small>The number of solvent A washes for samples running in bulb1.</small>	
Bulb1 Solvent B Washes	0
<small>The number of solvent B washes for samples running in bulb1.</small>	
Bulb1 Solvent C Washes	0
<small>The number of solvent C washes for samples running in bulb1.</small>	
Bulb2 Solvent A Washes	4
<small>The number of solvent A washes for samples running in bulb2.</small>	
Bulb2 Solvent B Washes	0
<small>The number of solvent B washes for samples running in bulb2.</small>	
Bulb2 Solvent C Washes	0
<small>The number of solvent C washes for samples running in bulb2.</small>	

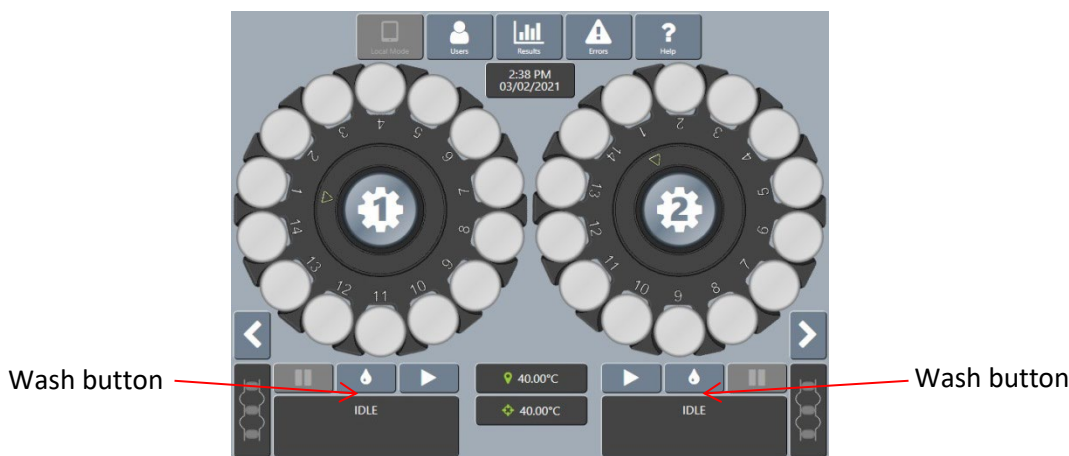
**Figure 34 — Wash Screen**

- Verify and adjust the wash values, as necessary.
- Once all settings are adjusted, select **Save**. Then click **Back** to return to the Bath screen.

### Run a Wash (Touchscreen)

The primary action when installing the CAV 4.1 is to run a wash. The CAV 4.1 is a uniquely useful instrument in that it is capable of automatically washing the sample tube, saving valuable operator time. Hence, prior to training the sensors or running tests, it is vital to first run a wash through the CAV 4.1.


- Insert an empty vial into position 1 of the carousel.
- From the main screen, click the wash button (water drop symbol).  The instrument immediately starts the wash cycle. Refer to Figure 35.



**Figure 35 — Main Screen (Wash Button)**

## Train the Sensors (Touchscreen)

After running a wash, the next step is to train the sensors. The sensors must be trained whenever operating the CAV 4.1 bath at a new temperature. Once trained, the calibration values for a particular temperature are saved and recalled when the CAV 4.1 runs at that temperature again. Retraining for a particular temperature is **only** necessary when the viscometer tube is changed or if sensor performance changes over time.

1. Insert an empty vial into position 1 of the carousel.
2. Fill a vial with a test solution that has a viscosity approximately three times higher than the lower viscosity limit of the Ubbelohde tube. Insert the vial into position 2.
3. From the main menu, click the **Tube** button.  This opens the **Train Screen** window.



**Note:** Uncheck the **Prewash** or **Trip Points Only** box options.

4. Press the **Start Training** button. Refer to Figure 36. CAV 4.1 instrument trains the sensors and then returns to the Main Menu. Refer to Figure 36.

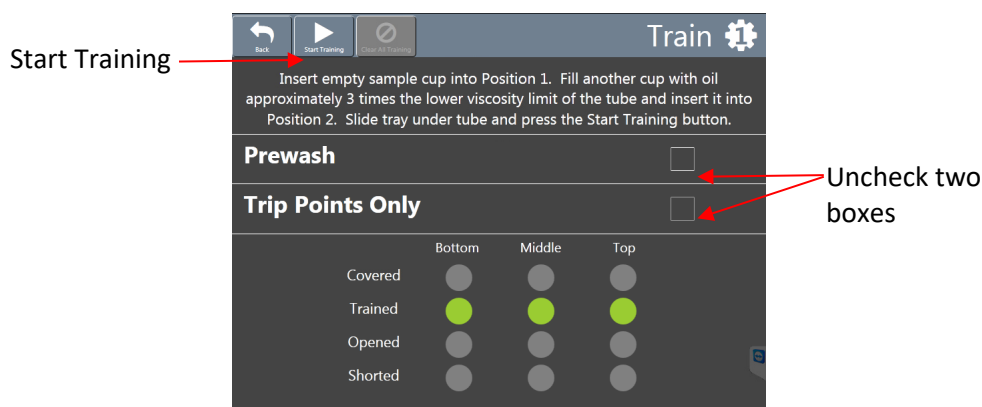


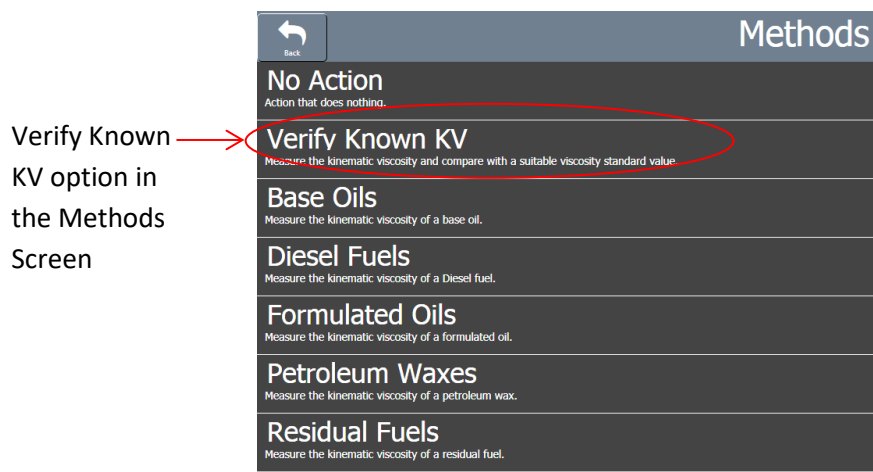
Figure 36 — Train Screen

## Run a Sample Test (Touchscreen)

This test verifies system calibration and provides a technician with basic training in operating the CANNON CAV 4.1. These instructions refer to the CAV 4.1 **Touchscreen**. Any level operator, Technician or Manager, can run a sample test.

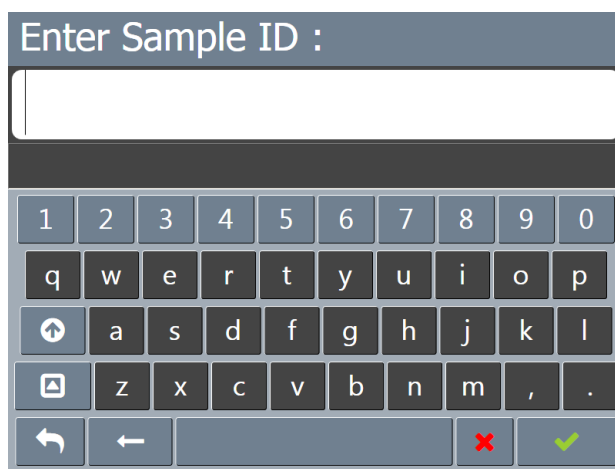
1. Following your appropriate laboratory practices, prepare a 10mL sample of test oil in the provided sample vials. Insert the sample vial into position 1 of the carousel.
2. From the main menu screen, click on the circle representing position 1 in the carousel. This opens the **Methods** screen.

- Click **Verify Known KV** in the **Methods** screen. The field entry screen open. Refer to Figure 37.





**Figure 37 — Methods Screen**

- Enter the **Sample ID**. Then click the green checkmark to submit the entry. Refer to Figure 38. Another field entry screen opens for the viscosity value.




**Figure 38 — Sample ID Entry Field**

- Enter the viscosity value (in cSt) of the test oil. Then click the green checkmark to submit the entry and return to the Main Menu screen. 
- Click the **Run** button. 
- When the test is complete, select the **Results** button to review the sample test results.

## Review and Export Data (Touchscreen)

Once a test completes, the results can be exported to a USB drive in CSV format.

- From the main screen, click the **Results** button.
- Review the results.
- Click the **Export** button. A field entry screen opens.

4. Enter the sample file name. Then click the green checkmark to submit it.  A **Save As** window opens.
5. Select the desired location to save the data file (USB), then click **Save**.



## Sample Preheating



**Note:** The preheating option is factory installed. This section is only applicable for instruments with the preheating option installed. If your instrument does not have preheat, then skip this section.

The preheating option on the CAV 4.1 is controlled via tube settings and can be used on either carousel. Prior to starting the process of activating preheating, ensure that the carousel is filled with the provided metal sleeves. An induction heating process is used for the preheating, therefore no foreign metal objects can touch or be near the glass cover. Use all proper laboratory procedures when handling hot surfaces.

