QUV

# QUV Accelerated Weathering Testers

QUV/se, QUV/spray, QUV/spray/rp, QUV/cw

Serial Numbers: XX-XXXXX-93

Manual

Q-LAB

Revision Date

1 Sep 2020

## Table Of Contents

# 1. Specifications, Classifications, Symbols

## 1.1. Specifications, Classifications (Apr 2019)

- The recommended ambient operating temperature and relative humidity (RH) for QUV testers is 23 ± 5 °C and 50 ± 25% RH.
- Operating outside the recommended range (or in rare cases, even within it), certain standards or test cycle conditions may not be achievable.
- This can result in the tester producing chamber temperature and/or humidity faults.
- Never operate your tester in lab temperatures >40 °C or >80% RH.
- Operating Humidity: Non-Condensing
- Ventilation: The QUV adds 700 watts (2400 BTU/hr) and 5 liters of water per day to room air. Locate away from drafts.
- Weight: 136 kg (300 lbs).
- Installation Category: Category II for transient over-voltages.
- Pollution Control: Pollution Degree 2.
- Sound Pressure Level: Sound Pressure Level does not exceed 74 dBA.
- Altitude: 2000 meters or less.
- Operation: Continuous Rating
- Voltage: 120 V or 230 V (as stated on the nameplate) ± 10% - single phase.
- Current: 16 A for 120 V testers. 8 A for 230 V testers.
- Frequency: 50 or 60 Hz.
- Supply Connection: Permanently connected or plug/socket connection (industrial type per IEC 60309 or twist lock type in North America).
- External Disconnect: Required for all connections.
- External Over-Current Protection: Must be rated for not more than 40 A (USA, Canada) or 64 A (Europe).

## 1.2. Symbols (Dec 2015)

**Electrical Shock Hazard**

**Hot Surfaces Hazard**

**Attention**

**Ultraviolet Light Hazard**

**Local Waste & recycling regulations per the WEEE Directive 2002/96/EC on Waste Electrical and Electronic Equipment**

# 2. Safety Information

Q-Lab accepts no responsibility for the consequences if the user fails to comply with the instructions in this technical manual. Q-Lab will accept responsibility for defective parts or components only if the machinery was defective at the time that the tester was shipped.

- This manual does not claim to address potential safety issues, if any, associated with the use of this product.
- It is the responsibility of the user of this manual to establish appropriate safety and health practices and to determine the applicability of regulatory limitations prior to use.
- If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment safety devices may be impaired.
- The QUV meets the European Low Voltage Directive 2014/35/EU and complies with the requirements of EN61010-1: 2010 (Third Edition), “Safety of Electrical Equipment for Measurement, Control and Laboratory Use.”
- The QUV meets the European Electromagnetic Directive 2014/30/EC and complies with the requirements of EN 55011:2007 Radiated and Conducted Emissions – class A.
- Use only parts that have been supplied or recommended by Q-Lab.

## 2.1. Electrical Shock Hazard (Aug 2008)

- The QUV uses 400 volts to operate its fluorescent ultraviolet (UV) lamps.
- This voltage is extremely dangerous.
- Interlock switches remove power to the UV lamps when end covers are removed (Figure 2.1).

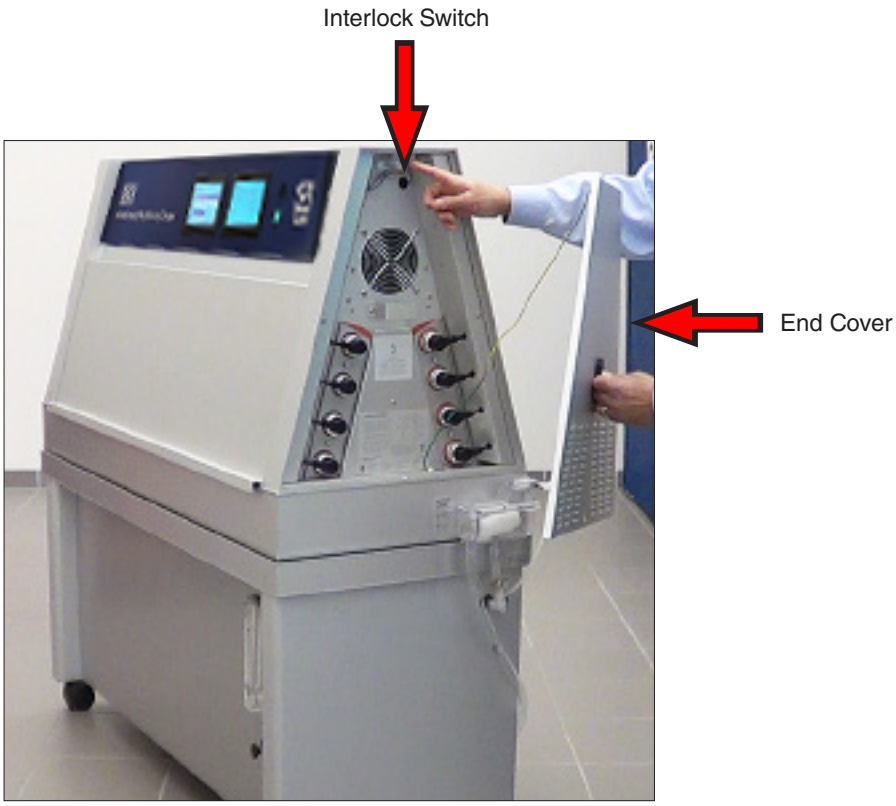



Figure 2.1: Power off to lamps when end covers removed.

## 2.2. Ultraviolet Hazards (Aug 2020)

- There is no Ultraviolet (UV) hazard from a QUV tester in normal operation with the doors closed.
- QUV front and rear swing-up doors are equipped with interlock switches which shut off the UV lamps when either door is opened.
- Always STOP the test before opening QUV doors and removing test panels.
- Never look at lighted UV lamps without UV-absorbing goggles.
- Sunburn and eye inflammation are delayed reactions. Symptoms (pain, redness, hot sensation) may appear 4 to 12 hours after UV exposure.
- Threshold Limit Values (TLV) for UV exposure are published by the American Conference of Governmental Industrial Hygienists. The Threshold Limit Values should be used as guides for control of UV exposure.
- If exposure to UV lamps is necessary, wear UV-absorbing goggles. Protect skin with opaque clothing or a quality sunscreen lotion (e.g. 5 percent PABA).
- Individuals with light complexion are more susceptible to UV, and some individuals are allergic to UV. Many common medications increase your sensitivity to UV (including sunlight).
- Do not use QUV UV lamps for any purpose except QUV testing.
- When discarding the lamps, disable them to prevent unauthorized use.
- To disable, remove two of the end-pins with a wire cutter or pliers (do not break lamps).
- UV lamps are not useful for plant growth or similar purposes.
- For QUV testers equipped with optional quadrant boxes (Part Nos. V-60301-K and V-60292-K), an optional door interlock kit (Part No. V-60353-K) is available for the right front end of the QUV tester.
    - The door interlock shuts off the lamps if a quadrant box is removed from either end of the QUV tester.
    - The interlock is typically factory-installed with new QUV testers that have the 3D quadrant boxes.

**Warning - Risk of Burns. Limit Exposure. Use Protective Gear.**

## Threshold Limit Value (TLV) exposure limits:

- One sample holder removed.
- Hand 50 mm from lamps (same as sample).
- Allowable daily exposure is 1 minute.

Figure 2.2a: Hand Exposure-One Holder Removed

- One sample holder removed.
- Hand 30 cm from lamps: allowable daily exposure 6 minutes.
- Face 1.0 m from lamps, allowable daily exposure 18 minutes.

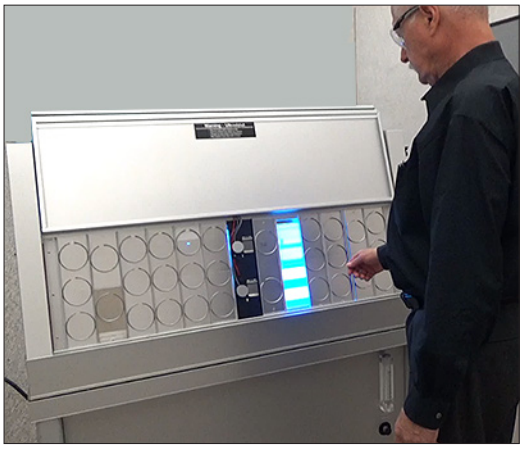


Figure 2.2b: Hand & Face Exposure-One Holder Removed

- All sample holders removed.
- Hand 30 cm from lamps: allowable daily exposure 2 minutes.
- Face 1.0 m from lamps, allowable daily exposure 6 minutes.

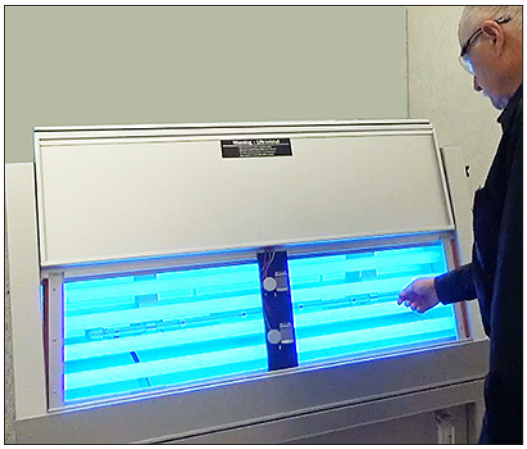


Figure 2.2c: Hand & Face Exposure-All Holders Removed

## 2.3. Disposal (Apr 2012)

- Dispose of UV lamps in accordance with local regulations.
- When disposing of the QUV, please follow local regulations.
- Components such as UV lamps, lithium batteries, or electronic assemblies may be restricted items for ordinary disposal.

# 3. General Description (Jul 2020)

- The LU-8047-TM QUV Technical Manual provides detailed information on the QUV/se, QUV/spray, QUV/spray/rp and QUV/cw models.
- For information on the QUV/basic model see LU-8047B-TM.

## Overview

- QUV Accelerated Weathering Testers simulate the damaging effects of sunlight, rain, and condensation on test specimens.
- Rain and dew are simulated by a condensation system and/or a water spray system.
- Fluorescent UV lamps simulate sunlight.
- Exposure temperature is automatically controlled, as is the daily sequence of UV periods, condensation and spray.
- The QUV can produce effects that might occur over months or years of outdoor exposure in days or weeks..

## QUV Models Description

- QUV/se: UV light with SOLAR EYE irradiance control, condensation, and dual touchscreen user interface.
- QUV/spray: UV light with SOLAR EYE irradiance control, condensation, water spray, and dual touchscreen user interface.
- QUV/spray/rp: UV light with SOLAR EYE irradiance control, condensation, water spray, integrated water repurification system, and dual touchscreen user interface.
- QUV/cw: cool white visible light with SOLAR EYE irradiance control, condensation, and dual touchscreen user interface.

## QUV Major Components

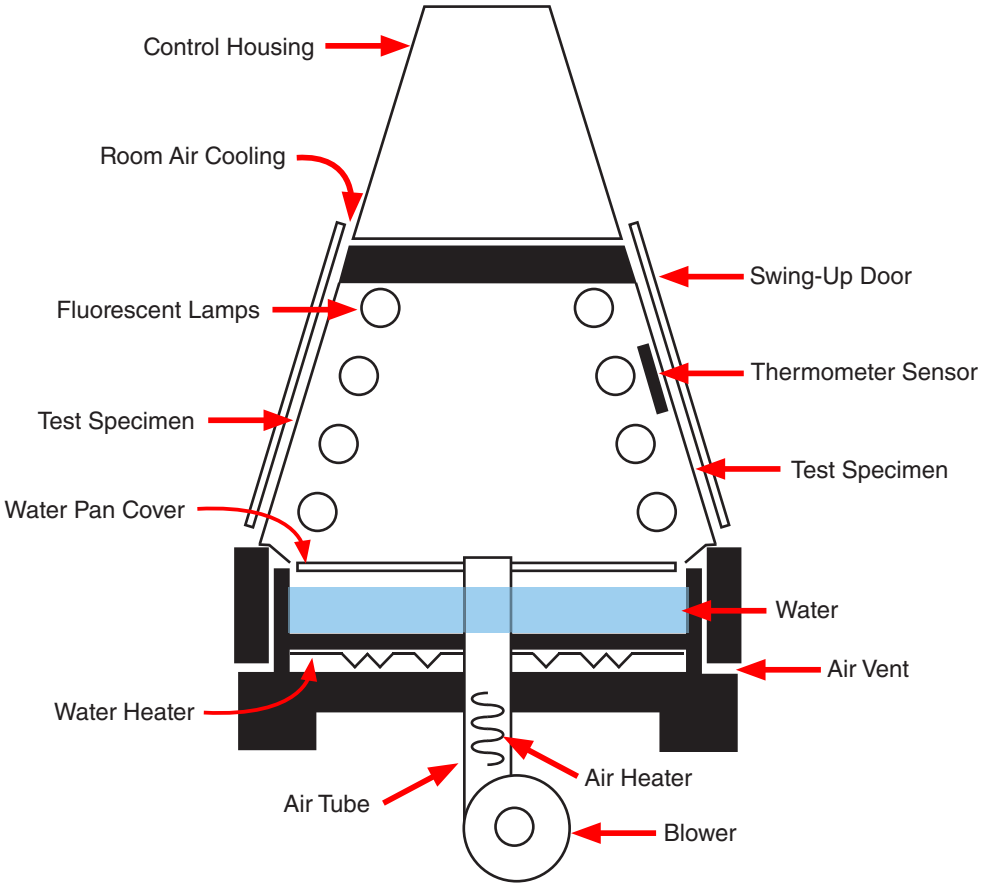



Figure 3: QUV cross section showing major components.

## Standard Tests Conducted in the QUV Weathering Tester

- The table below lists the standard tests that can be performed in a QUV tester.
- See LU-8012 Standards Met by QUV for additional information on standards met by QUV testers.

| General | Automotive | Adhesives & Sealants | Roofing |
|---|---|---|---|
| ASTM G151 | Ford FLTM BI 104-02 | ASTM C1184 | ANSI/RMA IPR-1, -2, -5, -6 |
| ASTM G154 | GM 4367M (General Motors) | ASTM C1442 | ASTM D3105 |
| BS 2782 | GM 9125P (General Motors) | ASTM C1501 | ASTM D4434 |
| GB/T 14522 | JIS D 0205 | ASTM D904 | ASTM D4799 |
| | NISSAN M0007 | ASTM D5215 | ASTM D4811 |
| | RNES B-00107 (Renault, Nissan) | UNE 104-281-88 | ASTM D5019 |
| | SAE J2020 | | BS 903 Part A54 Annex A & D |
| | | | CGSB-37.54-M |
| | | | EN 534 |
| | | | EN 1297 |
| | | | EOTA TR 010 |

| Paints & Coatings | Plastics | Other |
|---|---|---|
| ABNT NBR 15.380 | ANSI A14.5 | AATCC TM 186 (Textiles) |
| ASTM D4585 | ANSI C57.12.28 | ASTM E3006 (Photovoltaics) |
| ASTM D4587 | ASTM D1248 | ASTM F1945 (Printing Inks) |
| ASTM D5894 | ASTM D4329 | Colts Standard Test (Dyes) |
| EN 927-6 | ASTM D4674 | GSB AL 631 (Architectural) |
| GB/T 8013 | ASTM D5208 | IEC 61215 (Photovoltaics) |
| GB/T 16585 | ASTM D6662 | ISO 21898 (Packaging) |
| ISO 15110 | DIN 53384 | |
| ISO 12944-9 | GB/T 16422.3 | |
| ISO 16474-1, -3 | ISO 4892-1 | |
| JIS K 5600-7-8 | ISO 4892-3 | |
| KS M5982 | JIS K 7350-3 | |
| | UNE 53-104 | |

# 4. Operating Environment

### The Tester Must Be Located in a Suitable Environment

- All Q-Lab test chambers are sophisticated scientific instruments.
- All tester models must be operated in a suitable controlled environment (Section 4.1).
- Operating the tester in an unsuitable environment (Section 4.2) will **void the warranty**.

## 4.1. Suitable Environments (Apr 2020)

### Ambient Laboratory Temperature and Humidity

- The recommended ambient operating temperature and relative humidity (RH) for QUV testers is 23 ± 5 °C and 50 ± 25% RH.
- Operating outside the recommended range (or in rare cases, even within it), certain standards or test cycle conditions may not be achievable.
- This can result in the tester producing chamber temperature and/or humidity faults.
- Never operate your tester in lab temperatures >40 °C or >80% RH.
- Consult with Q-Lab for more specific information about achievable chamber temperature/humidity values based upon various ambient lab conditions.

### Physical Environment

- A room that is dry, clean and free of dust, particles, gases, or salt fog.
- A room with an HVAC (heating/ventilation/air-conditioning) system.
- A location away from windows or HVAC vents.
- A location that provides the necessary minimum clearances as specified in Section 5.2.

## 4.2. Unsuitable Environments (Apr 2020)

### Salt Fog or Other Airborne Contamination

- Operating a QUV tester in an unsuitable environment will void the warranty.
- DO NOT install QUV weathering testers in a room with corrosion chambers (Figure 4.2a).
- DO NOT locate a QUV tester in a room with machines or processes that generate dust, particles, vapors, gases, etc (Figure 4.2b).

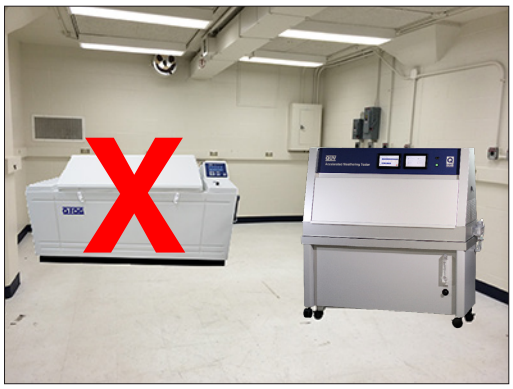


Figure 4.2a: Do not install QUV testers in a room with corrosion chambers.