**Warning:** Preheating causes hot surfaces. Use caution and only touch appropriate components. Always use the provided metal sleeves in carousel when preheating.



Induction heating means no metal objects can be near or touching the glass beneath the carousel when instrument is in operation.

Tray is hot – do not touch tray. Move the tray using only the black plastic handle.

### Preheat Procedure

Follow the proceeding steps to apply preheat to the sample. Using the CAV 4.1 touchscreen GUI:



**Note:** Most efficient heating occurs with carousel fully loaded with metal vials.

1. From the main menu, log in as a manager. Refer to Figure 39.



Figure 39 — Login as Manager

2. Using the touchscreen, slide to the appropriate carousel to preheat. Select Settings. Refer to Figure 40.



**Figure 40 — Slide to Desired Carousel Screen**

3. Press **Tube**. Refer to Figure 41.



**Figure 41 — Press Tube**



4. Select **Tray Preheat Temperature**. Refer to Figure 42.

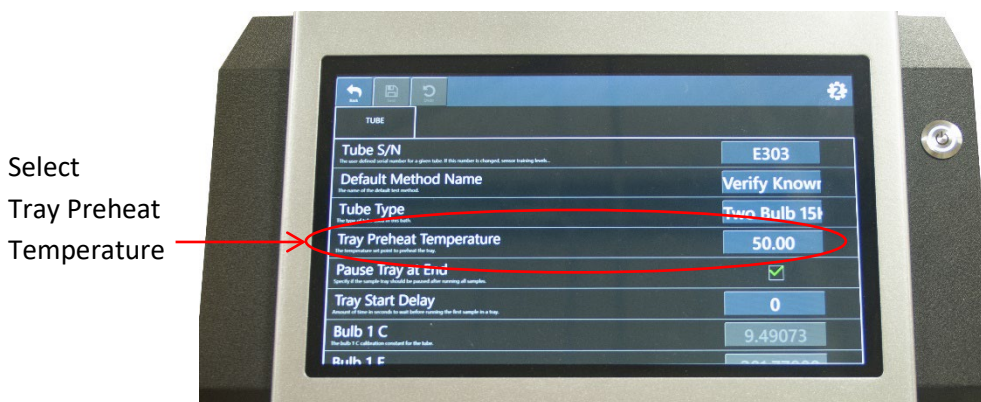



Figure 42 — Tray Preheat Temperature

5. Enter a temperature between 0–135 °C.



**Caution:** Heating is done through induction from below the carousel. The temperature reading is taken from the top of the next sample to be tested. To ensure proper loading of the sample into the tube, it is recommended to keep the set point below the bath temperature (approximately 5° for 50C testing and 10° for 100C testing).

6. Press **Save**. If not saved, red lights appear on-screen to indicate changes have been made that are not saved. Refer to Figure 43.

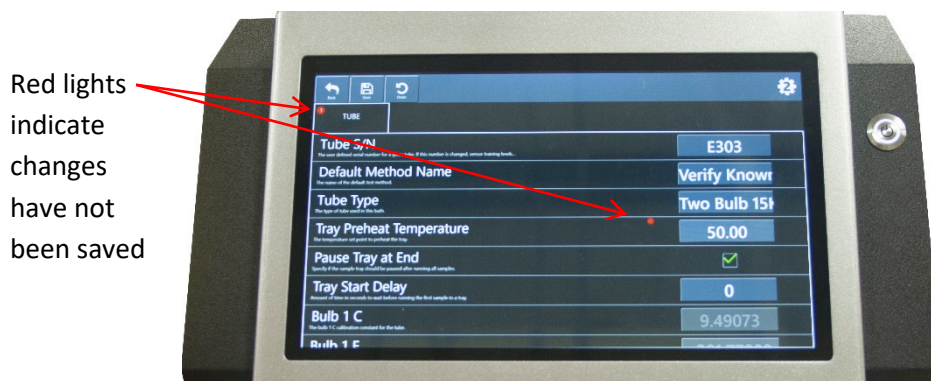
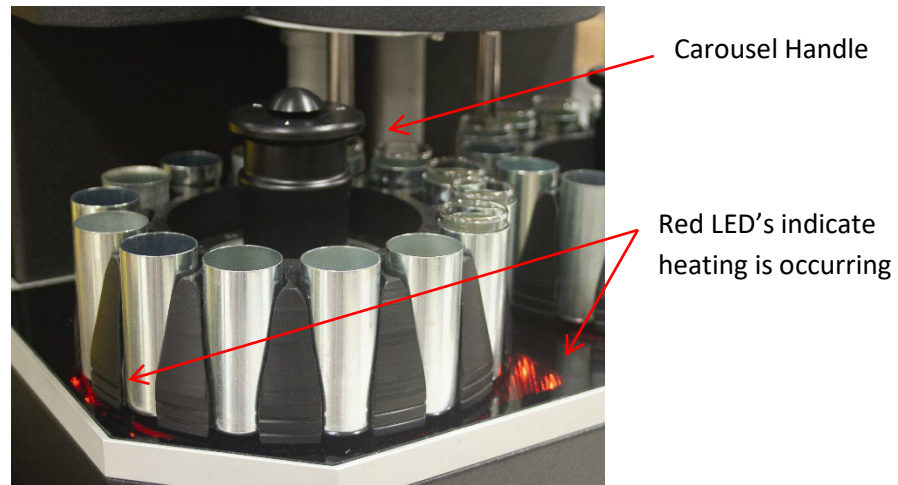


Figure 43 — Tray Preheat Temperature before Saving

7. Red LEDs in the glass indicate heating is occurring. Do not touch the glass or vials - only touch the black plastic handle in the center of the carousel, as shown in Figure 44.



**Figure 44 — LED's Indicating Heating**



**Warning:** *Sample carousel and metal sleeves are hot. The glass may also be hot due to proximity of the sample carousel and vials. Do not touch. Do not allow any metal items (other than the metal sleeves) to touch the glass.*

8. Go back to the main screen to exit the **Preheating** options.



## Sample TE Cooling



**Note:** The TE-Cooling option is factory installed. This section is only applicable for instruments with the cooling option installed. If your instrument is not installed with TE-Cooling, then skip this section.

If instrument is equipped with TE cooling option, follow the instructions outlined below in order to engage the CAV 4.1 in thermoelectric bath cooling. Always use proper laboratory procedures and caution when working with the CAV 4.1 instrument.

### TE-Cooling Procedure

1. Using the CAV 4.1 GUI touchscreen, log in as a manager. Refer to Figure 45.



Figure 45 — Login as Manager

1. Press **TE Cooler** button. Refer to Figure 46.

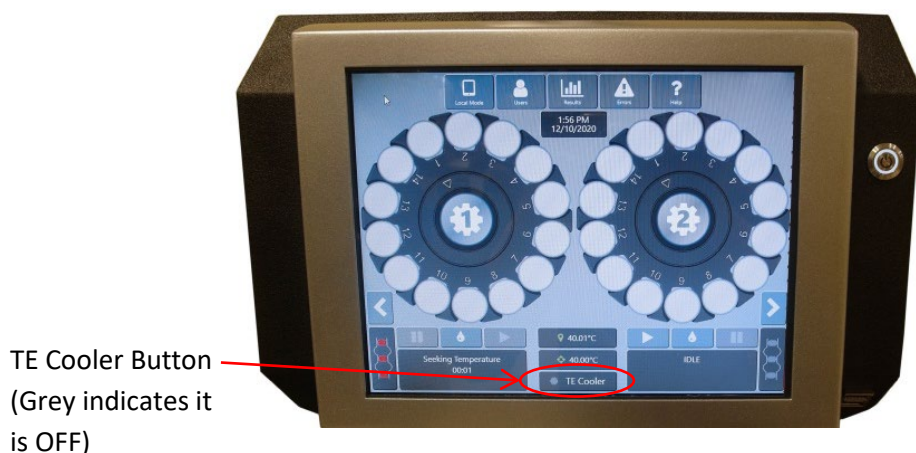


Figure 46 — Main Menu with TE Cooler Button

2. In the next menu, check **Use TE Coolers**. Refer to Figure 47.



**Figure 47 — Check Use TE Coolers**

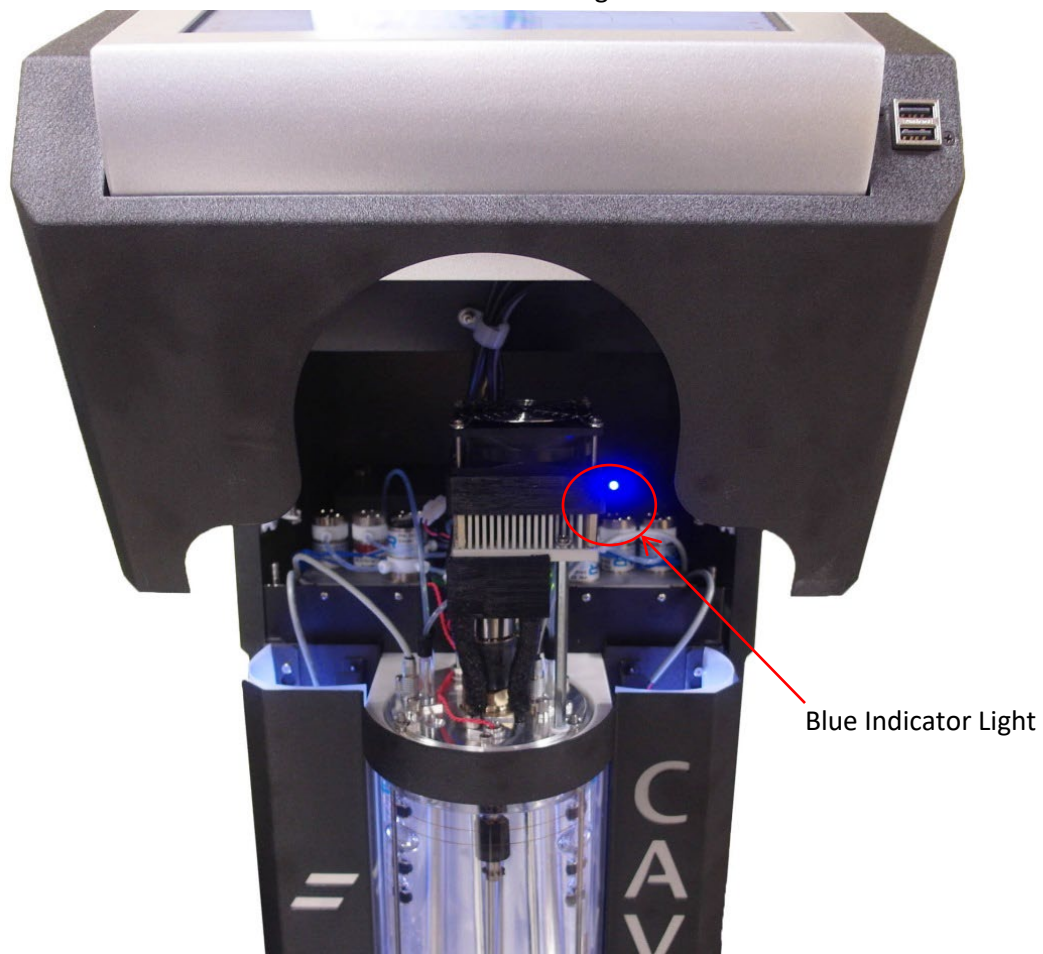
3. Press **Save**. Then hit the back button to return to the main menu.
4. The blue light indicates the TE Cooler is working. Refer to Figure 48.



**Figure 48 — TE Cooler Indicator Lit**



In order to troubleshoot and verify the TE Cooler is working properly, open the hood to ensure the blue light is lit. If not, contact CANNON Instrument Company service for assistance at [service@cannoninstrument.com](mailto:service@cannoninstrument.com) or 814-353-8000. Refer to Figure 49.



**Figure 49 — Blue Indicator Light for Proper TE Cooling**



## Connecting with VISCPRO II

The CAV 4.1 ships from CANNON ready for deployment on a dedicated, closed network. The following graphic, Figure 50, displays the default settings for the closed network. Windows®10 is the recommended operating system to use with VISCPRO and CANNON instruments.

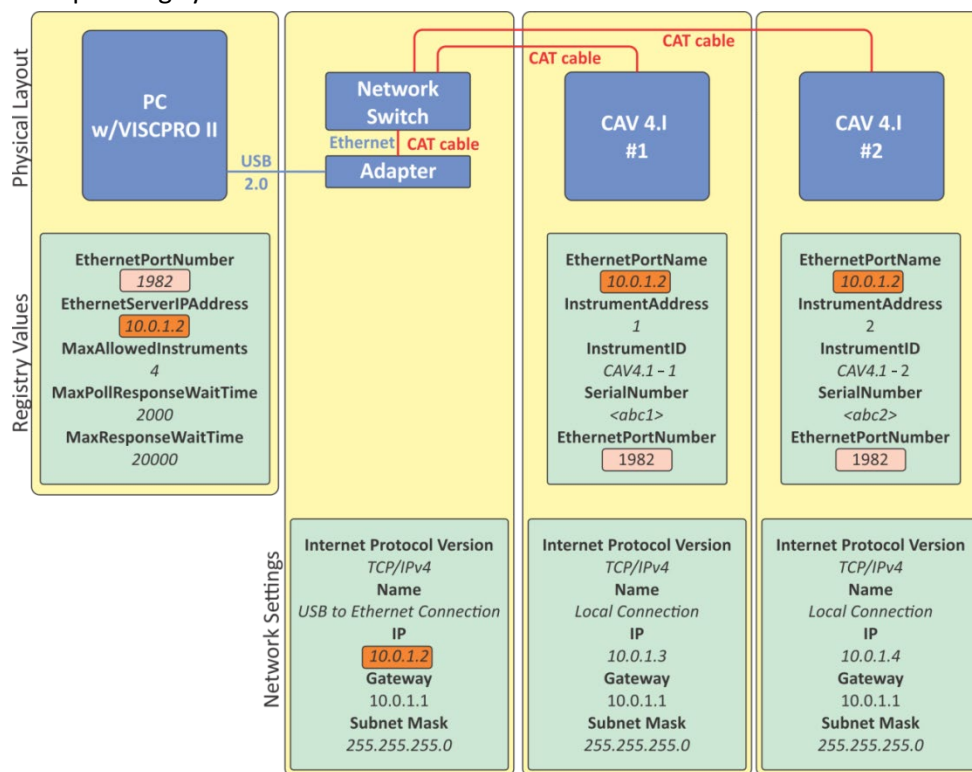


Figure 50 — Closed Network Settings

### Connect Equipment

All CANNON CAV systems and the PC (with USB 2.0 to Ethernet adapter) connect to the network switch using standard CAT 5e/6 cables. Refer to Table 10 for tools and materials required.

Table 10 — Tools and Materials Required

Description	Description
Assembled CAV 4.1	CAT cables, red (1 + 1 per CAV 4.1)
USB flash drive with VISCPRO II installation software and drivers	USB to Ethernet adapter
PC with Windows® 10 operating system	8-port network switch

1. Start and log in to the PC.

2. Plug the USB to Ethernet adapter into a USB 2.0 port on the PC. Windows® attempts to automatically install the required drivers. If necessary, a copy of the driver is provided on the USB flash drive.
3. Connect a CAT cable from the Ethernet adapter to the network switch.
4. Connect CAT cables from each CAV 4.1 to the network switch.

## Install VISCPRO II

There are no configurable options in the VISCPRO installation routine. Insert the USB and follow the on-screen prompts.

1. Uninstall any previous version of VISCPRO software.
2. Insert the USB drive into an open USB port on the PC.
3. Run **USB Flash Drive > VISCPRO > setup.exe**.

The following registry keys are set to default values during installation of VISCPRO. These cannot be edited from within the VISCPRO software. The only way to change these values is by directly editing the registry. Refer to Table 11.



**Caution:** *Editing registry entries may be hazardous to the operation of your Windows® system.*

**Table 11 — VISCPRO II Registry Entries**

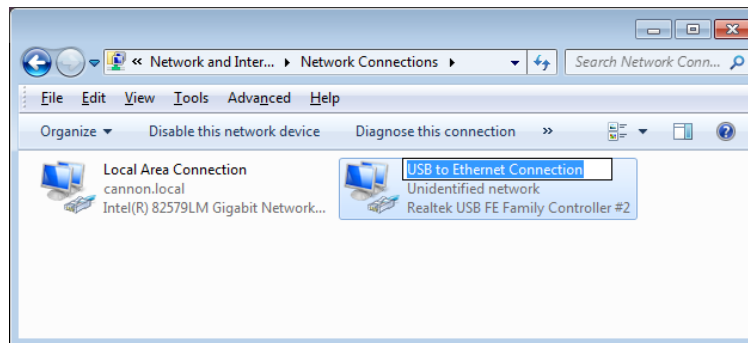
Registry Key	Default value	Description
EthernetPortNumber	1982	TCP port on which VISCPRO listens
EthernetServerIPAddress	10.0.1.2	IP address of the Ethernet connection that VISCPRO uses
MaxAllowedInstruments	4	Maximum number of instruments to which VISCPRO will connect. VISCPRO polls for instruments in sequential order of the InstrumentAddress. Once the maximum number of allowed instrument has been reached, it stops polling.
MaxPollResponseWaitTime	2000 (2 seconds)	Maximum time in milliseconds that VISCPRO waits for an instrument response when polling.
MaxResponseWaitTime	20000 (20 seconds)	Maximum time in milliseconds that VISCPRO waits for an instrument response.

## Setup Network Adapter

1. Open **Network and Sharing Center** on the PC.

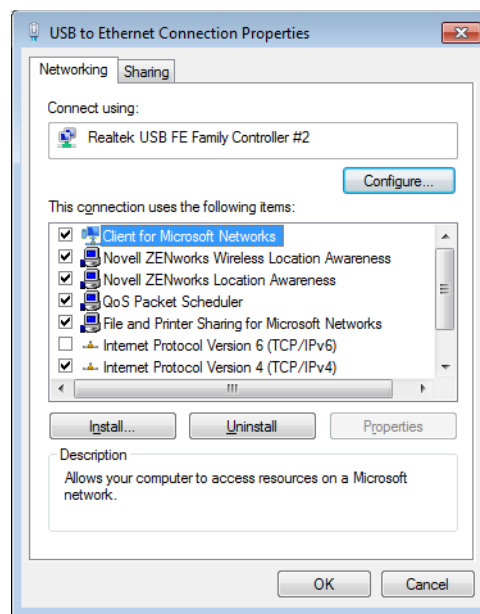


- Click **Change adapter** settings. This opens the **Network Connections** window. Right-click the device associated with the USB adapter and rename the connection **USB to Ethernet Connection**. Refer to Figure 51.