Figure 4.2b: Do not locate QUV testers in a room with airborne dust, particles or gases.

### Uncontrolled Temperature and Humidity

- Do not operate the tester in a room with uncontrolled temperature and humidity (Figure 4.2c).
- Do not locate tester near sources of cold or hot air (Figure 4.2d).


Figure 4.2c: Do not locate the QUV near open windows.


Figure 4.2d: Keep tester away from sources of hot or cold air.

## Other Unsuitable Environments

- **Outdoors:** Rain and dust will corrode or short out electrical components.
- **Metal Dust / Metal Chips:** Do not locate the tester near metal cutting machines or metal grinding machines. Conductive metal dust or metal chips in the air will damage electronic components.
- **Carbon Fibers:** Do not operate the tester where carbon fibers or carbon reinforced plastic are being cut. The conductive carbon fibers will damage electronic components.
- **Conductive Pigments:** Do not operate the tester where carbon black or other conductive pigment dust is in the air. The conductive dust will damage electronic components.
- **Other Corrosive Gases:** Do not expose the tester to acid fog, $SO_2$ gas, or other corrosive gases.
- **Excessive Voltage:** The electrical supply to the tester must be no more than 10% higher than the voltage listed on the nameplate.
- **Low Voltage:** Recurring “brown-outs” or voltages less than 90% of the rated voltage will damage electrical components.
- **Water Leaks from Ceiling:** Water leaking onto the tester will damage electrical components.

**For further detail on laboratory environment requirements, please contact Q-Lab Repair and Tester Support. See Section 18 for contact information.**

# 5. Setup

## 5.1. QUV Uncrating (Apr 2020)

- All QUV testers are shipped in one of two types of crates (Figure 5.1a and Figure 5.1b).
- Labels on the crate indicate the location of the instructions to be opened first (Figure 5.1c).
- Instructions for uncrating and setting up the tester are located in the envelope shown in Figure 5.1d.

**Carefully read these instructions before uncrating the tester.**
**Follow all local, OSHA, EHS, and other applicable equipment operation and material handling safety requirements, recommendations, and practices.**

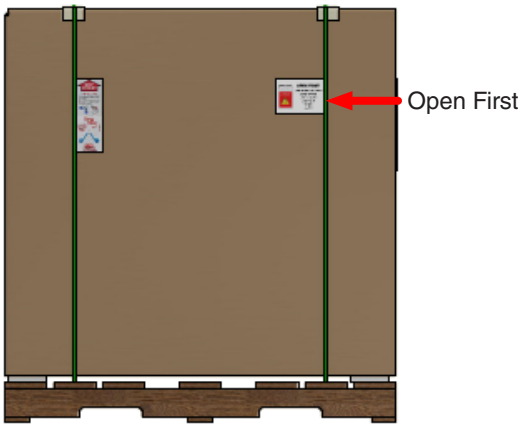



Figure 5.1a: This Crate has a Carton Banded to a Wooden Skid.

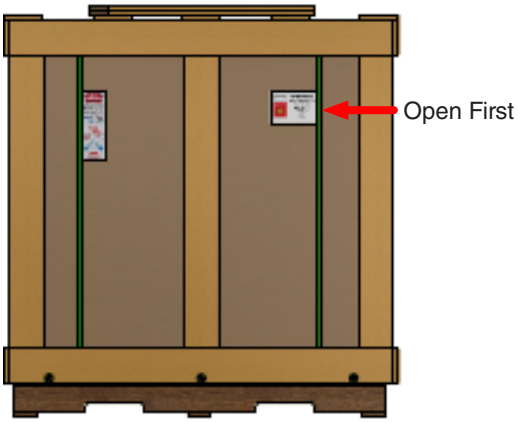



Figure 5.1b: This Crate has a Wooden Frame Surrounding the Carton.


Figure 5.1c: Labels on the crate indicate the envelope to be opened first.


Figure 5.1d: Open this envelope for important uncrating instructions.

**Shipping Weight (Approximate)**

| Packaging | QUV |
|---|---|
| On Skid With Wooden Crate | 181 kg (400 lbs) |
| On Skid With Carton Only | 136 kg (300 lbs) |

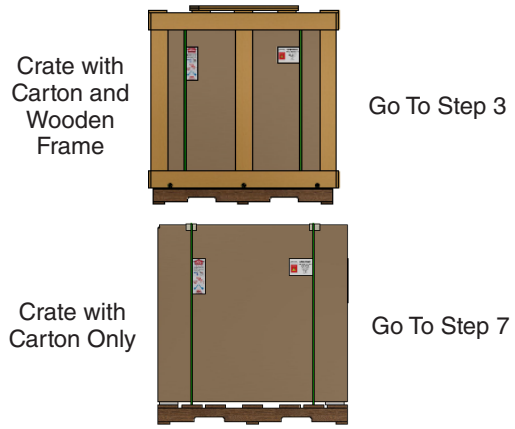
**Tools Required**

| | | |
|---|---|---|
| Phillips Screwdriver (Wooden Crate Only) | Flat Blade Screwdriver | Fork Lift* |
| Pry Bar (Wooden Crate Only) | Utility Knife | Band Cutter |

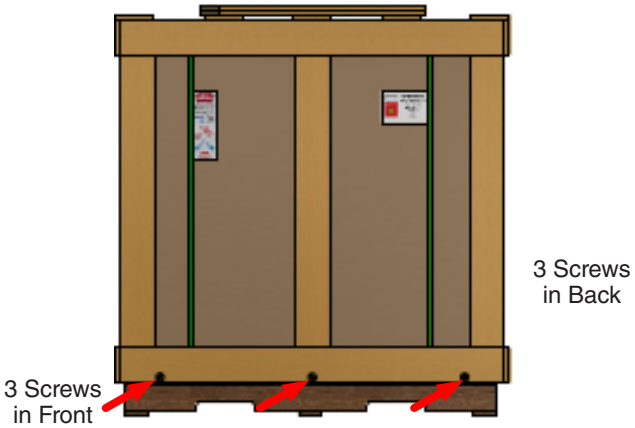
*A fork lift or other mechanical lifting device is recommended for use in moving the crated tester to the installation location, and to lift the frame in one piece from the crate with wooden frame.

## Follow the steps below to uncrate the tester.

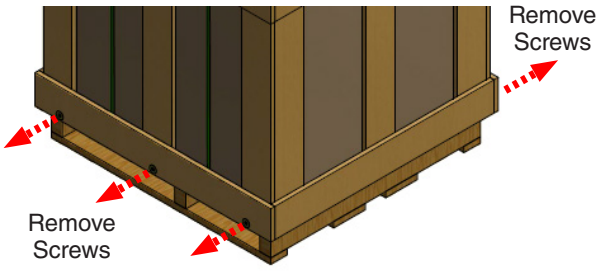

**1.** Uncrating instructions are located in this envelope. Remove and read the instructions.



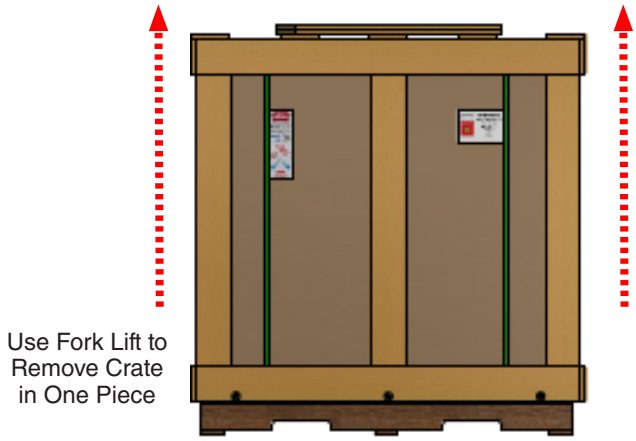

**2.** For crate with wooden frame continue with Step 3. For crate with carton only, go to Step 7.



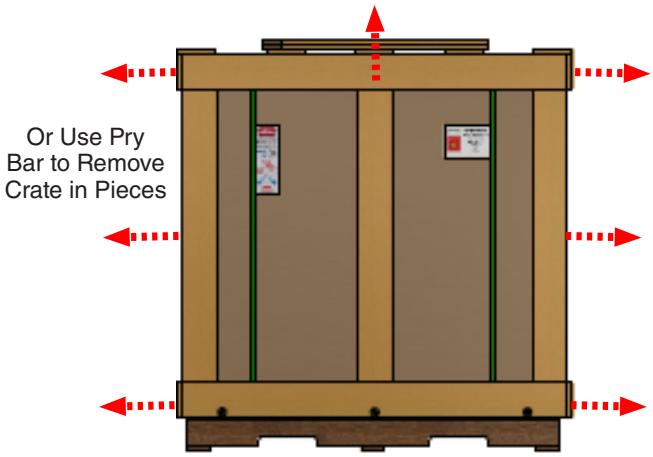

**3.** Locate the three (3) Phillips screws in the bottom front and three (3) screws back horizontal boards.



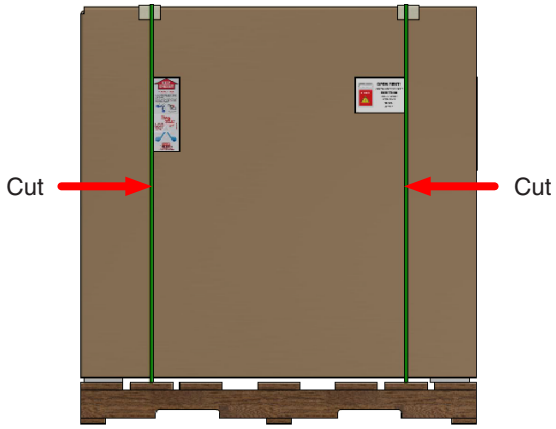

**4.** Remove all six (6) screws.



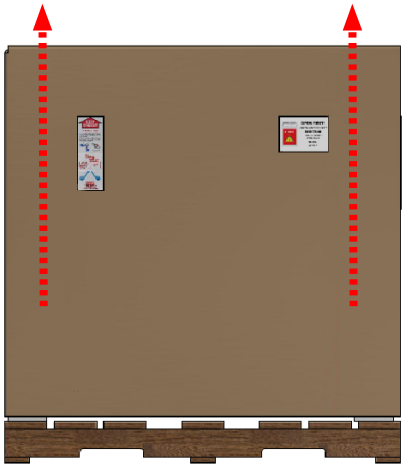

**5.** If a fork lift is available, use it to carefully lift the wooden frame up and off of the tester.



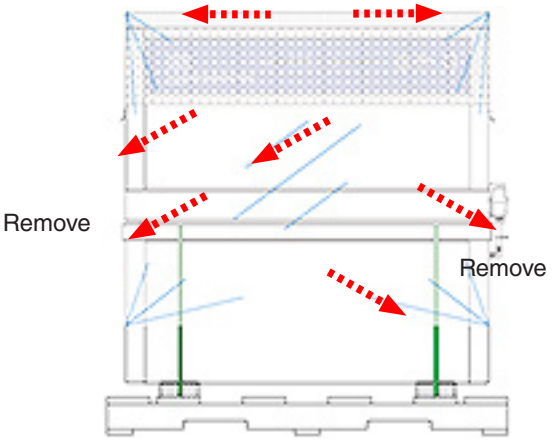

**6.** If a fork lift is not available, use a pry bar to carefully remove the horizontal and vertical wooden pieces from the tester.



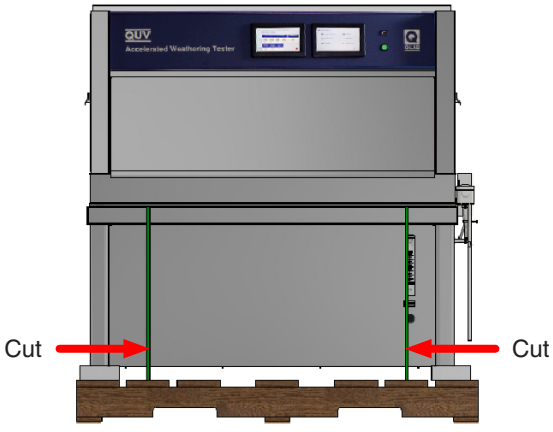

**7.** Cut the straps holding the carton to the skid. Remove the bands.



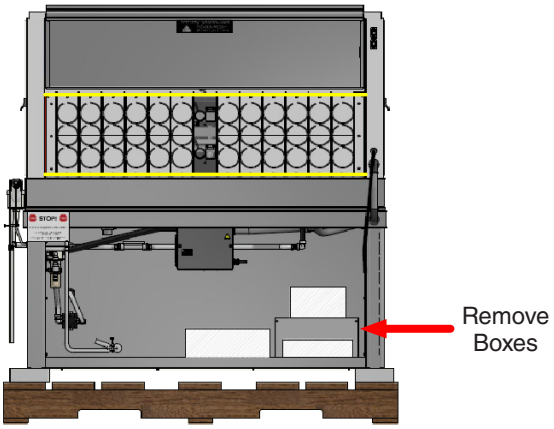
**8.** Carefully lift the carton up and off of the tester.



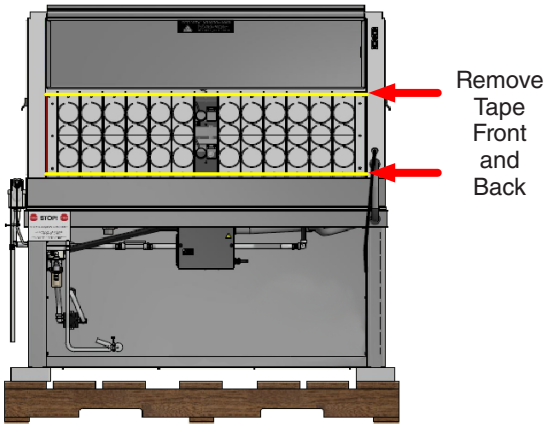

**9.** Remove all plastic wrap and foam from around the tester.



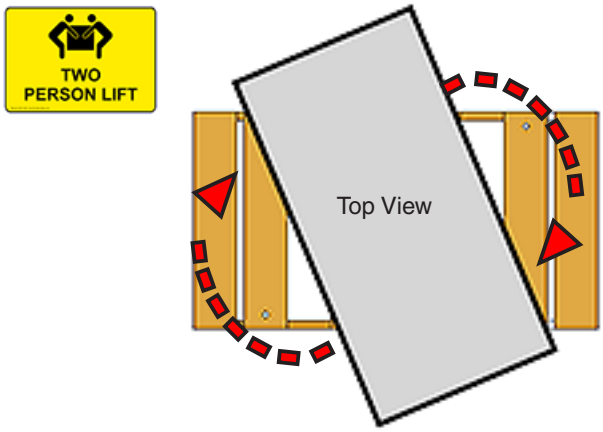

**10.** Cut the straps holding the tester to the skid. Remove the bands.




11. Remove boxes of accessories in the bottom of the tester.




12. Remove the tape from the specimen holders in front and back of the tester.




13. Use 2 persons to rotate the tester diagonally on skid as shown.

14. Locate four (4) casters in the boxes.


15. Install the casters into the sockets in the tester legs.


16. Use 2 persons to carefully remove the tester from skid.

## 5.2. Dimensions and Space Requirements (Apr 2020)

- The external dimensions for QUV testers are listed in Figure 5.2a.
- The testers should be positioned as shown in Figure 5.2b.
- Positioning testers as shown will allow sufficient room to operate each unit, gain access to service areas, and allow proper ventilation through the air intake and exhaust vents.

| Dimension | QUV |
|---|---|
| **A** | 137 cm (54.0") |
| **B** | 131 cm (51.5") |
| **C** | 52 cm (20.5") |
| **D** | 135 cm (53.0") |


Figure 5.2a: External dimensions.

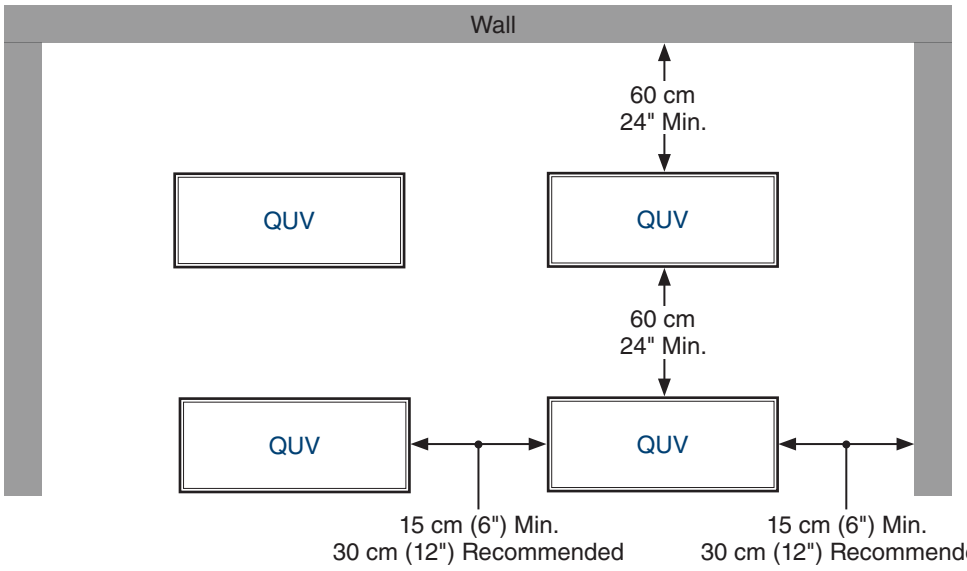



Figure 5.2b: Tester space requirements (top view).