**Figure 51 — Network Connections**

- Right-click the connection and select **Properties**. This opens the **Connection Properties** window. Refer to Figure 52.

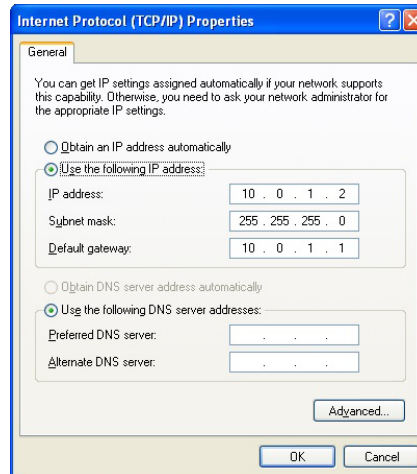


**Figure 52 — Connection Properties Window**

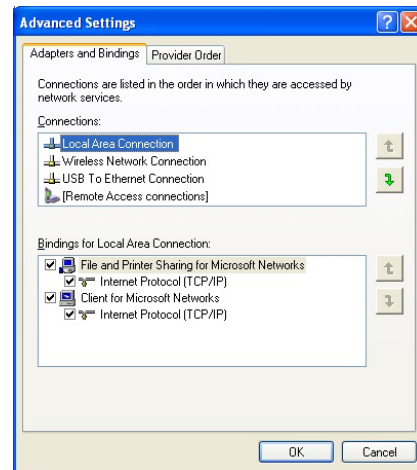
- Click **Configure**. The **Controller Properties** window opens.
- Select the **Power Management** tab. Uncheck **Allow the computer to turn off this device to save power**. Click **OK**.
- Right-click the connection and select **Properties**. The **Connection Properties** window opens.
- Uncheck **Internet Protocol Version 6 (TCP/IPv6)**.

8. Double-click **Internet Protocol Version 4 (TCP/IPv4)**. The **Internet Protocol (TCP/IP) Properties** window opens.

Set the IP address to *10.0.1.2*, the subnet mask to *255.255.255.0*, and the default gateway to *10.0.1.1*, then click **OK** to close the Internet Protocol (TCP/IP) Properties window. Refer to Figure 53 and Figure 54.



**Figure 53 — TCP/IP properties**



**Figure 54 — Advanced Settings**

9. Click **OK** to close the **Properties** window.
10. In the top **Network Connections** menu bar, click **Advanced > Advanced Settings**.
11. Move the *USB to Ethernet Connection* to the last connection position. Click **OK**.

## Configure Firewall Rules

The Windows® Firewall on the PC on which VISCPRO is installed must be configured to permit inbound, outbound, and ping communications on default port 1982.

1. If open, close VISCPRO.
2. Open **Control Panel > Windows Firewall > Advanced Settings**. This opens the **Windows Firewall with Advanced Security** window.
3. Configure an inbound rule:
  - In the upper left corner, click **Inbound Rules**.
  - In the upper right corner under **Actions**, click **New Rule**.
  - Select **Port**. Click **Next**.
  - Select **TCP** and **Specific local ports**. Enter **1982** in the port field.
  - Select **Allow the connection**. Click **Next**.
  - Check all boxes: **Domain**, **Private**, and **Public**. Click **Next**.
  - In the **Name** field, enter **Viscpro\_IN**. Click **Finish**.
4. Configure an outbound rule:
  - In the upper left corner, click **Outbound Rules**.
  - In the upper right corner under **Actions**, click **New Rule**.
  - Select **Port** and click **Next**.
  - Select **TCP** and **Specific local ports**. Enter **1982** in the port field.
  - Select **Allow the connection**. Click **Next**.
  - Check all boxes: **Domain**, **Private**, and **Public**. Click **Next**.
  - In the **Name** field, enter **Viscpro\_Out**. Click **Finish**.
5. Configure on inbound rule to respond to ping requests:
  - In the upper left corner, click **Inbound Rules**.
  - In the upper right corner, under **Actions**, click **New Rule**.
  - Select **Custom**. Click **Next**.
  - Select **All programs** and click **Next**.
  - Change **Protocol Type** to **ICMPv4**.
  - Click **Customize**.
  - Select **Specific ICMP types**.

- Check **Echo Request** and click **OK**. Click **Next**.
  - Select both **Any IP address** boxes. Click **Next**.
  - Select **Allow the connection**. Click **Next**.
  - Check all boxes: **Domain**, **Private**, and **Public**. Click **Next**.
  - In the **Name** field, enter *Ping In*. Click **Finish**.
6. Configure an outbound rule to send ping requests:
- In the upper left corner, click **Outbound Rules**.
  - In the upper right corner, under **Actions**, click **New Rule**.
  - Select **Custom**. Click **Next**.
  - Select **All programs** and click **Next**.
  - Change **Protocol Type** to **ICMPv4**.
  - Click **Customize**.
  - Select **Specific ICMP types**.
  - Check **Echo Request** and click **OK**. Click **Next**.
  - Select both **Any IP address** boxes. Click **Next**.
  - Select **Allow the connection**. Click **Next**.
  - Check all boxes: **Domain**, **Private**, and **Public**. Click **Next**.
  - In the **Name** field, enter *Ping Out*. Click **Finish**.
7. Close the **Windows Firewall with Advanced Security** window.

## Configure USB Power Settings

The Windows® Firewall on the controlling PC for VISCPRO must be configured to constantly provide power to the USB port for the **USB to Ethernet adapter**.

### USB Power Options

- Under **Control Panel > Power Options**, select **Change plan settings** for your power plan. Select **Change advanced power settings**:
- Under the **Hard Disk > Turn off hard disk after**, change the setting to **Never**.
- Under the **USB settings > USB selective suspend setting**, change the setting to **Disabled**.
- Under **Device Manager > Universal Serial Bus controllers**, double-click on the appropriate USB hub, select the **Power Management** tab, and uncheck **Allow the computer to turn off this device to save power**.

## CAV Registry Settings

The following registry keys are set up at CANNON prior to shipping and do not need to be adjusted for the initial installation. However, when reconfiguring a network or adding an additional CAV 4.1 to your setup, it may be necessary to change the **Instrument Address** and **Instrument ID** in order to avoid device collision.

The **Instrument Address** and **Instrument ID** values and the **Remote Client Name** can be edited from within the CAV 4.1 graphical user interface (GUI) which is the instrument touchscreen. Other values can only be changed by directly editing the registry. Refer to Table 12 for entry options.



**Caution:** *Editing registry entries may be hazardous to the proper operation of your Windows® installation.*

**Table 12 — CAV 4.1 Registry Entries**

Registry Key	CAV 4.1 GUI	Default value	Description
EthernetPortName	Remote Client Name	10.0.1.2	IP address of the Ethernet connection to which the instrument connects
InstrumentAddress	Instrument Address	1-4	Numeric address for the instrument
Instrument ID	Instrument ID	4	Instrument name
Serial Number	Serial Number	Text string	Instrument serial number
EthernetPortNumber	Not available	1982	TCP port on which VISCPRO listens



## In-Depth Operation

The CAV 4.1 can operate in either local or remote mode through the included software applications. In **Local Mode**, the CAV 4.1 GUI software program controls the instrument via the instrument touchscreen. In **Remote Mode**, a controlling computer with the VISCPRO II software program controls the instrument. Each of these programs is independent of the other and maintains its own data set. A data set consists of a run of tests, test results and error logs. Common instrument settings, method templates, and equipment status are shared between the programs.

The operating status of the CAV 4.1 is shown on the left-most button of the main screen menu of the CAV 4.1 GUI (touchscreen). This button toggles between **Local Mode** and **Remote Mode**. A green icon indicates that the instrument is connected to VISCPRO II. In **Remote Mode**, the **Users**, **Results**, and **Errors** action buttons are grayed to indicate that instrument operation cannot be managed from the CAV 4.1 touchscreen and to instead move to the computer and VISCPRO. Refer to Figure 55.










Figure 55 — CAV 4.1 Main Screen Menu

## CAV 4.1 GUI

The CAV 4.1 GUI is the software program shown on the touchscreen, embedded in the display hood of the CAV 4.1. The previous Getting Started section of this manual introduces the operator to the basic usage of the CAV 4.1 GUI. This section, including Table 13, provides more in-depth instructions.

**Table 13 — GUI Screen Details**

Area	Button	Action
Main screen menu	Local/Remote Mode	Toggles between the two control modes
	Users	Opens login menu
	Results	Opens local results log
	Errors	Opens local errors log
	Help	Opens help menu
Bath screen menu	Settings	Opens settings menu
	Tube Calibration	Opens tube calibration menu
	Methods	Opens methods menu
	Services	Opens services
Carousel	Positions 1 – 14	Each position displays the title of the sample. Click to configure a sample. Click center of carousel for bath options.
Screen sliders	Left/right arrows	Slides between screens
Status	Sensors	 Displays the status of the bath sensors: Red – unavailable; Green – covered; Gray – uncovered. Click to train sensors.
	TE Cooler	 Displays the status of the TE cooler. Click to turn on/off the TE cooler.
	Current temperature	 Displays the current bath temperature. Click to calibrate temperature.
	Target temperature	 Displays the target temperature. Click to set target temperature.
	Activity message	Displays current activity
	Preheater temperature	Displays current preheater temperature
Actions	Run/Stop	 Click to start or stop a run
	Wash	 Click to run a wash
	Pause	 Click to pause a run or wash



## VISCPRO II Software Interface

VISCPRO II is a Windows® software program comprising the general interface application and instrument/analysis-specific modules. A typical VISCPRO II interface displays an open instrument window, analysis log, application specific status window, and general information status windows, as shown in Figure 56.