## 5.3. Electrical (Apr 2020)

**Voltage:** Shown on the nameplate, either 120 V or 230 V, ± 10% (Figure 5.3).

**Transient Over Voltage:** Installation Category II of transient overvoltages

**Current:**

| 120 V | 230 V |
|---|---|
| 16 amps | 8 amps |

**Frequency:** 50 or 60 Hz

**Circuit Protection:** Built-in breaker, 20 A for 120 V machines and 10 A for 230 V machines

**Electrical Connection:** A 3-prong grounding plug is provided for 120V testers

**Wiring:**

| | 120 V | 230 V |
|---|---|---|
| **Power:** | Black | Brown |
| **Neutral:** | White | Blue |
| **Safety Earth Ground:** | Green | Green/Yellow |

- Although a Main Power Switch is provided at the rear of the unit, the specified means for disconnecting the AC Main supply circuit is the plug on the power supply cord.
- If the plug is not easily accessible for this purpose, then an external Disconnect Switch must be provided in the installation.
- To avoid nuisance tripping, Q-Lab does not recommend the use of Ground-Fault Circuit Interrupters (GFCI) circuit breakers with QUV testers.


Figure 5.3: QUV rear view: nameplate location.

## 5.4. Water (Apr 2020)

### QUV/se, QUV/cw

#### Supply Connections

- The water supply connects to the water feed assembly at the right rear side of the tester (Figure 5.4a and Figure 5.4b).
- Connect the water supply to the QUV water feed valve with 1/4" plastic tubing (included in CV-255-K), or 6 mm plastic tubing (included in CV-60131-K). See Figure 5.4b.
- Alternatively, 6 mm (1/4") copper tubing can be used.
- The water supply line should be equipped with a shutoff valve.


Figure 5.4a: QUV water supply connection location.

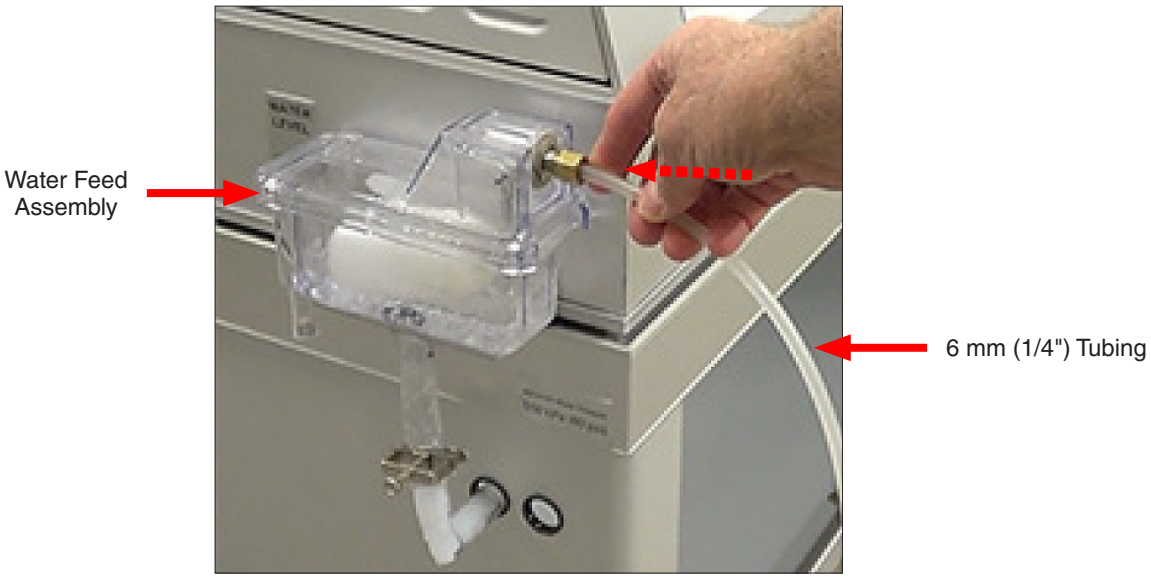



Figure 5.4b: Water supply connection.

## Water Level Adjustment

- Level the QUV tester.
- The water level in the water pan should be 10 mm to 15 mm high (Figure 5.4c).
- See CV-222-L for information on adjusting the water level.

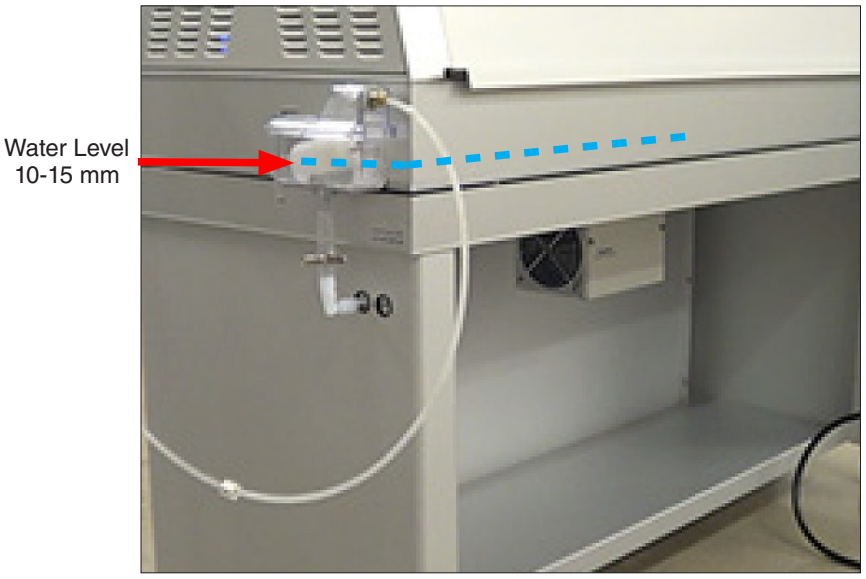



Figure 5.4c: Water level for all models without spray.

## QUV/spray

### Supply Connections

- The QUV/spray water supply connects to the solenoid valve assembly at the left rear of the tester.
- Three options are available to connect the water supply to the QUV/spray (see Figure 5.4d through Figure 5.4f ).
  1. Connect a ½" supply hose over the supplied hose barb and secure it with a hose clamp.
  2. Connect a ½" supply tube into the push lock elbow.
  3. Connect a ½ mm supply tube using the supplied tube adapter (Part # U-40816-X, 230 V testers only).
- Connections between QUV/spray and the water supply should be stainless steel or plastic.

Connection Location

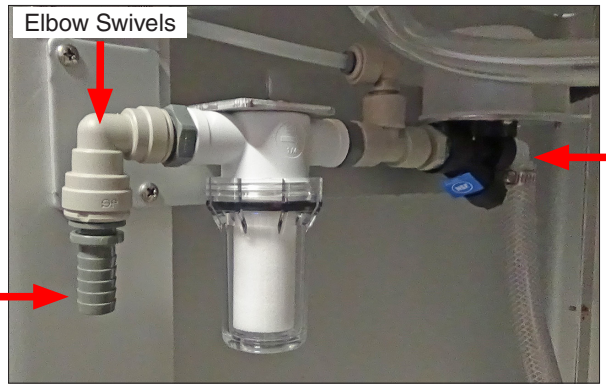



Figure 5.4d: Hose barb for ½" inch water supply hose.

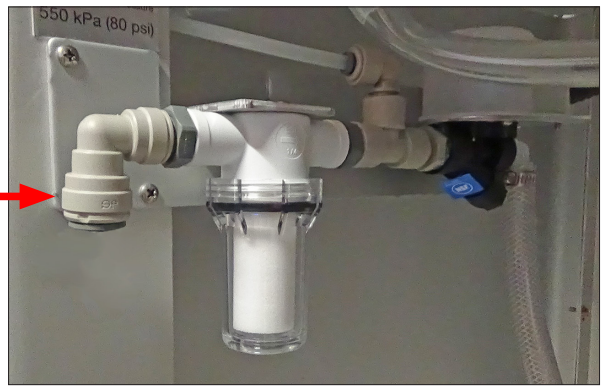



Figure 5.4e: Push lock elbow for ½" water supply tube


Figure 5.4f: Tube adapter for 12 mm water supply tube.

## QUV/spray/rp (Integrated Repurification System)

### Supply Connections

- Connect a 6 mm (1/4") water supply tube to the union tee on the water feed assembly (Figure 5.4g).
- Connections between QUV/spray and the water supply should be stainless steel or plastic.

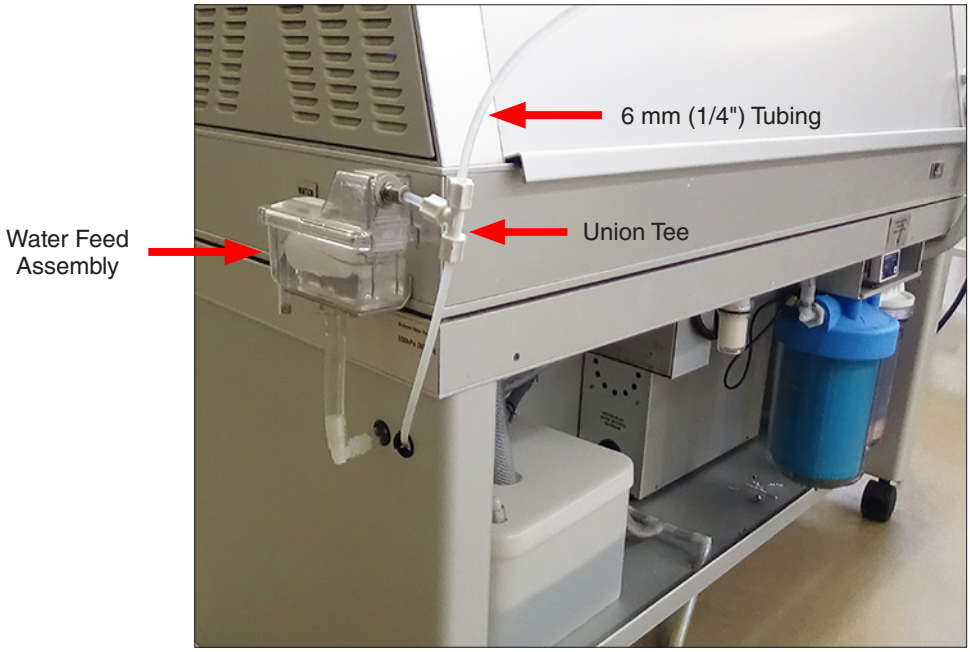



Figure 5.4g: Water supply connection for QUV/spray/rp testers.

### Water Level Adjustment - All Spray Models

- Level the QUV tester.
- The water level in the water pan is normally 10 mm to 15 mm, except after a spray step when it will be 25 mm (Figure 5.4h).
- See CV-222-L for information on adjusting the water level.


Figure 5.4h: Normal and after spray water levels.

## Purity

- **IMPORTANT** The tester **warranty is voided** if water purity requirements are not met.
- QUV models with water spray require much higher water purity than testers with no water spray.
- Figure 5.4i lists water purity requirements for all testers.

| Model | Pressure | Condensation Volume | Spray Volume | Resistivity | Conductivity | Total Dissolved Solids | pH |
|---|---|---|---|---|---|---|---|
| QUV/spray | 45-80 psi* (280-550 kpa) | 5.0 liters/day | 7.0 liters/min | >200k ohm•cm | <5.0 µS/cm | <2.5 ppm | 6-8 |
| QUV/spray/rp | 2-80 psi (20-550 kpa) | | 7.0 liters/min** | | | | |
| QUV/se QUV/cw | 2-80 psi (20-550 kpa) | | NA | Tap Water | | | |

Figure 5.4i: Water Purity Requirements

* The system pressure must be ≥ 45 psi when a spray step is running.
The system pressure is typically higher when there is no flow and then drops when the flow is on.

** For QUV/SPRAY/RP systems actual water use is 0 liters/min because all the spray water is recirculated.

- The reverse osmosis / deionized (RO/DI) water system shown in Figure 5.4j produces water pure enough for spray systems.
- T**his type of RO/DI system is required for water spray in QUV testers.**

**Important: Use Type I, not Type II anion in the mixed bed tanks of the RO/DI system.**

The Strong Base **Type I** Anion resin in the mixed bed tanks is the most important part of these systems to prevent water spotting. This is because strong base Type I anion resin is the only resin that can effectively remove suspended silica. **Suspended silica is the major cause of specimen spotting.** Type I anion is much better at removing suspended silica than Type II.

Unfortunately, Type II is the most common anion. So be sure to insist that your water purification supplier installs Type I, not Type II. The cost for Type I anion is about the same as Type II. Note that Type I anion is only necessary in the mixed bed “polishing” stages of the deionization, not in the initial “rough” purification stages.

## Reverse Osmosis / Deionization System

- Figure 5.4j below shows an effective Reverse Osmosis / Deionized Water System with Anion Type I Resin for spray water silica removal.
- For information on water purification systems, contact the Life Science business of Merck KGaA, Darmstadt, Germany. The Life Science business of Merck KGaA, Darmstadt, Germany operates as MilliporeSigma in the USA and Canada.

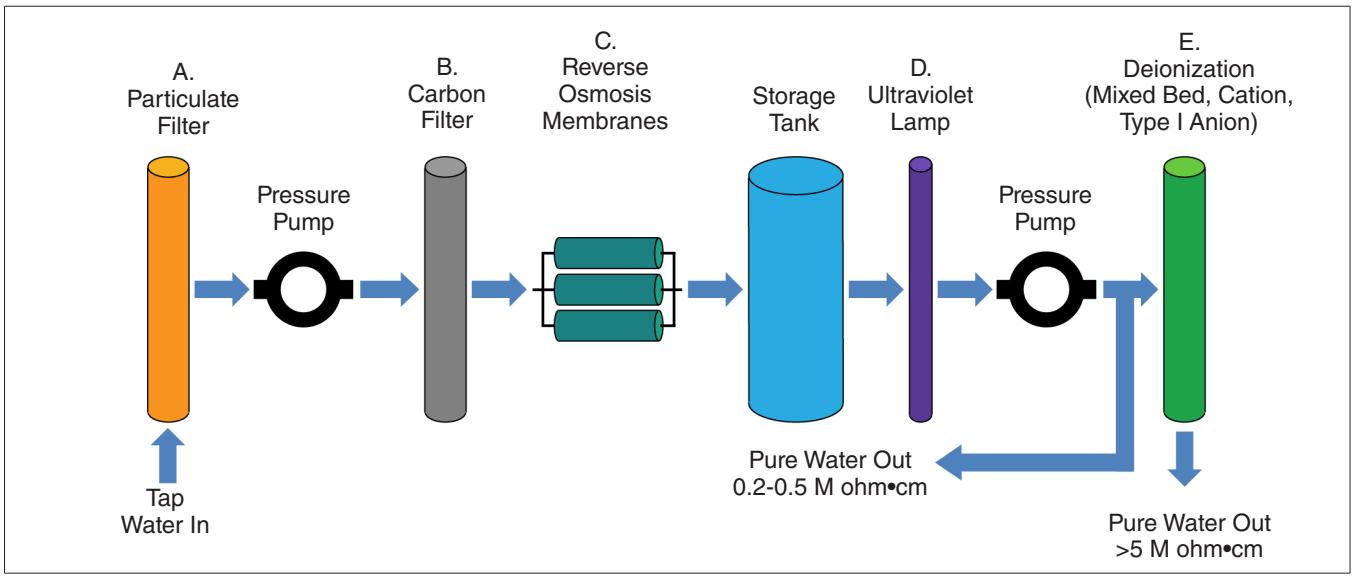



Figure 5.4j: Reverse Osmosis / Deionized water system.

- Additional RO/DI system information is shown below.

| Stage | Purpose | Outgoing Purity | Notes |
|---|---|---|---|
| A. Particulate Filter | Remove small particles | | Replace once per year |
| B. Carbon Filter | Remove chlorine | | Replace once or twice per year |
| C. R/O Membranes | Remove dissolved solids, colloidal silica, organic and biological contaminates | 0.2-0.5 M ohm•cm | Rough purification stage |
| D. Ultraviolet Lamp | Disinfect water | | Rough purification stage |
| E. Mixed Bed Tank | Final polishing to remove positively and negatively charged ions | > 5 M ohm•cm | Final polished water purity |

## Drains

### Water Pan Cleaning Drain (All Models)

- Turn off water supply and unclamp the water pan cleaning drain to empty the water pan (Figure 5.4k).

### Water Feed Overflow Drain (All Models)

- The 12 mm (1/2") supplied hose should be connected to the water feed overflow drain and run to a floor drain (Figure 5.4k).

### Water Pan Drain (QUV/spray)

- 32 mm (1-1/4") drain hose supplied.
- Connect to the fitting under the water pan and secure with a hose clamp ( Figure 5.4l).

### Repurification System Drain (QUV/spray/rp)

- 12 mm (1/2") drain hose supplied.  Connect to the repurification system drain and run to a floor drain (Figure 5.4m).