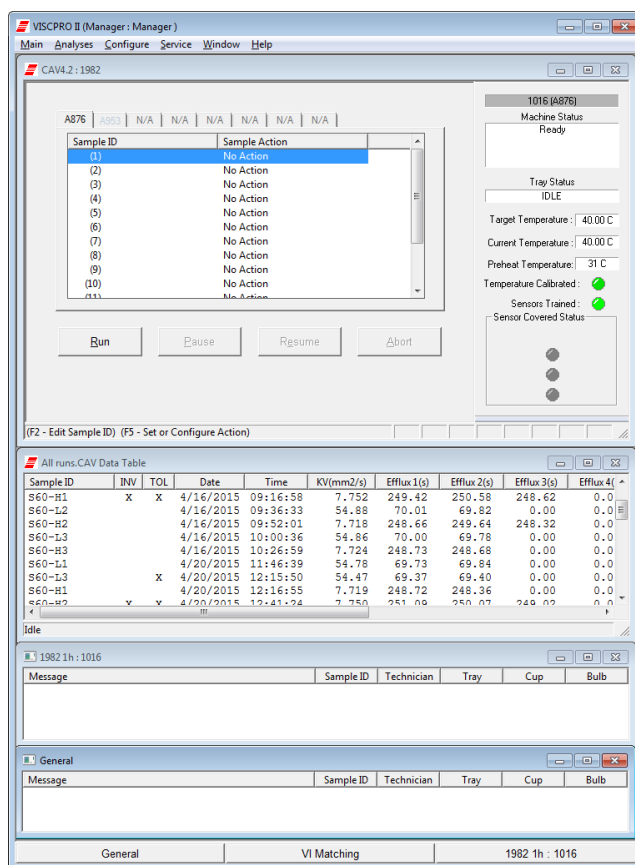


Figure 56 — VISCPRO Interface Window

Table 14 describes various software options.

**Table 14 — VISCPRO Window Details**

Area	Detail	Click to open a window for ...
VISCPRO II Menu	Main	... managing the VISCPRO application.
	Analyses	... displaying, configuring, and managing analysis logs.
	Configure	... configuring the settings of attached instruments.
	Service	... servicing an attached instrument.
	Window	... managing the open windows.
	Help	... managing VISCPRO help.
CAV 4.1 Instrument Window	Use this window to view the status of the instrument and manage sample test runs.	
Analysis Log	Displays a specific analysis report.	
Information Status Bar	General	Click to open the general information status window.
	VI Matching	Click to open the VI Matching information status window.
	<instrument>	Click to open a status window for a particular instrument.

## Manage User Accounts (VISCPRO II/CAV 4.1 GUI Touchscreen)

VISCPRO II and CAV 4.1 GUI user accounts are independent of each another. The VISCPRO II accounts are associated with the entire software installation and are not instrument specific.

Both VISCPRO II and the CAV 4.1 GUI Touchscreen start with three default accounts, as described in Table 15.

**Table 15 — Default User Accounts**

Username	Privilege Level	Privileges
CANNON Instrument Company	Service	Access to all instrument and security parameters. Call CANNON for the current password for the CANNON Instrument Company login.
Manager	Manager	Access to advanced configuration and reporting options
Unknown	Technician	Access to operational features required for testing samples and routine operations

VISCPRO II displays the username and privilege level of the active user in the title bar of the main window. If no user is logged in, VISCPRO II displays the default account - **Unknown: Technician**. The CAV 4.1 GUI does not display login status.

## Log In

Log in as soon as possible to avoid problems. Multiple users can be logged in at once. You can log in as another user even if you are already logged in.



**Note:** *The initial password for the Manager account is blank.*

1. **VISCPRO II:** click **Main > Log In**. The **Log In** window opens.  
**CAV 4.1 Touchscreen:** click **Users**. The **Login Menu** window opens.
2. Select the desired user. Type the corresponding password.
3. Click **OK**.

## Change Password

When using the touchscreen GUI, the user needing to change a password must be logged in. In other words, in order to change a password, you must be logged in as the user whose password you are changing. However, VISCPRO II allows a user with a higher privilege level to assign new passwords to other users and edit user accounts.

1. **VISCPRO II:** click **Main > Change Password**. The **Change Password** window opens.  
**CAV 4.1 Touchscreen:** click **Users > Change Manager Password**. Because new accounts cannot be created using the CAV 4.1 GUI, this is the only option.
2. Type the new password into the appropriate fields.
3. Click **OK** or select the green checkmark.

## Setup and Edit User Accounts

(**VISCPRO II** only) Service level users can setup and edit manager and technician accounts. Manager level users can setup and edit technician level accounts. The default account is not editable.

1. Click **Main > Update User Information**. The **Change User List** window opens.
2. Select the appropriate user. To create a new user, type a unique username.
3. If desired, assign a password to a user by typing a password into the appropriate fields. Or leave this field blank.
4. To assign a privilege level other than default Technician, select the desired level in the drop-down box.
5. Save changes by clicking **Add or Update User**.
6. To close the **Change User List** window, click **Done**.
7. To delete a user record from the database, click **Remove User**.

## Logout

It is not necessary to logout to change user accounts. Logging out does not close VISCPRO II, logging out just changes the login to the default **Unknown: Technician** account.

- **VISCPRO II:** click **Main** > **Logout**.  
**CAV 4.1 Touchscreen:** click **Users** > **Logout**.

## Connect VISCPRO II to the CAV 4.1

VISCPRO II and the CAV 4.1 must be set up and communicating to attempt to establish a connection. Refer to **Connecting with VISCPRO II**.



**Note:** *The preheat option is factory installed. This section is only applicable for instruments with the preheating option installed.*

## Preheat Option

The preheating option on the CAV 4.1 is controlled via tube settings and can be used on either carousel. Prior to activating the preheating, ensure that the carousel is filled with the provided metal sleeves. An induction heating process is used for preheating; therefore no foreign metal objects can touch or be near the glass cover. Use all proper laboratory procedures when handling hot surfaces.

**Warning:** *Preheating causes hot surfaces. Use caution and only touch appropriate components.*



*Always use the provided metal sleeves in carousel when preheating. Induction heating means no metal objects can be in close proximity or touching the glass beneath the carousel.*

*Tray is hot. Do not touch tray or carousel. Only move the tray using the black plastic handle in the center of the carousel.*

- For **VISCPRO II:** select **Configure** > **[instrument group]** > **[instrument]** > **Tray Settings: Tube**. The **Tray Settings** window opens.
- Select the correct tube and enter the appropriate number of duty cycle into the **Sample Cup Heater Duty Cycle, Parameter Value** field. Click **Save** and then **Close**.
- For **CAV 4.1 Touchscreen:** navigate to the **Bath Screen**, click **Settings** > **Tube**.
- Enter the appropriate number of duty cycle into the **Sample Cup Heater Duty Cycle** field. Click **Save** and then **Close**.



## VISCPRO II Instrument Set Up

1. Start VISCPRO II on the PC.
2. On the **CAV 4.1 Touchscreen**, touch the **Local Mode/Remote Mode** button to toggle the instrument state to **Remote**. The icon turns green to indicate that the CAV 4.1 is found and communicating with VISCPRO II.
3. In the **VISCPRO II** Menu, click **Main** and then **Poll for Instruments**. If an instrument is located, an associated message box is added to the status bar on the bottom of the VISCPRO II window.



**Note:** CAV 4.1 are grouped according to the Ethernet port number on which they communicate. Since VISCPRO II can only communicate on one Ethernet port at a time, there will be only one group of CAV 4.1 instruments.

4. Click **Main > View Instrument** and select the CAV 4.1 instrument group. The **CAV 4.1 Instrument Window** opens.



**Caution:** When multiple instruments (CAV 2100/2200, CAV 4.2, CAV 4.1) are connected to the same VISCPRO II application, verify that all instruments have completed their current operations before closing VISCPRO II.

### Set Bath Temperature (VISCPRO II)

1. In the **VISCPRO II Menu**, select **Configure > [instrument group] > [instrument] > Tray Settings: Temperature**.
2. Adjust the **Temperature Units**, **Target Temperature**, and **Temperature Tolerance**, as necessary.
3. Click **Save**; wait for the system to save the changes, and then click **Close**.
4. Wait for the bath to adjust to the new temperature.



**Note:** Temperature calibration, vacuum and pressure adjustment, and sensor training can easily be performed directly from the CAV 4.1 GUI Touchscreen.

Refer to previous section Set Bath Temperature (Touchscreen) for more information.

### Calibrate Temperature (VISCPRO II)

Calibrate the temperature of the CAV 4.1 whenever the instrument is moved, a new bath temperature is scheduled to be used, or the bath fluid is refilled. The instrument is calibrated by inserting a thermometer through an access hole in the display hood, measuring the actual temperature of the bath fluid, and entering that temperature into the CAV 4.1 software.

1. If raised, lower the display hood.
2. Carefully insert a thermometer through the access hole in the display hood and into the bath until the top of the thermometer is in the middle of the capillary portion of the viscometer tube. The thermometer passes through the same hole in the top of the bath unit that is used to fill the unit with fluid.
3. Wait for the thermometer to adjust to the temperature of the bath fluid. Read the reference temperature.
4. In the **VISCPRO II Menu**, select **Service** > [instrument group] > [instrument] > **Temperature Calibration**. The **Temperature Calibration** window opens.
5. Enter the reference temperature measured in step 3 in the **Reference Temperature** field.
6. Click **Calibrate**; wait for the system to save the adjustment, and then click **Done** to close the window.
7. Remove and clean the thermometer.

## Set Vacuum and Pressure (**VISCPRO II**)

Set the vacuum and pressure of the CAV 4.1 before running the instrument.

1. In the **VISCPRO II Menu**, select **Service** > [instrument group] > [instrument] > **Adjust Vacuum/Pressure**.
2. Follow the instructions on the screen to set the vacuum and then the pressure for the bath.

## Train Sensors (**VISCPRO II**)

Train the sensors whenever operating the CAV 4.1 bath at a new temperature. Once trained, the calibration values for a particular temperature are saved and will be recalled if the CAV 4.1 is set to run at that temperature again. Retraining for a particular temperature is only necessary when the viscometer tube is changed or if sensor performance changes over time.



**Note:** Sensor training uses **Test** and **Advanced** settings from the default method, but **Default Wash** settings.

1. Insert an empty vial into position 1 of the carousel.
2. Fill a vial with a test solution that has a viscosity approximately 3 times higher than the lower viscosity limit of the Ubbelohde tube. Insert the vial into position 2.
3. In the **VISCPRO II Menu**, select **Service** > [instrument group] > [instrument] > **Train viscometer tube sensors**. The **Train viscometer tube sensors** window opens.
4. (Optional) Check **Prewash** to run a wash cycle prior to training sensors.
5. (Optional) Check **Trip Points Only** to skip adjusting the power levels of the sensors.
6. Click **Start**.

## Run a Wash (VISCPRO II)

When necessary, washes may be run independent of a sample test.

1. In the **VISCPRO II Menu**, select **Service** > [instrument group] > [instrument] > **Wash viscometer tube**.
2. Select the tube to wash.
3. Select whether to use wash parameters from the last sample run or use default wash parameters.
4. The initial cup evacuation can be bypassed by checking the appropriate box.
5. Click **Begin Wash**.

## Run a Sample Test (VISCPRO II)

This procedure details how to run and configure various kinematic viscosity tests on the CAV 4.1 using VISCPRO II software.

1. Verify that the CAV 4.1 is running and has achieved steady-state temperature in the bath.
  - The status window displays **IDLE**. During warmup, **SEEKING TEMPERATURE** is displayed.
  - The current temperature and target temperature icons are green, indicating that the bath has been temperature calibrated at that temperature. If any other condition is indicated, refer to **Calibrate Temperature (VISCPRO II)**.
  - The tube sensor icons are all grey, indicating that the sensors are trained and uncovered. If any other condition is indicated, refer to **Train sensors**.
2. Connect VISCPRO II to the CAV 4.1:
  - a. Start **VISCPRO II** on the PC.
  - b. On the **CAV 4.1 Touchscreen**, touch the **Local Mode/Remote Mode** button to toggle the instrument state to **Remote**. The icon turns green to indicate that **VISCPRO II** has found the CAV 4.1 instrument.
  - c. In the **VISCPRO II Menu**, click **Main > Poll for Instruments**. If an instrument is located, an associated message box is added to the status bar on the bottom of the **VISCPRO II** window.
  - d. Click **Main > View Instrument** and select the CAV 4.1 instrument group. The **CAV 4.1 Instrument** window opens.



**Note:** Do not overfill the vials or the sample may overflow when the vial is raised into position and the viscometer tube displaces some sample.

3. Follow your laboratory practices to prepare 10 mL samples and load the vials into the carousel. 10 mL is half a vial.
4. Populate the sample run in VISCPRO II:
  - a. In the **CAV 4.1 Instrument** window, click on the tray tab.



- b. **Left-click** on the first tray position that is populated with a sample. The entire entry highlights blue.
  - c. **Left-click** the **Sample ID** field and enter a short description for the sample. Press **Enter**. The **Sample Action** field is populated with the default action ("Method") associated with the viscometer tube.
  - d. If the default action is **Verify Known KV**, the **Sample Configuration** window opens automatically. Enter the kinematic viscosity value (cSt) of the sample as the **Parameter Value** of **Check Standard KV**. When finished, click **Save**, and then **Close**.
  - e. Continue entering data in the remaining positions. Press **ESC** to stop entering data.
5. To edit or customize the sample action for a particular tray position, right-click anywhere on the row to open the editing menu.
  - **Shift-left-click**—to select a contiguous range of entries.
  - **Ctrl-left-click**—to select multiple entries.
  - **Configure**—enables editing of all values for the selected entry. These localized changes do not affect the default values of the sample action ("Method").
  - **Sample Actions**—selecting a new action (method template) replaces the existing action. All localized changes are lost.
  - **Delete**—deletes the selected entry. All following entries are decreased one position.
  - **Insert At**—inserts a new entry into the carousel at the active position. All following entries are advanced one position.
  - **Copy All Selected Samples**—copies selected entries to the clipboard.
  - **Paste Into Selected Samples**—pastes all entries that were copied to the clipboard into the carousel at the highlighted positions. Existing entries are overwritten, not moved.

**Note:** Several additional actions are available from the right-click editing menu:

- **Sequential Sample IDs**—use this action to populate sequential Sample ID fields.
- **Save Tray to Archive**—saves the current tray (carousel) to an archive file. You can copy the complete set of entries from one tray to another.
- **Restore Tray from Archive**—restores a previously saved tray.
- **Delete Tray from Archive**—opens the archive to allow deleting saved trays.



6. Click **Run**. The **Select Trays** window opens.
7. Select the trays to run. Click **OK**. The CAV 4.1 begins running the selected trays. Additional samples may be added to the trays until the run completes.
  - **Pause**—opens a selection window. Pausing a tray "Now" immediately halts all actions for that tray. If a test is halted prior to the start of the wash cycle, the data for that sample is discarded.

- **Resume**—opens a selection window to resume operation for selected trays.
  - **Abort**—opens a selection window to abort all activity for selected trays.
8. When each test completes, the measured KV is shown in the **Sample Action** field. Once the entire test run finishes, the tray pauses. No additional samples may be added to the run. Click **Resume** to clear all data for the active tray.

## View Test Results (VISCPRO II)

Data obtained during sample testing is temporarily displayed in the **Sample Action** field and permanently stored in the database, which may be viewed by opening an analysis package.

Tests must finish running before they can be viewed. The entire tray does not need to have finished, but individual results are only available in the database after they have completely finished.

1. In the **VISCPRO II Menu**, select **Analyses > View Analysis**. The **Choose Analysis** window opens.
2. Open **Basic Package** and select **CAV Data Table**.
3. Select the **Open Select Analysis Configuration** radio button.
4. Select an analysis and click **OK**.



## Advanced Setup



**Note:** You must be logged in as a Manager (CAV 4.1 GUI or VISCPRO) to perform advanced procedures.

### Calibrate Viscometer Tube (VISCPRO II)

Viscometer tube calibration values are associated with specific temperatures. A calibration must be performed any time the CAV 4.1 bath is operating at a new temperature. Once the tube is calibrated at a particular temperature, the instrument saves the C and E constant values. The values are then automatically recalled if the tube is run at that temperature again.

1. Assemble a set of standard oils with known kinematic viscosities, using at least different two standards for each bulb being calibrated. The CAV 4.1 is designed to run "thin" standards (those with viscosities less than 10X the lower limit of the viscometer tube) in two bulbs, while "thick" standards (those with viscosities greater than 10x the lower limit of the viscometer tube) run in only the lower bulb.
2. Follow the procedures in **Run a Sample Test (VISCPRO II)** to prepare, load, and run all of the calibration standards with setting **Verify Known KV**.
3. When all tests are complete, using the **VISCPRO II Menu** select **Configure** > **[instrument group]** > **[instrument]** > **Tube Calibration**. The **Tube Calibration** window then opens.
4. Select the tube and the bulb to calibrate.
5. Select the desired date range from which to retrieve test data.
6. Select the sample entries to use for calibration. Select at least two entries for the software to recalculate the constants.
  - **Shift-left-click**—selects a continuous range of entries.
  - **Ctrl-left-click**—selects multiple entries.
7. Select **Calculate new constants**. The new C and E constants display in their respective fields.
  - Evaluate the accuracy of the new calibration constants for each standard by comparing the **Known Viscosity** with the **Calculated Viscosity**. This difference is displayed as a percentage in the **% Difference** column. Repeat the calibration by selecting other sample entries.
  - Check **Limit E Constant** before calculating constants to limit the E constant to no more than 10000.
8. When the new calibration constants are acceptable, select **Update bulb**. This saves the C and E constants and calibration data to the local database and updates the constant values in the CAV 4.1 registry.

## Method/Test Settings

Method templates are stored in the CAV 4.1 registry. When VISCPRO II software connects with a CAV 4.1 instrument, the method templates in the instrument are pushed to VISCPRO II. Any changes made to the method templates in VISCPRO II synchronize with the instrument. No method templates are permanently stored within VISCPRO II.