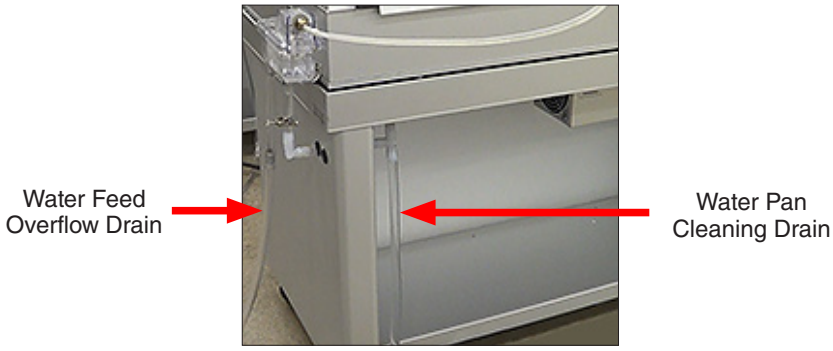



Figure 5.4k: QUV/se, QUV/cw

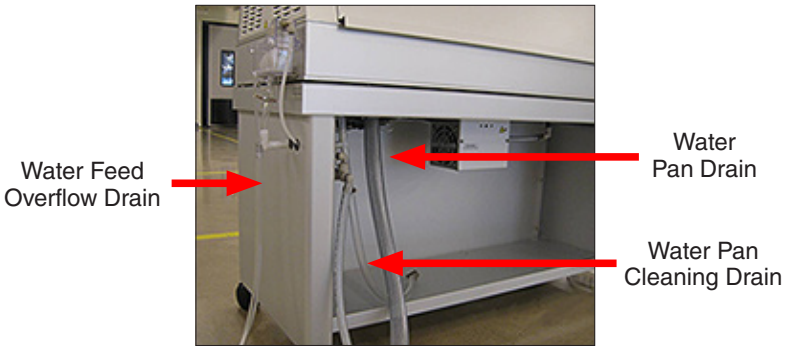



Figure 5.4l: QUV/spray

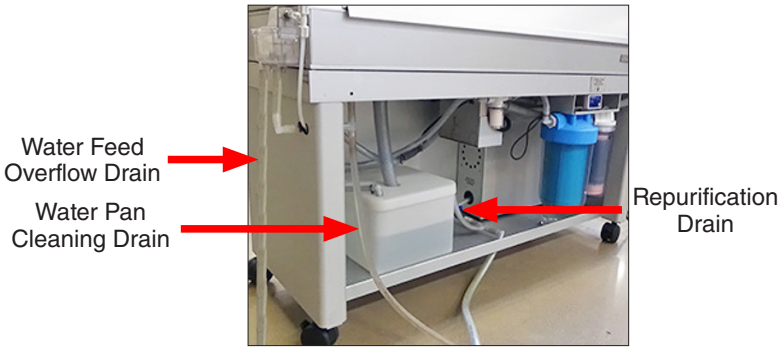



Figure 5.4m: QUV/spray/rp

# 6. Ultraviolet (UV) Light System

## 6.1. Lamp Types (Aug 2020)

- **UVA-340:** The UVA-340 provides the best possible simulation of sunlight in the critical short wavelength region from 365 nm down to the solar cutoff of 295 nm.
  - Its peak emission is at 340 nm.
  - These lamps are recommended for use at typical and low irradiances, below 0.70 W/m$^2$/nm @340 nm.
- **UVA-340+:** The UVA-340+ lamp delivers the same light spectrum as the UVA-340 lamp, plus extended lifetime at high irradiance. See Section 10.2.
  - These lamps are recommended for use at typical and high irradiances.
- **UVA-351:** The UVA-351 simulates the UV portion of sunlight filtered through window glass.
- **UVB-313EL:** Substantially higher UV than UVA-340 and UVA-340+ lamps, with wavelengths as short as 275 nm and peak emission at 313 nm.
  - This often delivers faster test results than UVA-340 and UVA-340+ lamps.
  - Used in place of the QFS-40 in the QUV/se and QUV/spray.
- **UVB-313EL+:** The UVB-313EL+ lamp delivers nearly the same light spectrum as the UVA-313EL lamp, plus extended lifetime at high irradiance. See Section 10.2.
- **QFS-40:** Also known as FS-40 or F40 UVB, the original QUV lamp. FS-40 lamps are still specified in some automotive test methods.
- **Cool White Lamps:** Cool white lamps are commonly used in commercial, retail, and office environments. The same cool white lamps can be used in the QUV/CW but at much higher intensities to test for indoor photostability of materials.
- **Do Not Mix Different Types of Lamps:** All 8 lamps must be the same type.

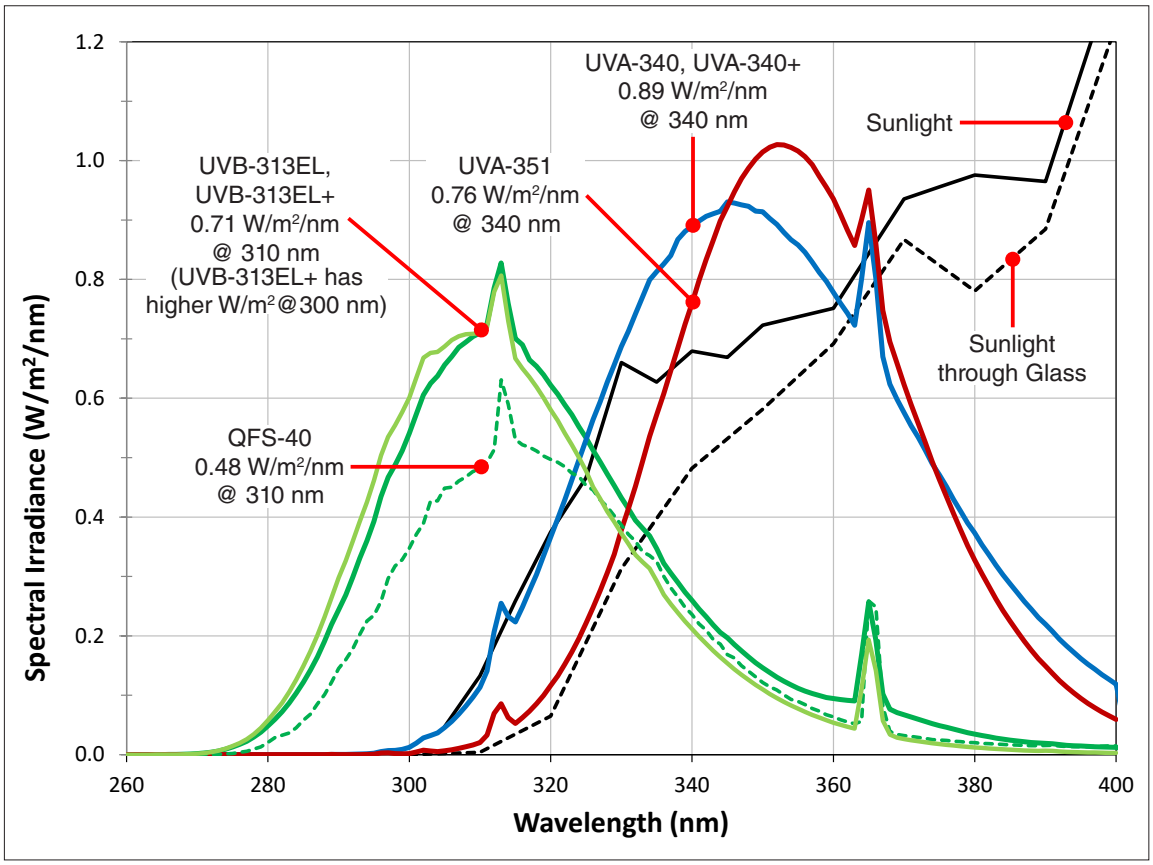



Figure 6.1a: UV Lamps compared to sunlight.

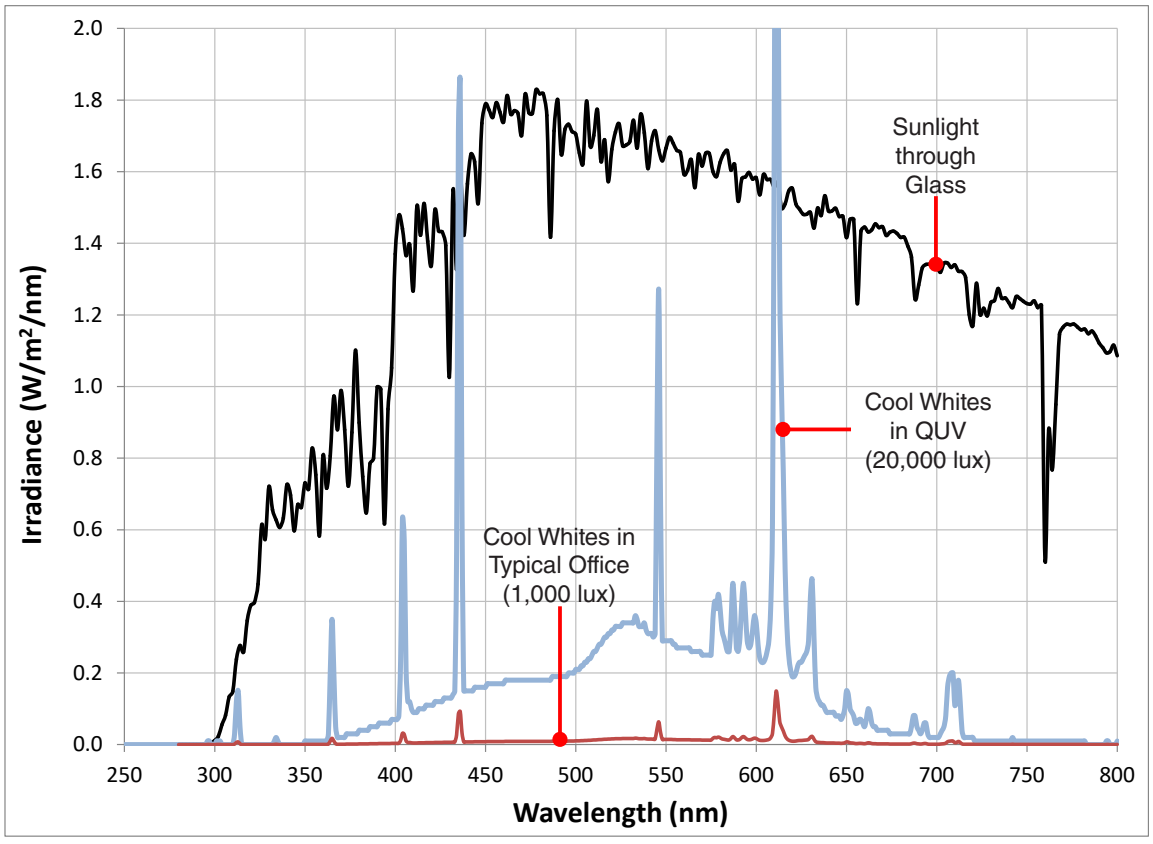



Figure 6.1b: Cool White Lamps Compared to Sunlight

## 6.2. Irradiance Control (Aug 2020)

- An irradiance control system monitors the UV intensity via four sensors at the sample plane (Figure 6.2a and Figure 6.2b).
- A four-channel feedback loop system compensates for any variability by adjusting the power to the lamps.
- For more information on irradiance control see Q-Lab Bulletin LU-8010, Controlled Irradiance in Laboratory Weathering.

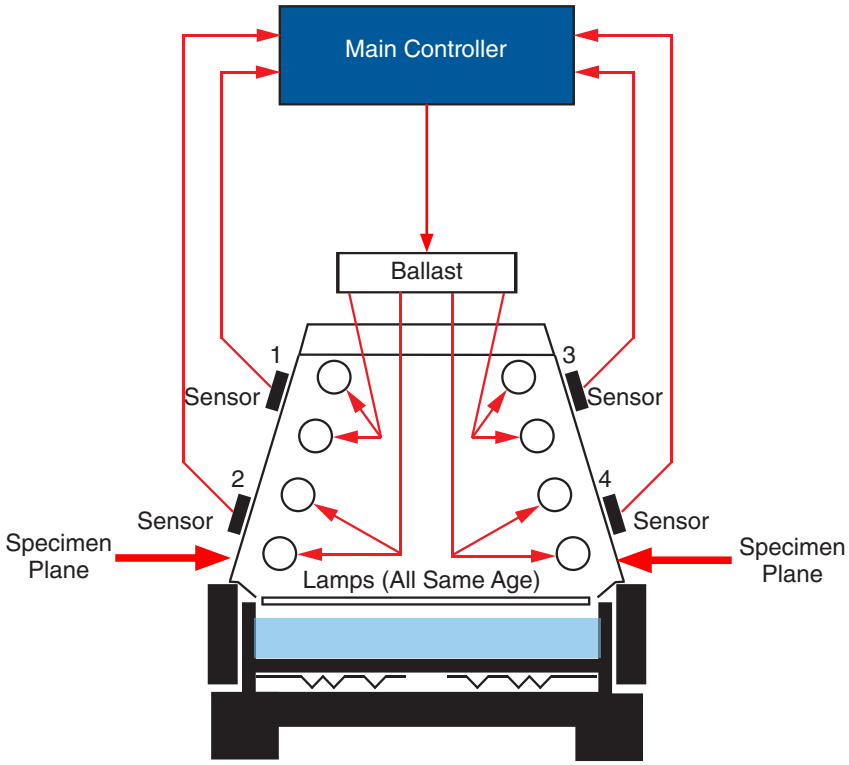



Figure 6.2a: Irradiance control system schematic.

- The UV sensors are located on black panels in the center of the sample exposure area.
- There are two sensors on each side of the QUV tester.
- Each sensor monitors the irradiance of two lamps.
- The controller adjusts the power to each pair of lamps to maintain the programmed irradiance (see Section 9).
- Each sensor must be calibrated separately (see Section 11).
- Sensor lenses should be periodically cleaned with alcohol and a clean, soft cloth.

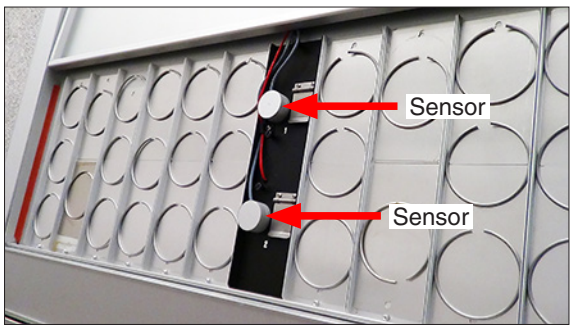



Figure 6.2b: UV sensors.

## UVA-340 and UVA-340+ Lamps

- 0.89 W/m²/nm at 340 nm - Typical irradiance (UVA-340 and UVA-340+ lamps)
- 1.55 W/m²/nm at 340 nm - High irradiance (UVA-340+ lamps preferred)
- 1.70 W/m²/nm at 340 nm - Maximum irradiance (UVA-340+ lamps only)

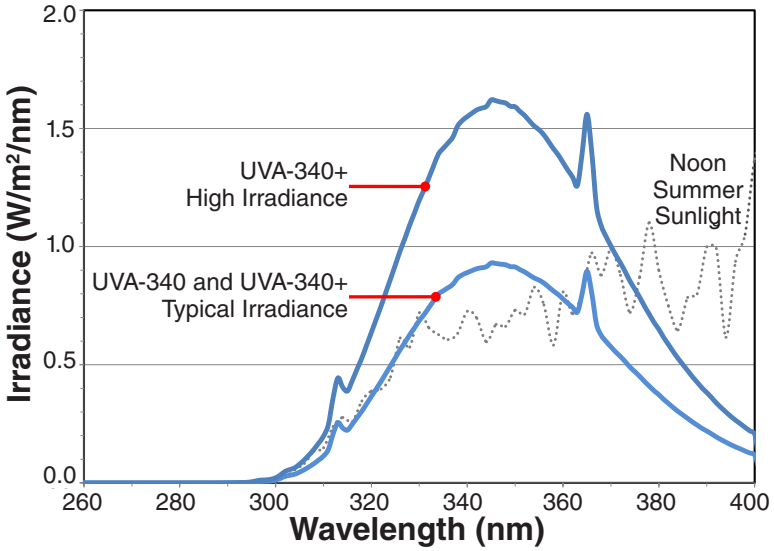



Figure 6.2c: UVA-340 and UVA-340+ lamps compared to sunlight.

## UVB-313EL and UVB-313EL+ Lamps

- 0.71 W/m²/nm at 310 nm - Typical irradiance (UVB-313EL and UVB-313EL+ lamps)
- 1.55 W/m²/nm at 310 nm - High irradiance (UVB-313EL+ lamps only)
- 1.70 W/m²/nm at 310 nm - Maximum irradiance (UVB-313EL+ lamps only)

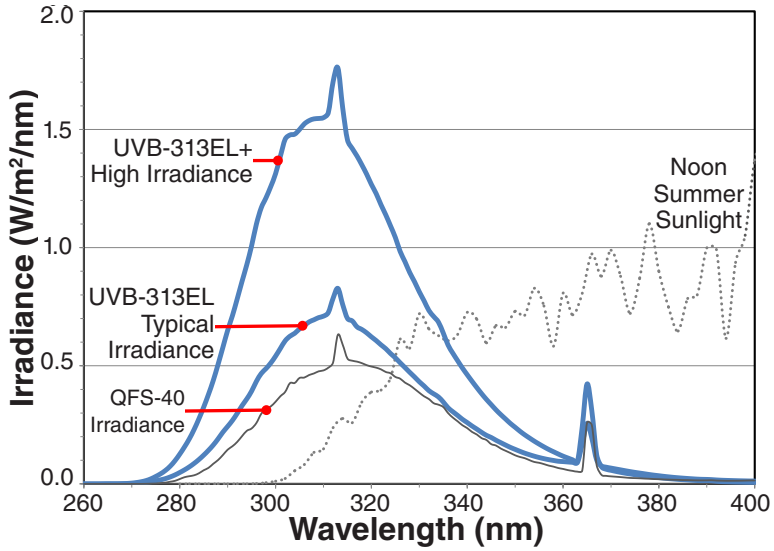



Figure 6.2d: UVB-313EL and UVB-313EL+ lamps compared to sunlight.

## 6.3. Lamp Cooling (Jul 2020)

- Fans at each end of the control housing cool the ends of the lamps for maximum efficiency.

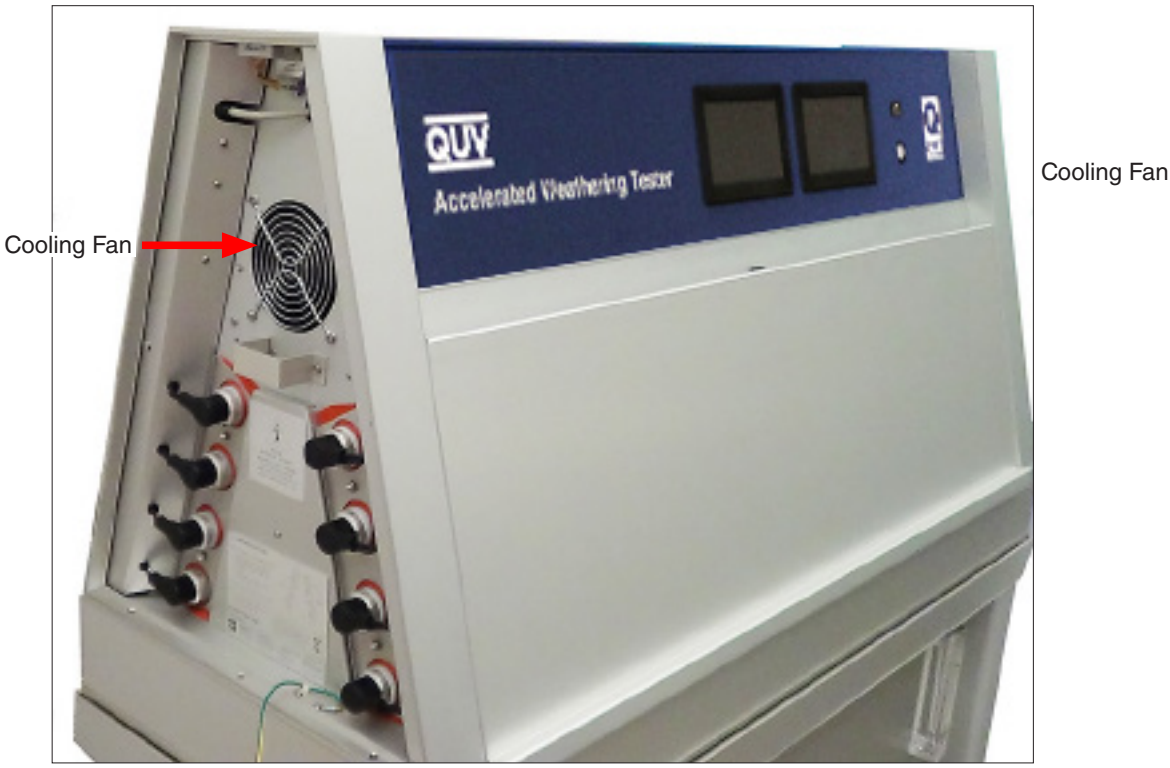



Figure 6.3: QUV left end cover removed showing cooling fan.

# 7. Moisture System

## 7.1. Condensation (Aug 2008)

- All QUV testers reproduce the effects of outdoor moisture by condensation.
- Panel holders form the side walls of the test chamber holding water vapor inside.
- Room air on the back side of the specimens cools them to a few degrees below the vapor temperature causing liquid water to condense on the specimens.
- The swing-up doors allow room air to reach the backs of the test panels and shields them from drafts and room temperature changes.
- During the condensation cycle, a heating element located under the water pan is turned on. Water vapor fills the test chamber, condenses on the test panels and drains back to the water pan.

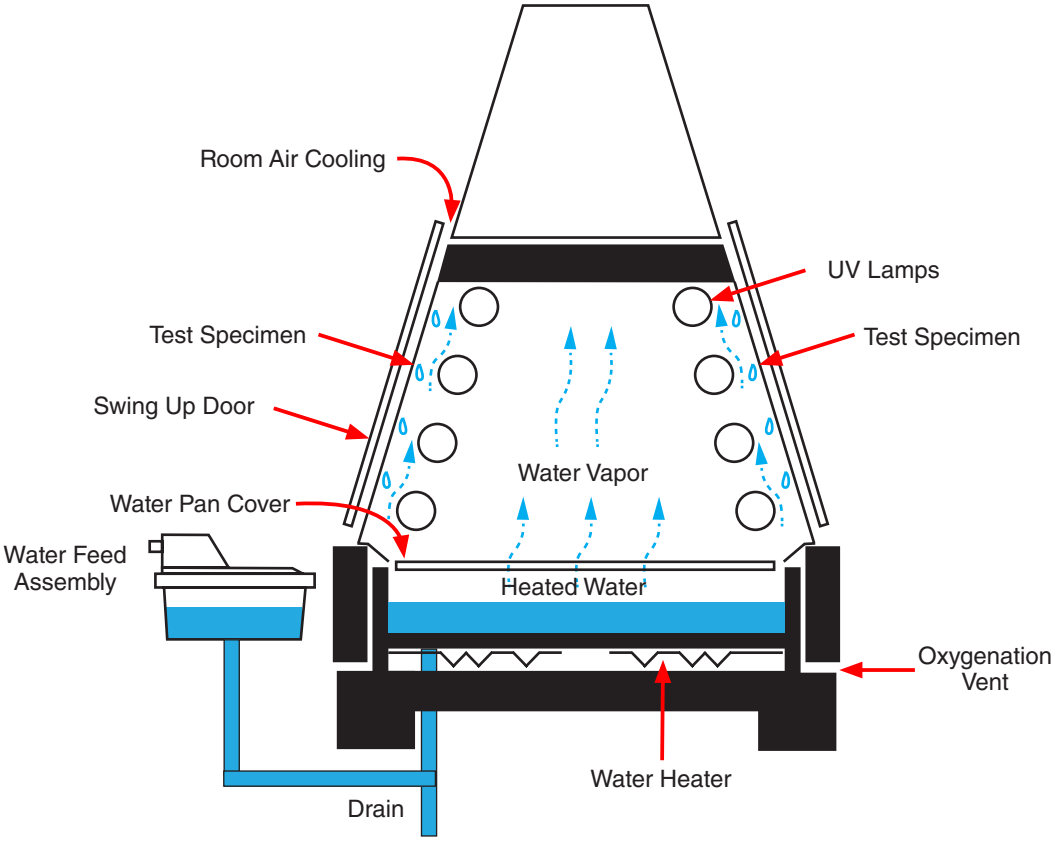



Figure 7.1: QUV condensation system schematic.

## 7.2. Water Spray (Apr 2017)

- QUV/spray  and QUV/spray/rp models can also spray water on test specimens.
- The system consists of 12 spray nozzles (6 on each side) and the associated piping, controls, and drain.
- The nozzles are mounted between the UV lamps.
- When running a SPRAY step, the UV lamps are turned off.

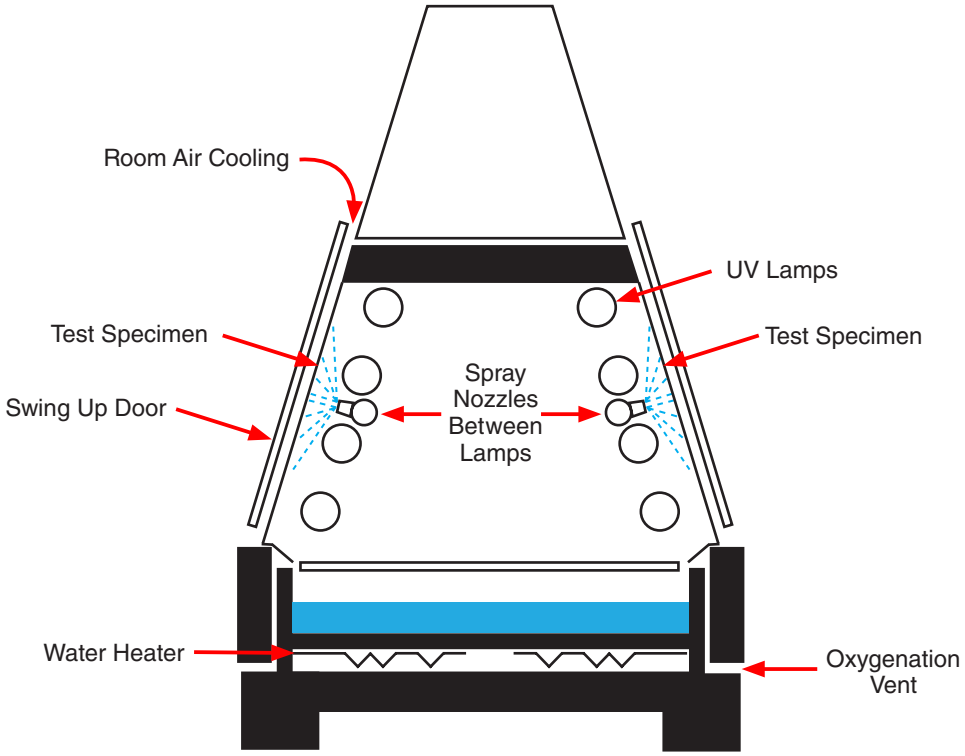



Figure 7.2a: QUV spray system schematic.

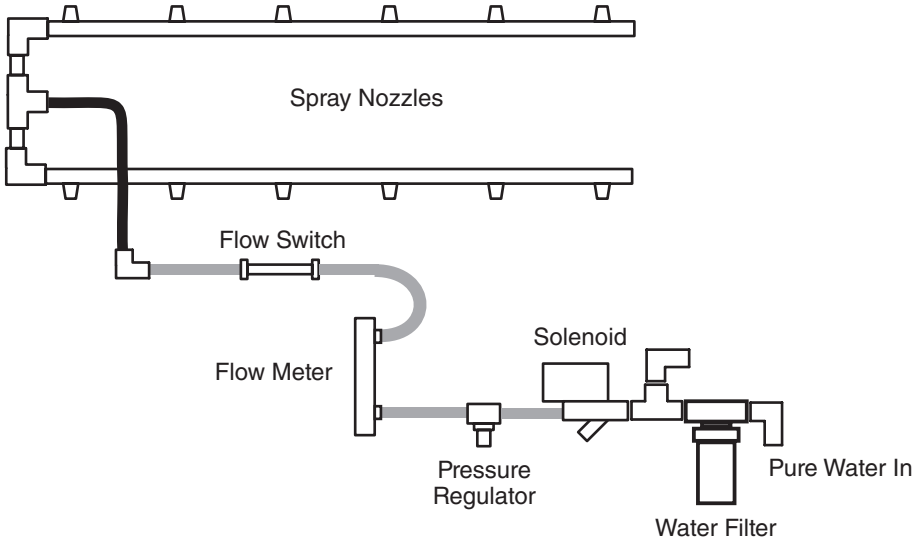



Figure 7.2b: QUV spray system plumbing diagram.

# 8. Temperature Control System

## 8.1. Panel Temperature Sensor (Apr 2019)

- The uninsulated panel temperature sensor is located on the interior of the black panel in the center of the front sample exposure area (Figure 8.1a, Figure 8.1b). This sensor is sometimes referred to as a black panel sensor.
- An optional insulated panel temperature sensor is available (Figure 8.1c, Figure 8.1d). The insulated sensor is designed to:
  - Make the temperature of specimens mounted in 3D boxes (with doors removed) nearly the same temperature as when mounted in a standard panel holder.
  - Make the temperature of plastic specimens mounted in standard panel holders closer to the set point.
- Q-Lab recommends an IBP only for use with 3D specimen boxes, and/or plastic specimens.
- Temperature sensors should be calibrated every six (6) months. See Section 11.2 for calibration instructions.

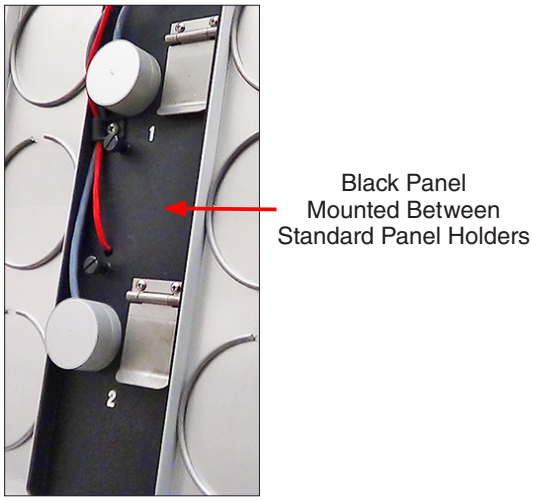



Figure 8.1a: Exterior of black panel with uninsulated temperature sensor.

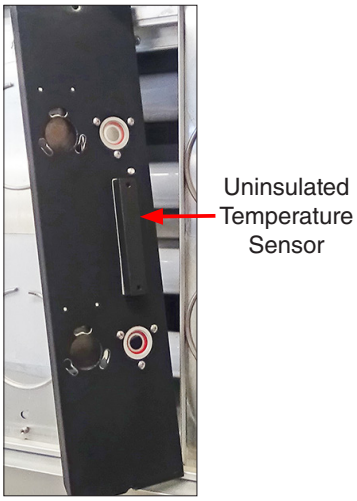



Figure 8.1b: Interior of black panel showing uninsulated temperature sensor.

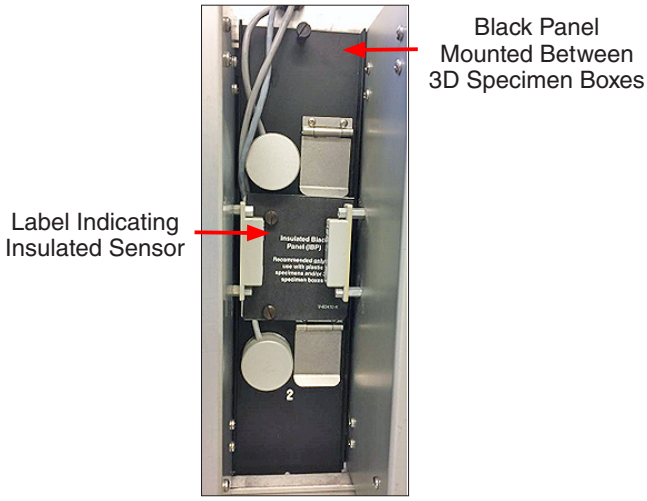



Figure 8.1c: Exterior of black panel with insulated temperature sensor.

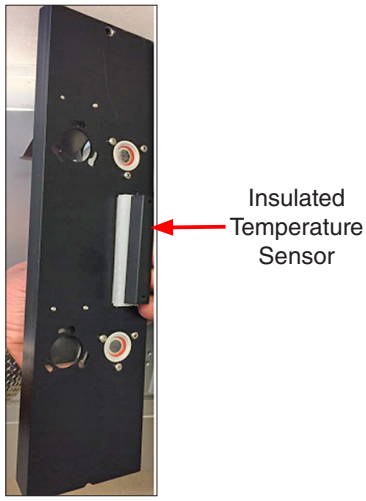



Figure 8.1d: Interior of black panel showing insulated temperature sensor.

## 8.2. Laboratory Temperature Sensor (May 2017)

- Laboratory temperature is monitored and displayed in the controller diagnostics (see Section 9.8).

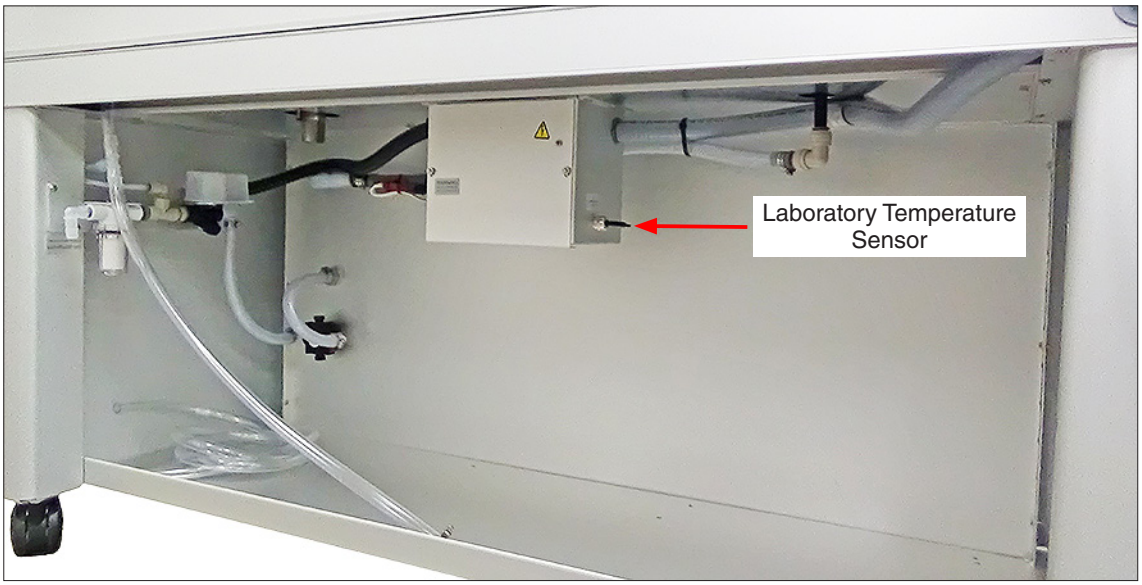



Figure 8.2: QUV laboratory temperature sensor location.

## 8.3. Water Temperature Sensor (Aug 2008)

- The temperature of the water in the water pan is monitored and displayed in the controller diagnostics (see Section 9.8).

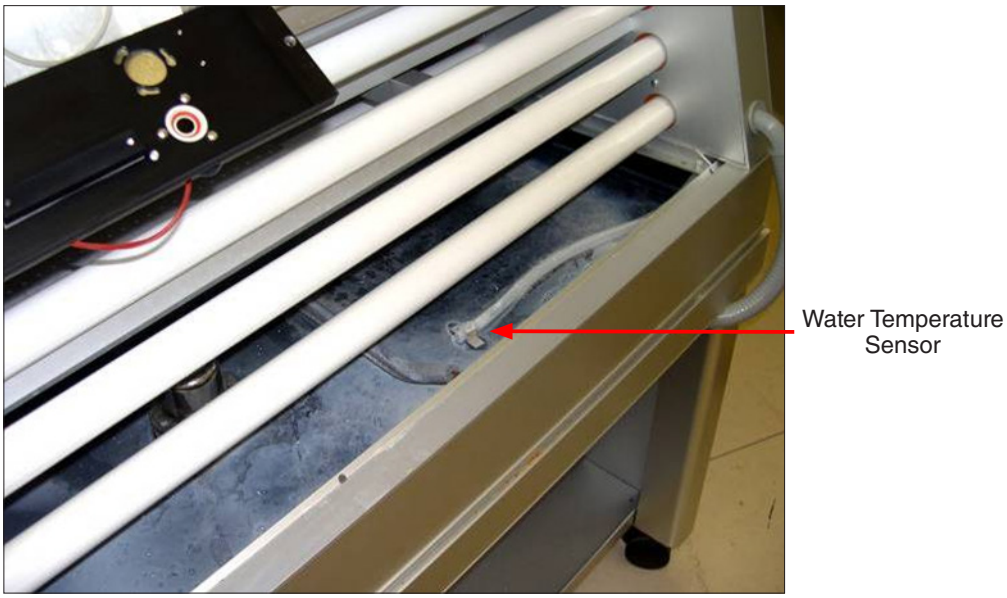



Figure 8.3: Water temperature sensor location (shown with water pan cover removed).