All method templates have the same set of fields. However, when the **Verify Known KV** method is applied to a sample test, the **Check Standard KV** value is added to the information set for that test. Verify Known KV must be used when running a calibration sample test.

## Print Method Settings

- For **VISCPRO II**: select **Configure** > [instrument group] > [instrument] > **Print Instrument Settings**. The **Select Methods to Print** window opens.
  - Select the desired methods to print. **Shift-left-click** selects a continuous range of entries; **Ctrl-left-click** selects multiple random entries.
  - Click **OK**. The print dialog box opens.
- For **CAV 4.1 GUI Touchscreen**: navigate to the **Bath Screen**, click **Methods**.
  - Select the method. Click **Export** and follow the on-screen instruction to export the method settings as a text file to a USB drive.

## Edit Method Settings

- For **VISCPRO II**: select **Configure** > [instrument group] > [instrument] > **Method Settings**. The **Select Methods** window opens.
  - Select the tube and method to edit.
  - Click **OK**. The **Method Settings** dialog box opens.
- For **CAV 4.1 Touchscreen**: navigate to the **Bath Screen**, click **Methods**.
  - Select the method to edit. Refer to Table 16—Table 19.

**Table 16 — Method Settings: Test**

Parameter name	Description
Wet Tube	Runs an initial, unrecorded sample drop to coat the inside of the tube with the sample material.
Soak Time Units	Time unit in seconds, minutes, or hours
Bulb1 Soak Time	Time to thermal soak a sample that draws only into bulb 1.
Bulb2 Soak Time	Time to thermal soak a sample that draws only into bulb 2.
Bulb3 Soak Time	Time to thermal soak a sample that draws only into bulb 3.

**Table 17 — Method Settings: Wash**

Setting	Description
Bulb1 Solvent A Washes	Number of solvent A washes for samples run in only bulb 1
Bulb1 Solvent B Washes	Number of solvent B washes for samples run in only bulb 1
Bulb1 Solvent C Washes	Number of solvent C washes for samples run in only bulb 1
Bulb2 Solvent A Washes	Number of solvent A washes for samples run in bulbs 1/2
Bulb2 Solvent B Washes	Number of solvent B washes for samples run in bulbs 1/2
Bulb2 Solvent C Washes	Number of solvent C washes for samples run in bulbs 1/2
Bulb3 Solvent A Washes	Number of solvent A washes for samples run in bulbs 1/2/3
Bulb3 Solvent B Washes	Number of solvent B washes for samples run in bulbs 1/2/3
Bulb3 Solvent C Washes	Number of solvent C washes for samples run in bulbs 1/2/3
Maximum Solvent A Fill Time	Max time (sec) to fill the solvent bulb with solvent A
Maximum Solvent B Fill Time	Max time (sec) to fill the solvent bulb with solvent B
Maximum Solvent C Fill Time	Max time (sec) to fill the solvent bulb with solvent C
Solvent A Injection Time	Time (sec) that solvent A is injected after bulb empties
Solvent B Injection Time	Time (sec) that solvent B is injected after bulb empties
Solvent C Injection Time	Time (sec) that solvent C is injected after bulb empties
Cup Empty Time	Time (sec) to empty cup of sample at start of wash cycle
Tube Tip Soak Time	Time (sec) for tip to soak after solvent injection
Solvent Evacuation Time	Time(sec) to empty cup of solvent after soaking
Final Air Dry Time	Time(sec) to force air dry A-Pipe at end of wash cycle
Wash B-Pipe	Specify washing B-Pipe
B-Pipe Solvent A Washes	Number of solvent A washes for B-Pipe
B-Pipe Solvent B Washes	Number of solvent B washes for B-Pipe
B-Pipe Solvent C Washes	Number of solvent C washes for B-Pipe
B-Pipe Dry Time	Time(sec) to force air dry B-Pipe

**Table 18 — Method Settings: Advanced**

Setting	Description
Maximum Bulb 1 Fill Time	Maximum time (sec) to fill bulb 1
Minimum Bulb 1 Select Time	Time (1/10 sec) used to determine whether the sample runs in bulb 1 or bulb 2. Bulb 1 is selected if the efflux exceeds this time
Minimum Bulb 2 Fill Time	Maximum time (sec) to fill bulb 2
Maximum Bulb Empty Time	Maximum time (sec) for the sample to drop between the target sensor and the bottom sensor
Tube Empty Time	Percentage of the bulb 1 efflux time that is used to empty the tube after the bottom sensor becomes uncovered
Bulb 1 Overdraw Time	Time (sec) that the sample is pulled past the target sensor during a bulb 1 sample fill
Bulb 2 Overdraw Time	Time (sec) that the sample is pulled past the target sensor during a bulb 2 sample fill
Bulb 3 Overdraw Time	Time (sec) that the sample is pulled past the target sensor during a bulb 3 sample fill
Sample Draw Delay	Time (sec) after the sample cup is raised before sample is drawn into the tube
Bulb 1 Vent Drain Time	Time (sec) for a bulb 1 sample between when the tube vent is opened to atmosphere and the sample efflux starts
Bulb 2 Vent Drain Time	Time (sec) for a bulb 2 sample between when the tube vent is opened to atmosphere and the sample efflux starts
Bulb 3 Vent Drain Time	Time (sec) for a bulb 2 sample between when the tube vent is opened to atmosphere and the sample efflux starts

**Table 19 — Method Settings: Drop Criteria**

Setting	Description
Maximum Determinations	Maximum number of efflux determinations to run when trying to match a set
Required Determinations	Number of valid efflux determination needed to produce a matched set
Maximum % Difference	Maximum percent difference between efflux determinations to be considered for inclusion in a matched set
Maximum Efflux Difference	Maximum efflux difference between efflux determinations to be considered for inclusion in a matched set
Drop Criteria Mode	Determines how the efflux determination is selected for inclusion in a matched set
Use Percent Difference	Stipulates that a positive match between two determinations is dependent upon the percent difference between the two
Use Efflux Difference	Stipulates that a positive match between two determinations is dependent upon the efflux difference between the two
Use Either	If 'Use Percent Difference' and 'Use Efflux Difference' are both set, then if true, a match between two determinations is made if either criteria is met. if false, both criteria must be met to produce a matched set.

## Adjust Default Wash Settings

- For **VISCPRO II**: select **Configure** > [instrument group] > [instrument] > **Tray Settings: Default Wash**. The **Tray Settings: Default Wash** window opens.
  - Select the tube to edit.
- For **CAV 4.1 Touchscreen**: navigate to the **Bath Screen**, click **Settings > Default Wash**.

## Create a Standard CAV Data Table Analysis (VISCPRO II)

The software uses an analysis to view detailed data stored in the VISCPRO II database.

- Select **Analysis** and then **View Analysis**. The **Choose Analysis** window opens.
- Open **Basic Package**.
- Click on **CAV DATA Table**.
- Select **Define and Open New Configuration**. Click **OK**. The **CAV Analysis Configuration** window opens.
- In the **Date Filter** tab, set the appropriate range for the data to be displayed.
- In the **Sample Filter** tab, set the filters on the type of data to be displayed.
- In the **Report** tab, select the data items to display (refer to Table 20):



**Table 20 — CAV Data Table Fields**

Setting	Description
Sample ID	Descriptive name given to the sample
INV	Invalid test indication
TOL	(Tolerance) Acceptable difference in multiple test results for the test
Date	Date the test was run
Time	Time the test was run
Tube S/N	Tube serial number
Tray	Bath number
Smple Index	Sample position
Bulb	Bulb in which the sample ran
Technician	The technician logged into VISCPRO when the test was run
Instrument Type	Instrument type (CAV, CCS, etc.)
Instrument ID	Instrument identification, from <a href="#">Instrument Settings</a>
Comment	Displays comments associated with the sample
Method Name	Name of the method used to run the sample
KV	Average kinematic viscosity of the sample
% KE	% contribution of the kinetic energy correction to the measured viscosity
Known KV	Value entered for the known KV of the sample
% Diff KV	% difference between the measured KV and the known KV
Temp	Average bath temperature
T1-T4	Times for the valid effluxes used in the calculations
% Diff	(Max efflux time – Min efflux time)/average efflux time
Abs. Diff	Max efflux time – Min efflux time
{1,10} Efflux %d	Adds the first 10 efflux times to the analysis
{1,20} Efflux %d	Adds the first 20 efflux times to the analysis
Avg Efflux	Average efflux time calculated using valid effluxes
C	C constant of calibration
E	E constant of calibration
SUS	Saybolt Furol Seconds calculation
Display Kinematic Viscosity Data	Displays samples not run with Verify Known KV method (when checked)
Display KV Check Data	Displays sample run with Verify Known KV method (when checked)
Max KV % Difference	When the <b>% Diff KV</b> exceeds this value, <b>X</b> is displayed in the <b>TOL</b> column

8. Click **OK**. The software prompts user to save the analysis.
  - If selecting **YES**, the analysis is displayed after it is saved.
  - If selecting **NO**, the analysis displays, but is not saved.



## Maintenance and Service

CANNON recommends that problems and operation issues are reported to, and performed by, CANNON certified service personnel. However, there are some troubleshooting and minor maintenance issues that can be performed by operators experienced with the CAV 4.1.