## 8.4. UV Cycle (Sep 2011)

- **Fan:** The fan is located on the underside of the unit (Figure 8.4). It operates continuously throughout the UV cycle.
- **Air Heater:** Located in the air tube above the blower.
- **Air Distribution:** Air from the fan enters the test chamber through the air tube in the center of the water pan. It vents to the room through the air vent slot around the top of the water pan.
- The minimum panel temperature that can be reached is about 45 °C due to the heat from the lamps.

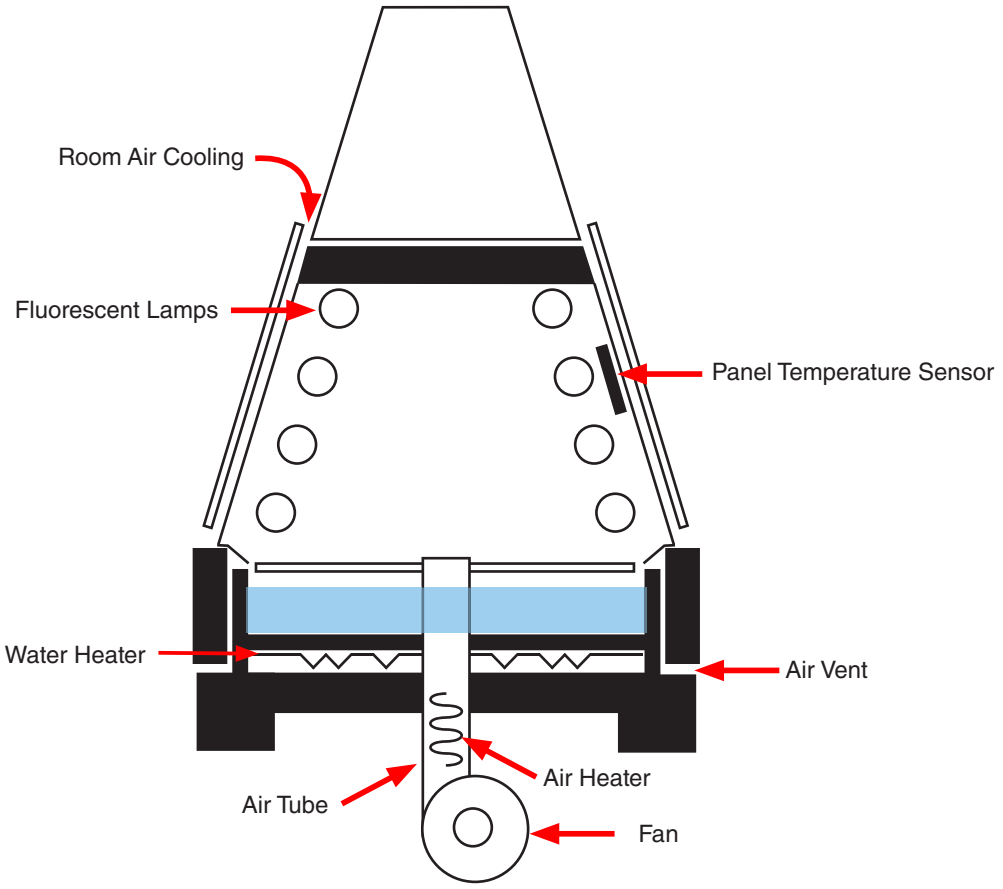



Figure 8.4: Temperature control components schematic.

## 8.5. Condensation Cycle (Aug 2008)

- The temperature control system during condensation steps consists of:
  - Water heater (Figure 7.1).
  - Panel temperature sensor (Section 8.1).
  - Water temperature sensor (Section 8.3).
  - Controller (Section 9).
- The fan (Figure 8.4) is operated for the first few minutes of the condensation cycle to provide a rapid cooling of the test chamber to the condensation temperature set-point.

## 8.6. Spray Cycle (Aug 2008)

- The panel temperature is displayed but not controlled during spray steps.
- The water heater, air heater, and fan are all off (Figure 8.4).

## 8.7. Dark Cycle (Sep 2011)

- **Fan:** The fan is located on the underside of the unit (Figure 8.4).
  - The fan operates continuously throughout the Dark cycle.
- **Air Heater:** Located in the air tube above the blower.
- **Air Distribution:** Air from the blower enters the test chamber through the air tube in the center of the water pan.
  - The air vents into the room through the air vent slot around the top of the water pan.
- The maximum panel temperature that can be reached is about 60 °C.

# 9. Main Controller Operation

## Overview

- The QUV main controller controls all functions of the tester.
- Interactive software allows easy programming using dual, full-color touch-screen displays.
- Many common test cycles have been pre-programmed
- Custom test cycles can be easily created.
- The main controller continuously displays all test status conditions and continuously monitors for errors.
- The main controller will automatically stop a test if an error is detected.
- New software revisions can easily be downloaded and installed.
- System configuration and performance data can be exported to assist in troubleshooting.

## 9.1. Overview (Aug 2020)

- Two touch-screen monitors mounted on the QUV control panel are used to control tester operation and the display of test status (Figure 9.1a).
- The Status Screen is on the left and the Menu Screen is on the right (Figure 9.1b, Figure 9.1c)
- The Status Screen displays tester current running conditions.
- The Menu Screen is the main interface for operator control of the tester, including settings, programming, and calibration.
- The screens are activated when the tester is powered on.
- After an interval of inactivity, the screens will automatically deactivate. Just tap a screen to reactivate (Figure 9.1d).
- The touch-screens should be cleaned with a soft cloth and alcohol. Do not use water to clean the screens.
- The screens can be operated using a stylus. Many operators prefer using a stylus with the touch-screens.
- A large LED indicator, to the right of the menu screen and visible from a distance, changes colors to indicate current operational status of the test.

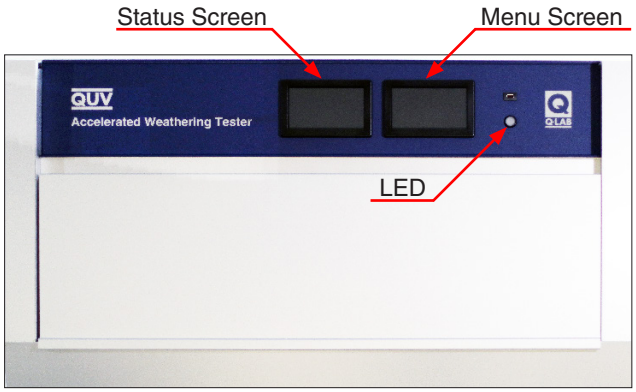



Figure 9.1a: Touch-screens and LED locations.

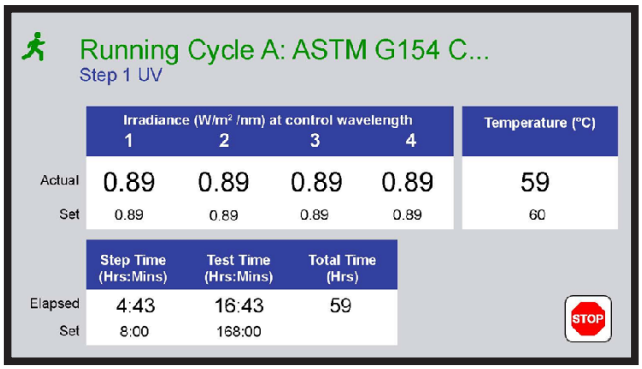



Figure 9.1b: Status screen displaying typical operating conditions.

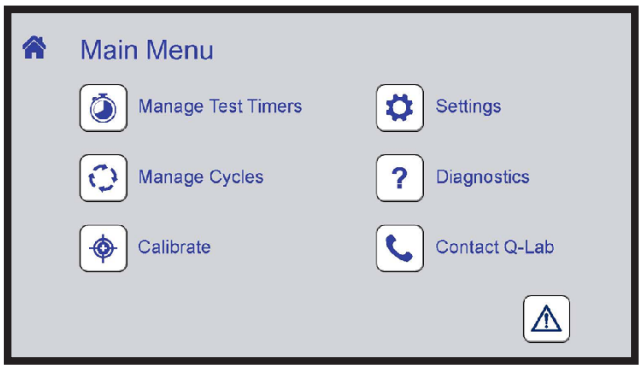



Figure 9.1c: Menu screen displaying the main menu.

Figure 9.1d: Touch to activate.

## 9.2. Status Screen (Sep 2020)

- The Status Screen (Figure 9.2a) displays:
  - The status icon and state that indicates the overall status of the tester (see Overall Test Status).
  - The cycle identification and the name of the test being run.
  - The current test step number and type of step.
  - Actual irradiance and set point irradiance values for all four sensor channels.
  - Actual temperature and set point temperature of the panel temperature sensor.
  - Elapsed and set step time and test time.
  - Tester total operation time.
  - RUN / STOP button. This button is the only operator control interface on the status screen.

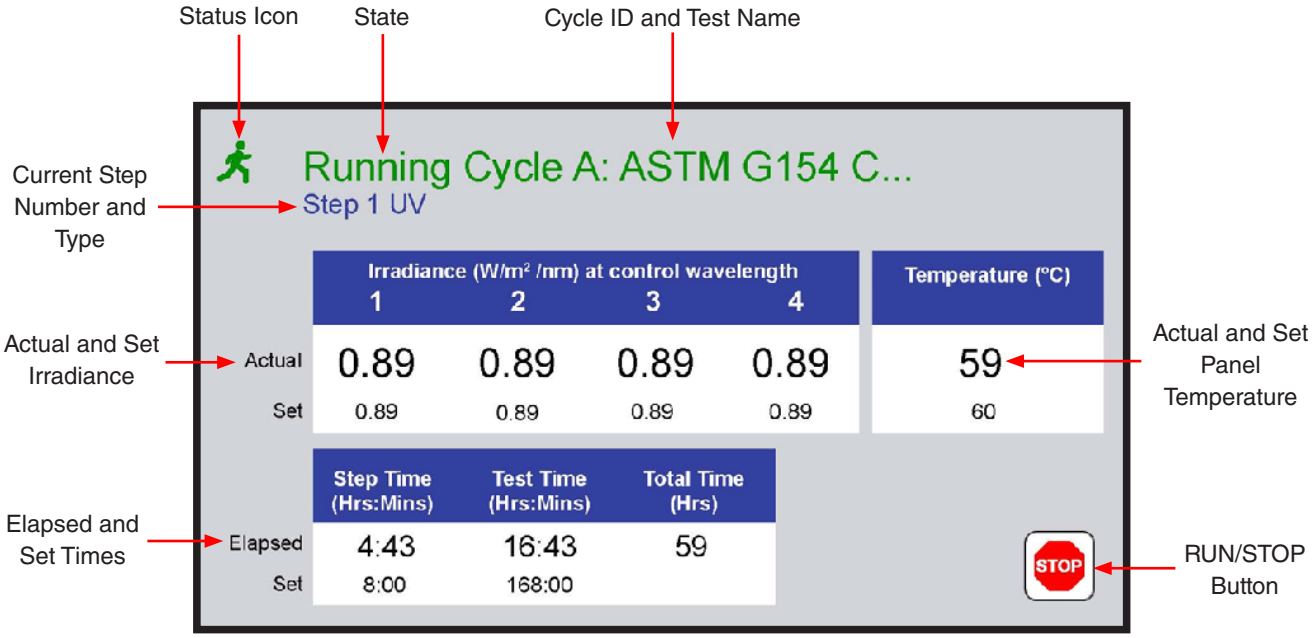



Figure 9.2a: Status screen components.

## Overall Test Status

- A colored icon and title at the top of the screen indicate the overall status of the test: running or stopped (Figure 9.2b, Figure 9.2c).
- Icons in the lower right corner of the screen can be used to stop or run the test.
- The title also shows the test cycle letter and the name of the test cycle.
- The LED status indicator changes color corresponding to the icon and title status.
- The table below summarizes all status conditions.

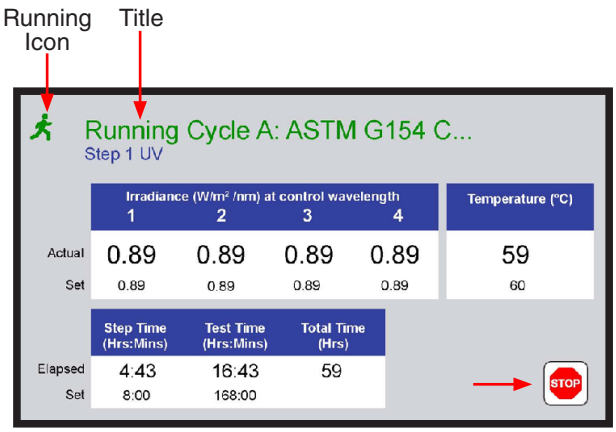



Figure 9.2b: Status icon and title when test running.

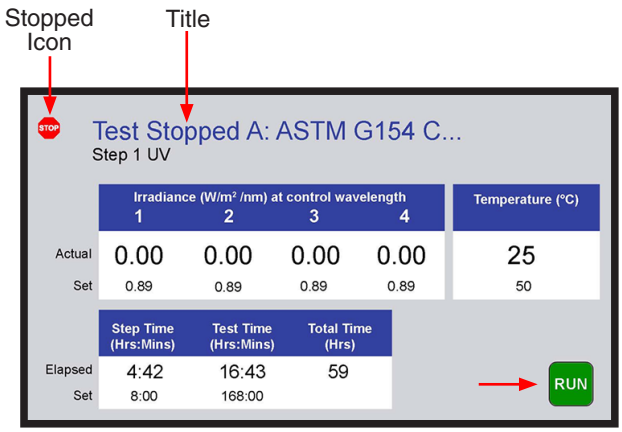



Figure 9.2c: Status icon and title when test stopped.

| Icon | Title (color) | LED (color, condition) | Status |
|---|---|---|---|
|  | Running Cycle (Green) | (Green, Static) | Test running normally, no active notifications. |
|  | Test Completed (Blue) | (Blue, Flashing) | Test completed. |
|  | Running Cycle (Green) | (Yellow, Flashing) | Test running, one or more notifications. |
|  | Test Stopped (Blue) | (White, Static) | Power on, stopped, no active notifications (standby). |
|  | Test Suspended (Red) | (Red, Flashing) | Error, test stopped. Check Notifications on the menu screen. |
| Does not affect the icon. | Does not affect the title. | (Magenta, Static) | Software Install or VSC transfer using USB port. |

## 9.3. Main Menu Screen (Jul 2020)

- The Main Menu is the home display for the menu screen (Figure 9.3a).
- The Main Menu screen provides access to all other operator controls for the tester.
- The Main Menu displays icons to access these functions:
  - Main Menu
  - Manage Test Timers (Section 9.5)
  - Manage Cycles (Section 9.6)
  - Calibrate (Section 11)
  - Settings (Section 9.7)
  - Diagnostics (Section 9.8)
  - Contact Q-Lab (Section 9.9)
  - Notifications (Section 9.4)

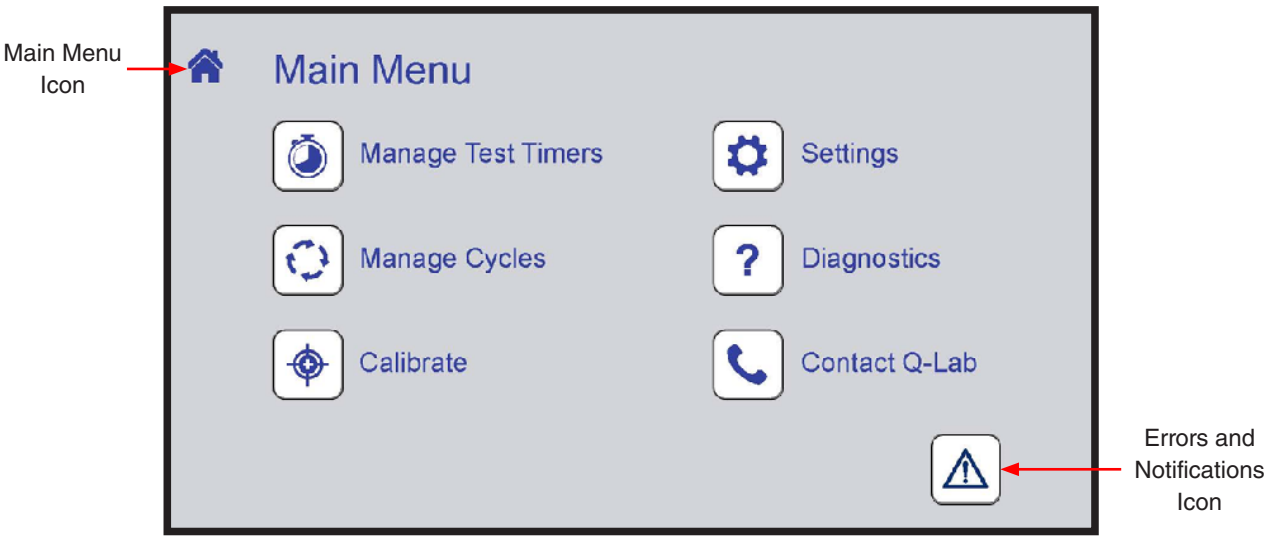



Figure 9.3a: Main Menu screen.

## 9.4. Notifications (Jul 2020)

- Notifications provide useful diagnostic information for technicians and repair personnel.
- Notifications show significant tester events and errors that occurred in the recent past.
- Up to 50 notifications are automatically stored by the QUV controller.
- On the Main Menu screen, touch the notification icon to display the Notifications Screen (Figure 9.4a).
- The type, information icon, identification code (ex. M10), and name are displayed for each notification (Figure 9.4b).
- "Active" and "Cleared" notifications are listed separately, in chronological order, most recent at the top of the list (Figure 9.4c, Figure 9.4d).
- Color-coded attention icons indicate the type of notification (Figure 9.4e).
  - A red triangle indicates an error occurred that stopped the test.
  - A yellow triangle indicates an event that did not stop the test, such as a maintenance reminder.
  - A blue triangle indicates the successful completion of a test.
- Touch the notification information icon to display details (Figure 9.4f and Figure 9.4g).
- See Section 15.1 for a complete list of notifications.

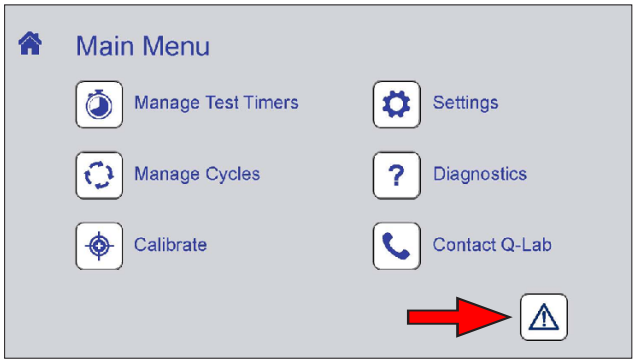



Figure 9.4a: The notifications icon. Icon color changes depending on notification status.

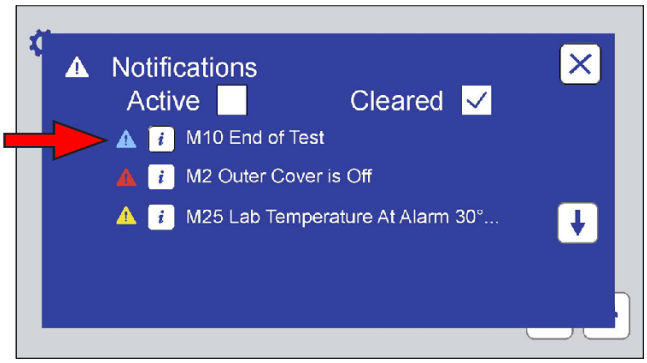



Figure 9.4b: The Notifications Screen lists notification information.

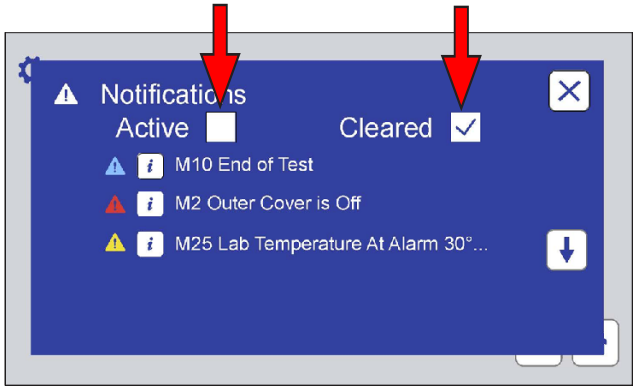



Figure 9.4c: Touch the Active or Cleared check box to view active or cleared notifications.

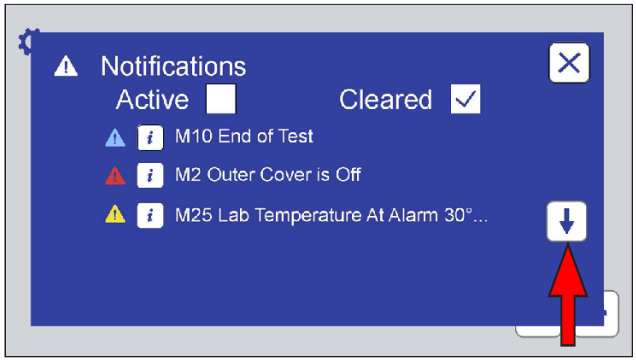



Figure 9.4d: Touch the scroll button(s) to move down or up the notification list.

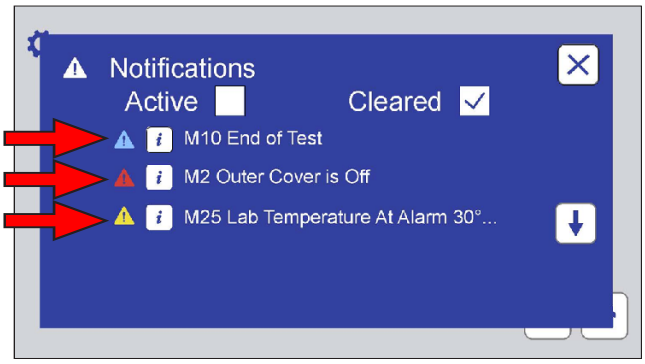



Figure 9.4e: Color coded icons show notification type.

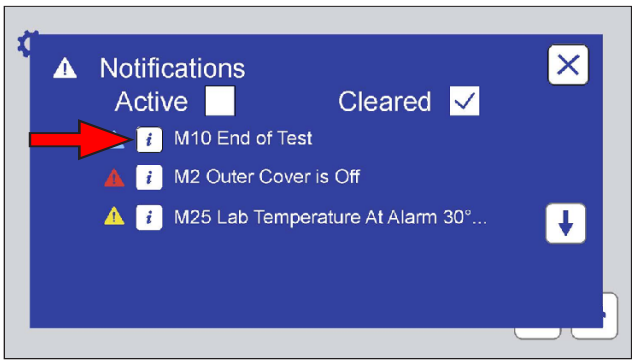



Figure 9.4f: Touch the information icon to display notification details.

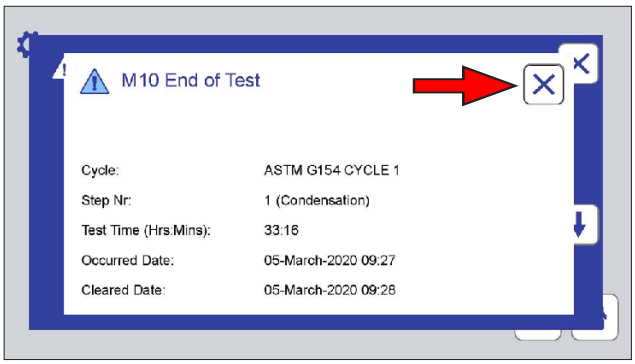



Figure 9.4g: Notification details. Touch the Close icon to return to the Notifications Screen.

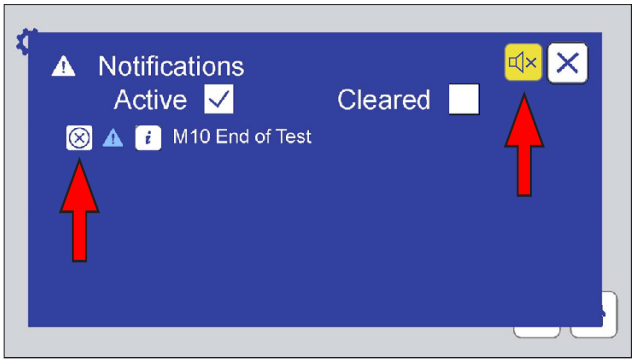



Figure 9.4h: If the alarm is active, touch the yellow mute icon to silence. When the notification has been resolved, touch the icon to the left of the notification to clear it.

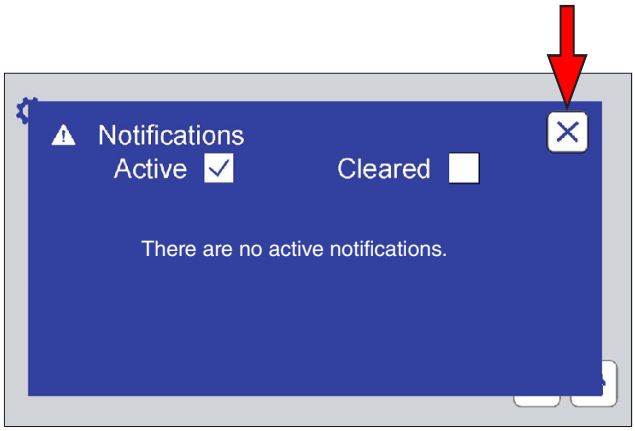
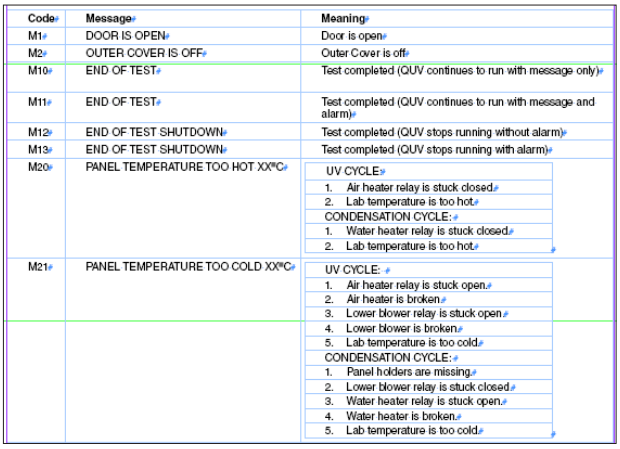



Figure 9.4i: Touch the Notification Screen close icon to re-display the main menu.



| Code | Message | Meaning |
|---|---|---|
| M1 | DOOR IS OPEN | Door is open |
| M2 | OUTER COVER IS OFF | Outer Cover is off |
| M10 | END OF TEST | Test completed (QUV continues to run with message only) |
| M11 | END OF TEST | Test completed (QUV continues to run with message and alarm) |
| M12 | END OF TEST SHUTDOWN | Test completed (QUV stops running without alarm) |
| M13 | END OF TEST SHUTDOWN | Test completed (QUV stops running with alarm) |
| M20 | PANEL TEMPERATURE TOO HOT XX°C | UV CYCLE<br>1. Air heater relay is stuck closed.<br>2. Lab temperature is too hot.<br>CONDENSATION CYCLE:<br>1. Water heater relay is stuck closed.<br>2. Lab temperature is too hot. |
| M21 | PANEL TEMPERATURE TOO COLD XX°C | UV CYCLE:<br>1. Air heater relay is stuck open.<br>2. Air heater is broken.<br>3. Lower blower relay is stuck open.<br>4. Lower blower is broken.<br>5. Lab temperature is too cold.<br>CONDENSATION CYCLE:<br>1. Panel holders are missing.<br>2. Lower blower relay is stuck closed.<br>3. Water heater relay is stuck open.<br>4. Water heater is broken.<br>5. Lab temperature is too cold. |

Figure 9.4j: A complete list of notifications and their meaning is given in Section 15.1.

## 9.5. Manage Test Timers (Aug 2020)

- On the Main Menu screen touch the Manage Test Timers icon to display the Manage Test Timers screen (Figure 9.5a).
- The Manage Test Timers screen provides three functions:
  1. Specify what action the tester should perform at the end of a test (Figure 9.5b and Figure 9.5c).
     - Stop
     - Message only
     - Alarm only
     - Stop and alarm
     - None
  2. Set test elapsed time.
     - Change the elapsed time in hours and minutes for the current test (Figure 9.5d).
  3. Set test duration.
     - Set the duration in hours and minutes for the current test (Figure 9.5e).
- If any changes are made to Manage Test Timers, the operator can accept or cancel the changes (Figure 9.5f and Figure 9.5g)

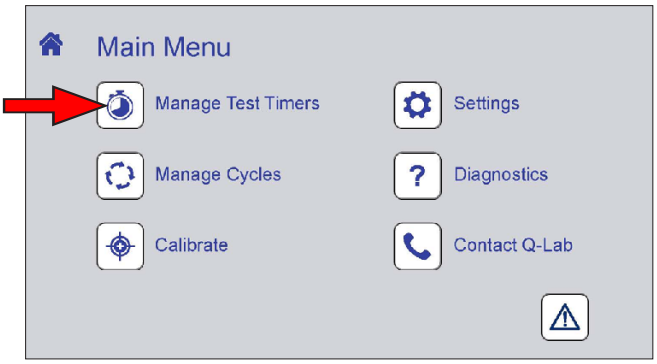



Figure 9.5a: Manage Test Timers icon.

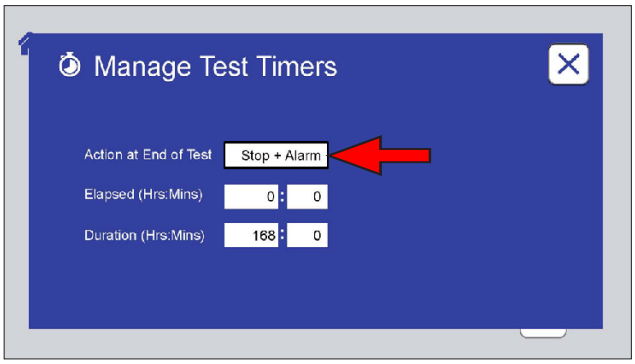



Figure 9.5b: Manage Test Timers screen. Touch the Action at End of Test text box to specify the action.

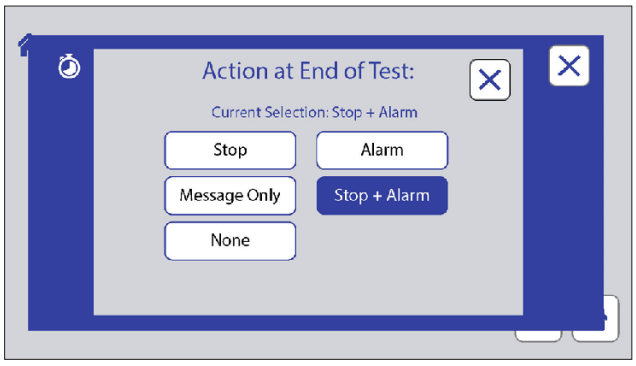



Figure 9.5c: Action at End of Test screen. Touch an action button to select that action.

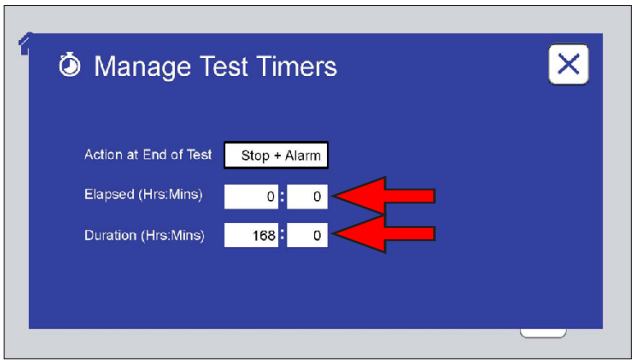



Figure 9.5d: Touch the Elapsed or Duration text boxes to reset the elapsed or duration time of the current test. A numeric keypad will be displayed.

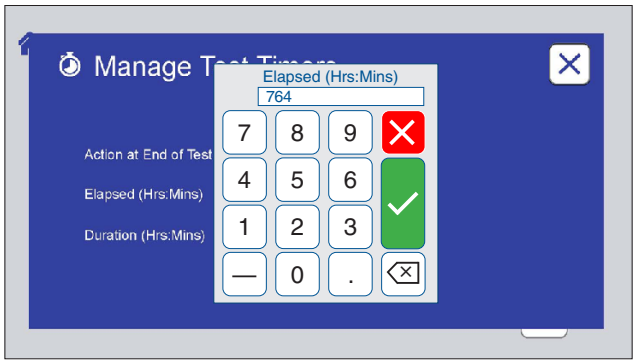



Figure 9.5e: Enter the desired hours and minutes. Touch the check mark to save, or the X to cancel changes.

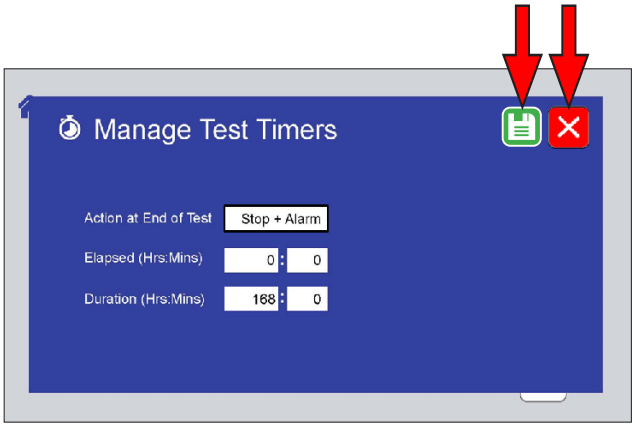



Figure 9.5f: If any changes have been made, touch the save changes icon or the cancel changes icon to re-display the Main Menu screen.

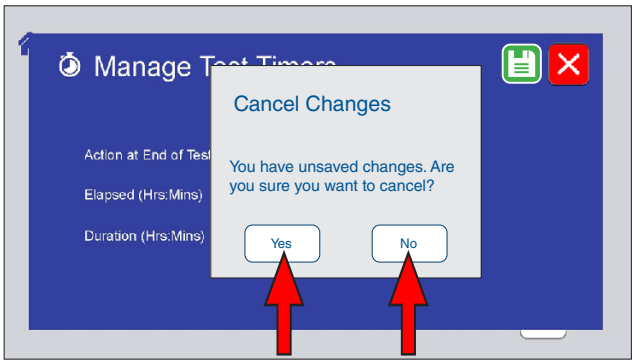



Figure 9.5g: If the cancel changes icon is touched, the operator is prompted for verification. Touch Yes or No.