### Update CAV 4.1 Software and Firmware

Software and firmware code updates may occasionally need to be manually installed on the CAV 4.1 user-interface, controller boards, and controlling PCs. There are four types of code that can be installed:

- **UI updater:** this software is the complete UI updater program (UpdateUI.exe) that runs on the CAV 4.1. It is used to install the UI software and firmware updates. It is updated by copying it over the existing UpdateUI.exe.
- **CAV 4.1 GUI software:** this software is the CAV 4.1 user-interface. To update the CAV 4.1 GUI software, log out of the user-interface and run the UI updater instead.
- **Firmware updates:** this code controls the bath, sample handlers, and valve controls. It is installed directly onto the respective controller boards using the UI updater.
- **VISCPRO II:** this software is installed on the controlling PC.

### Tools and Materials Required

The following tools and materials are required to update the software and firmware:

- #2 Philips screwdriver
- Software/firmware updates
- USB Type A-Male to Mini B cable (6ft)
- USB flash drive
- USB keyboard

### Prepare the USB Flash Drive

A USB flash drive must be loaded with the software and firmware to be updated.

1. On a PC, download the update packages from the CANNON website Downloads Page [www.cannoninstrument.com/downloads](http://www.cannoninstrument.com/downloads)
2. Unpack and copy the update files to the USB flash drive. Only **one** set of files can be on the USB flash drive during an update.

### Replace the UI Updater

1. From the GUI, click **Help > Upgrade UpdateUI**.
2. Plug the prepared USB flash drive into the USB connection.
3. Follow the instructions on the screen.

## Update the UI Software



**Note:** A video of this procedure is available on CANNON's YouTube channel.

<https://www.youtube.com/c/Cannoninstrument>

1. Using the touchscreen, click **Help** and then **Upgrade Instrument**. Click **OK**. The bath is placed into Bootloader mode (orange lights), and the Windows® login screen displays.
2. Plug the prepared USB flash drive into the USB connection port.
3. Click **Updates**. This runs the `UpdateUI.exe` program, which opens into the update shell.
4. Click **Update Software**. A **File Open** dialog opens.
5. Select and run the `setup.exe` program in the CAV UI update directory on the proper drive (E).
6. Follow the instructions provided by the setup program.
7. Select **Save And Exit**. The instrument reboots several times, but the bath lights remain orange indicating that they are still in Bootloader mode.
8. After the CAV finishes its rebooting routine, power cycle the unit by completely turning it off using the power switch on the hood. Wait 10 seconds, and then turn it back on.

## Update the Controller Firmware



**Warning:** Be careful not to touch any moving parts or live wires in the CAV 4.1.



**Note:** A video of this procedure is available on CANNON's YouTube channel.

<https://www.youtube.com/c/Cannoninstrument>

1. Slide the trays out and remove the carousels.
2. With the Philips screwdriver, remove the screws securing the corner panels.
3. Remove the corner panels. Remove the center panel. Raise the lid. Push the trays in.
4. From the touchscreen GUI, click **Help** and then **Upgrade Instrument**. When prompted, confirm this action.
5. Click **OK**. The bath is placed into Bootloader mode (orange lights), and the Windows® login screen displays.
6. Click **Updates**. The update shell opens.
7. Plug the prepared USB flash drive into the USB connection port on the rear of the instrument.
8. Click **Update Firmware**.
9. Select the type of controller to update. Windows® Explorer opens.

10. Using the GUI touchscreen, select and open the firmware update in the firmware update directory on the E: drive.
11. Remove the USB flash drive.
12. To update a sample handler or valve controller, connect a USB cable between the USB connection and the controller board. The bath controller can be updated without connecting them with a USB cable.
13. Repeat steps 7 through 10 as necessary to update the applicable controller boards.
14. Click **Save And Exit**.
15. Power cycle the unit by completely turning it off with the power switch on the hood, waiting 10 seconds, and then turning it back on.

## Update the VISCPRO II Software

Run the VISCPRO II installation program. Follow all instructions in the installation on-screen prompts.

## Change Viscometer Tube



**Warning:** *Do not attempt to drain the bath fluid until the bath has cooled to ambient or a safe temperature.*

1. Turn off the CAV 4.1 and allow the bath to cool to ambient/room temperature.
2. Drain the silicone bath fluid into a clean container. Save the fluid to refill the bath.
3. Raise the hood.
4. Note the solvent line connections for future reconnection. Gently unscrew the solvent lines from the top of the viscometer tube.
5. Disconnect the sensor cable by gently pulling it straight up.
6. Unscrew the thumb screws until they spring free of the bath top.
7. Gently draw the viscometer tube straight up and out of the bath.
8. Inspect the new viscometer tube for defects, especially small chips on the top and bottom of the tube. These can cause vacuum leaks and problems with solvent contamination.
9. Clean the bottom of the new tube and apply a light coating of silicone bath fluid.
10. Gently lower the viscometer tube into the bath and press it into the cone of the tube tip in the bottom of the bath. The viscometer tube must pass through two O-rings in the cone and sit gently on the top of the metal tube tip. Failure to seat the viscometer tube properly may result in poor performance.
11. Press the top bracket into position and evenly tighten the thumb screws.
12. Verify that the bath drain set screw is tight, and then refill the bath with silicone bath fluid.

13. Connect the solvent lines and sensor cable.
14. Turn the CAV 4.1 ON.
15. In **Tube Settings**, enter the name of the new tube.
16. If necessary, adjust and calibrate the temperature of the bath. If the temperature has not changed, temperature calibration is not necessary.



**Note:** *Sensor training data is associated with the temperature setting of the bath. When a tube is changed and the bath temperature is either kept the same or changed to a temperature at which a tube was previously trained, the CAV displays that the sensors are trained. This is correct. The sensors must be trained whenever a tube is changed.*

17. Train the sensors.
18. Verify the **Default Wash** and **Method Settings**, especially **Verify Known KV**, for the bath.
19. Calibrate the new viscometer tube.

## Replace Power Supply

The CAV 4.1 power supply is a switching regulated power supply designed to handle 90 – 240 VAC. To accommodate different locations, only the MAINS AC power cable needs to be changed.



**Caution:** *The power supply is easy to replace. The side panels do not need to be removed to access the power supply attachment point. It is not connected via cable. Instead, a mating coupler is attached to a bulkhead in the chassis.*

1. Turn off the CAV 4.1 and unplug it from the MAINS AC power.
2. Remove the power cable.
3. Remove the four screws securing the power supply assembly to the chassis.
4. Firmly pull the power supply assembly from the chassis.



## Warranty

### Products Limited Warranty

In addition to other manufacturers' warranties, Cannon Instrument Company ("the Company") warrants all products (other than reagents and chemicals) delivered to and retained by their original purchasers to be free from defect in material and workmanship for one year from the date of the Company's invoice to the purchaser. For a period of one year from the date of such invoice, the Company will correct, either by repair or replacement at the Company's sole discretion, any defect in material or workmanship (not including defects due to misuse, abuse, abnormal conditions or operation, accident or acts of God, or to service or modification of the product without prior authorization of the Company) without charge for parts and labor. The determination of whether any product has been subject to misuse or abuse will be made solely by the Company.

The Company shall not be liable for any special, incidental, or consequential damages, or any damage to plant, personnel, equipment or products, directly or indirectly resulting from the use or misuse of any product. Representations and warranties made by any person, including dealers and representatives of the Company, which are inconsistent, in conflict with, or in excess of the terms of this warranty shall not be binding upon the Company unless placed in writing and approved by an officer of the Company.

### Reagent and Chemical Warranty

Cannon Instrument Company ("the Company") warrants all reagents and chemicals sold by the Company and delivered to and retained by their original purchasers to conform to the weight, specifications and standards stated on the package. The Company will, at its sole option, either replace or refund the price (net of freight, handling charges and taxes), of any reagent or chemical sold by the Company which does not conform to such weight, specifications and standards upon the prompt return of the unused portion. Except for replacement or refund of the net price, the Company shall not be liable for any damages occurring as a consequence of the failure of any reagent or chemical sold by the Company to conform to the weight, specifications and standards stated on the package.

### Returning a Product to CANNON

Before returning a CANNON product for repair or service, make every attempt to identify the problem. If, after careful checking, the problem remains unidentified or unsolved, telephone CANNON Instrument Company (or the local service agent) to consult with a product specialist. If the specialist cannot recommend a simple solution or repair, CANNON will authorize the return of the product through the issuance of a Return Authorization number (RA).

- CANNON Telephone Number: 814-353-8000
- CANNON email: [info@cannoninstrument.com](mailto:info@cannoninstrument.com)

Products returned to CANNON must be carefully packed. Ship prepaid to the following address:

CANNON Instrument Company  
ATTN: Return Authorization # \_\_\_\_\_  
2139 High Tech Road  
State College, PA 16803 USA

The following information must be included with the return shipment.

### **Required Information**

- The Return Authorization number (RA).
- The name and telephone number of the person at your company to contact regarding the product.
- Shipping and billing instructions for the return of the product to your location.
- A detailed explanation of the reason for the return. If the product is not covered by warranty, the customer will be provided with an estimate of the repair costs and asked for approval before any repairs are made. The customer will be required to issue a purchase order for the cost of the repairs.

### **Hazardous Materials**

Please contact CANNON before returning a product that could possibly contain hazardous material.

### **Shipping Notification**

Products returned without CANNON's prior authorization will not be accepted. The customer may be billed a testing fee if a product is returned to CANNON and found to be working properly.





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