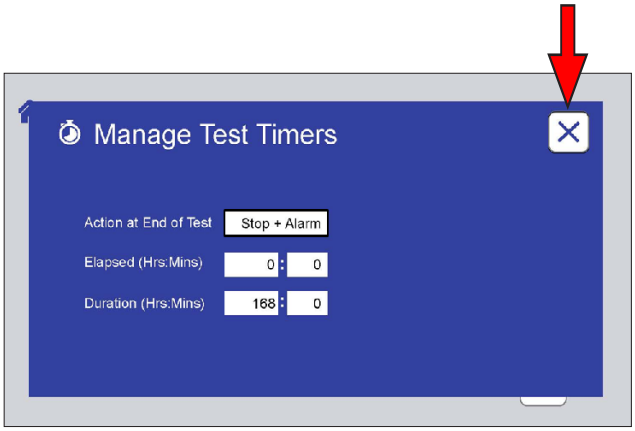



Figure 9.5h: Touch the Manage Test Timers screen close icon to re-display the main menu.

## 9.6. Manage Cycles (Aug 2020)

- On the Main Menu screen touch the Manage Cycles icon (Figure 9.6.1a) to display the Manage Cycles screen.
- The Manage Cycles screen is displayed showing the active test cycle and the steps in the cycle, with the currently executing step indicated (Figure 9.6.1b).
- Each cycle is stored with an alphanumeric (A through M) identification tab (Figure 9.6.1b).
  - Touch a tab to select a cycle.
    - The cycle name (ex. ASTM G154 CYCLE 1) along with step number, function, irradiance and temperature set points, and time are shown for each step in the cycle.
- Each lettered cycle tab provides controls to:
  - Delete a cycle (Figure 9.6.2a).
    - An actively running cycle cannot be deleted (Figure 9.6.2b).
    - Deleting an inactive cycle will create a blank cycle with only a final step (Figure 9.6.2c).
  - Lock a cycle to prevent unauthorized changes (Figure 9.6.3a through Figure 9.6.3e).
  - Add, edit, or delete steps in a cycle (Figure 9.6.4a through Figure 9.6.6c). Pre-programmed test cycles cannot be edited (they can be deleted).
  - Create a new cycle (Figure 9.6.7a through Figure 9.6.7e).
  - Run a cycle from any of its steps (Figure 9.6.8a through Figure 9.6.8d).
- The QUV main controller can store thirteen (13) test cycles.
- A test cycle can consist of up to twenty-five (25) steps.

### 9.6.1 Select a Cycle

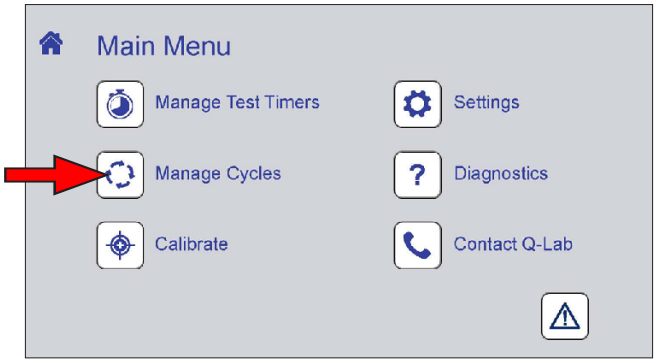



Figure 9.6.1a: Manage Cycles icon.

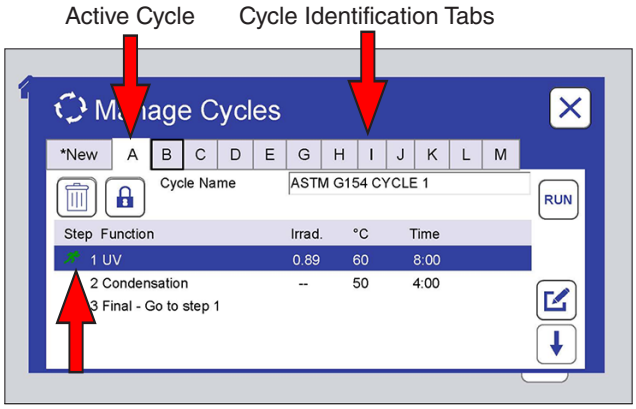



Figure 9.6.1b: Manage Cycles screen. The active cycle is displayed. The currently running step is indicated. Touch any ID tab to display that cycle.

## 9.6.2 Delete a Cycle

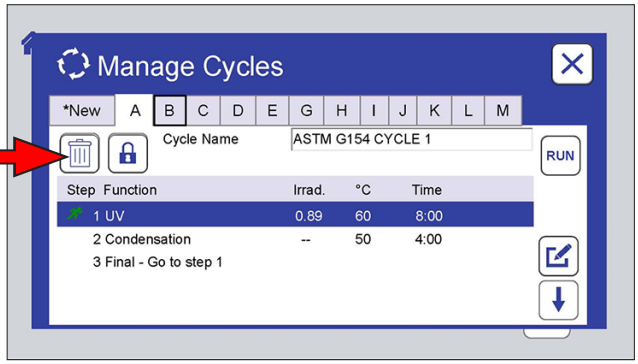



Figure 9.6.2a: Touch the delete icon to delete the selected cycle.

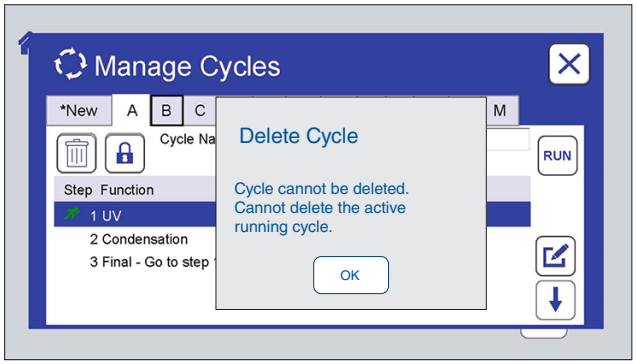



Figure 9.6.2b: The active running cycle cannot be deleted. Touch OK to clear message.

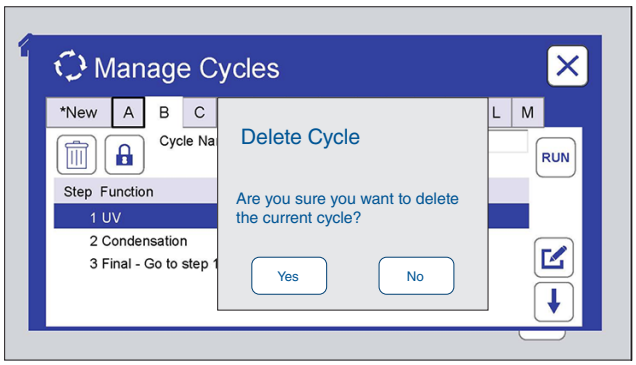



Figure 9.6.2c: To delete an inactive cycle, the operator is prompted for verification. Touch No to cancel delete. Touch Yes to create a blank cycle.

## 9.6.3 Lock a Cycle

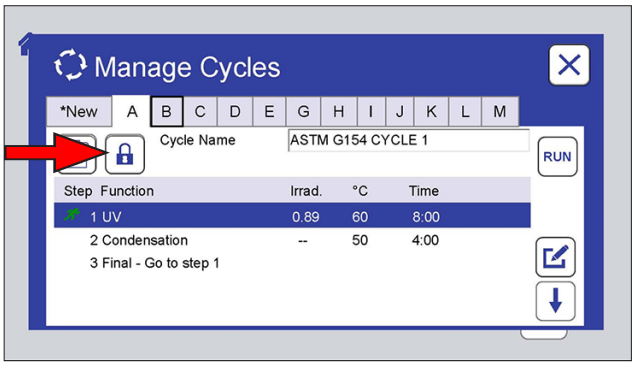



Figure 9.6.3a: Touch the lock icon to lock the cycle.

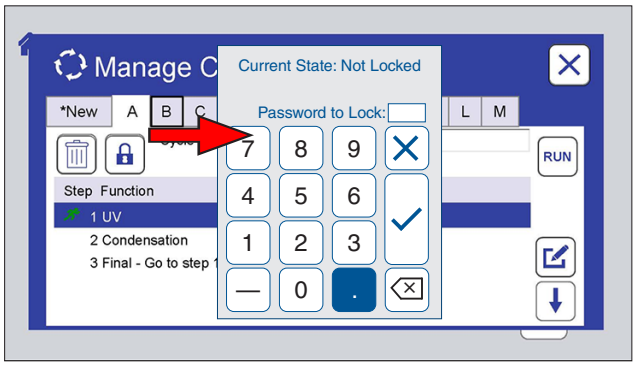



Figure 9.6.3b: The numeric keypad is displayed. A password must be entered to lock the cycle.

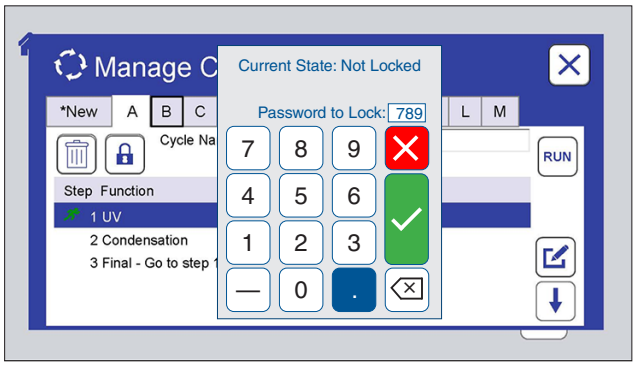



Figure 9.6.3c: Enter the numeric password. Touch the check mark button to save, or the X button to cancel setting the password.

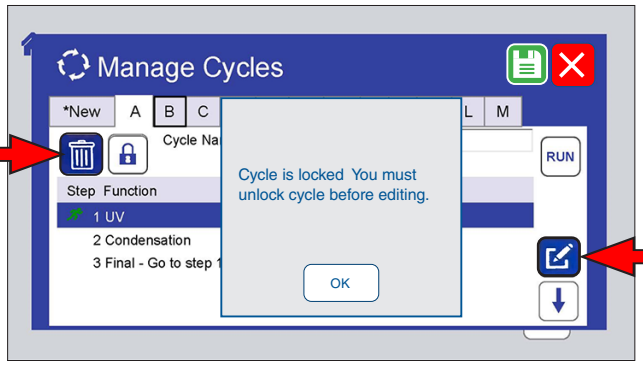



Figure 9.6.3d: This message is displayed if a delete or edit icon is touched on a locked cycle.

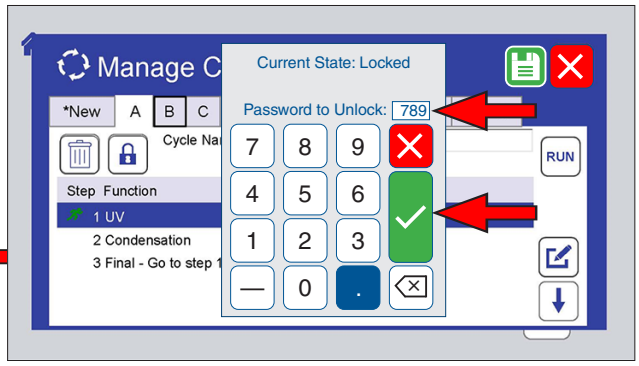



Figure 9.6.3e: To unlock a cycle, touch the lock icon, enter the password, then touch the check mark button.

## 9.6.4 Add a Step to a Cycle

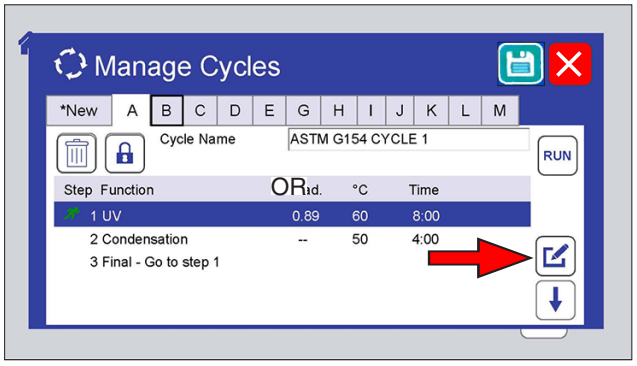



Figure 9.6.4a: For any cycle, a new step can be added before or after an existing step. Select the existing step then touch the Edit icon.

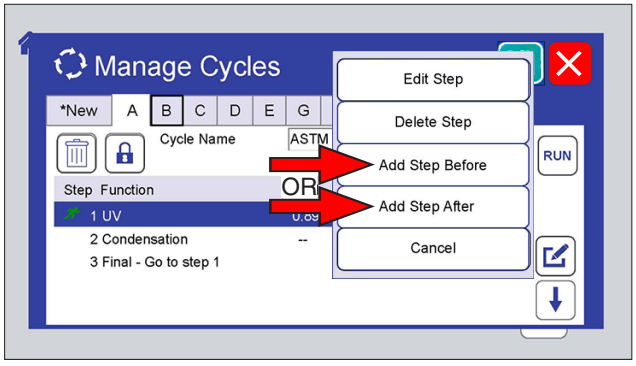



Figure 9.6.4b: Touch Add Step Before or Add Step After.

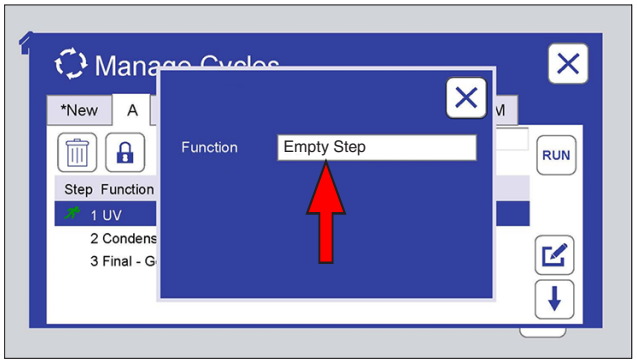



Figure 9.6.4c: Touch the function text box to select a function.

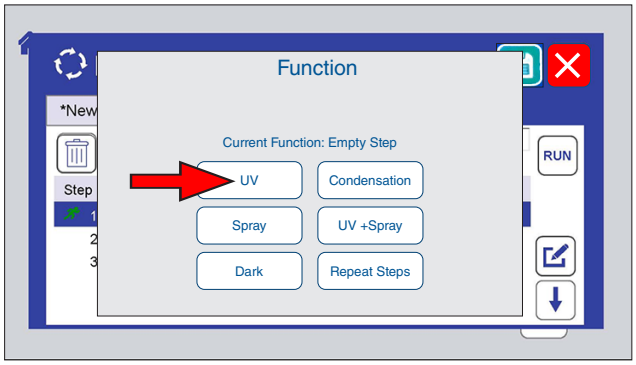



Figure 9.6.4d: Touch the desired function. Spray functions are displayed for spray (S) models only.

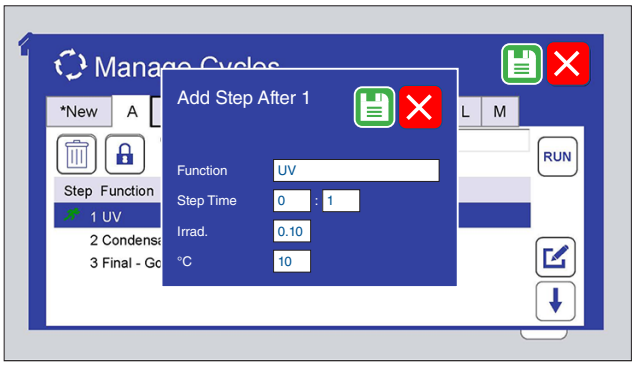



Figure 9.6.4e: Step values must be entered. Touch the Step Time (Hrs:Mins), Irrad(iance), and °C text boxes to select.

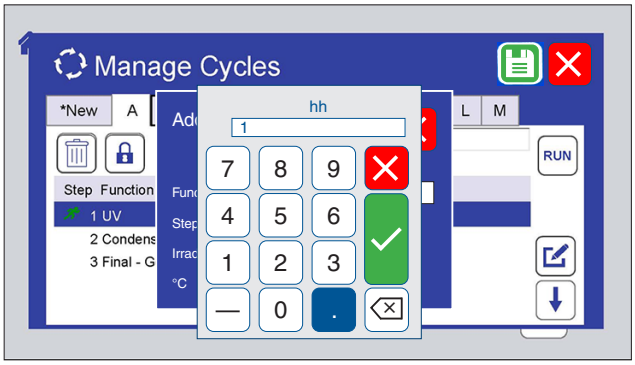



Figure 9.6.4f: Use the numeric keypad to enter the values for each parameter. Touch the check mark button to accept those values or the X button to cancel.

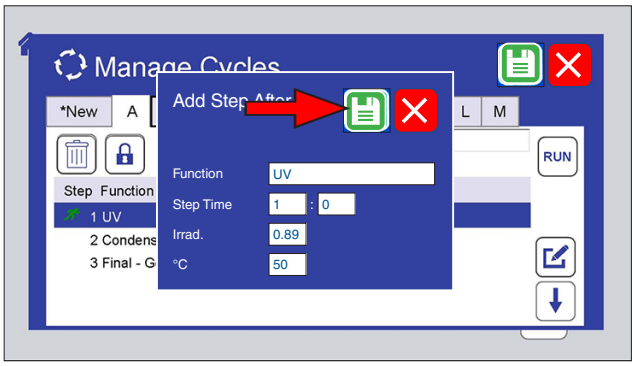



Figure 9.6.4g: The new step values are displayed. Touch the save icon to save the new step.

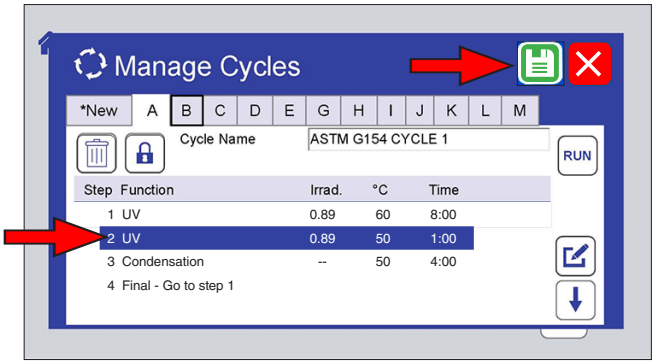



Figure 9.6.4h: The new step is shown for the cycle. Touch the save icon to save the modified cycle.

## 9.6.5 Edit a Step

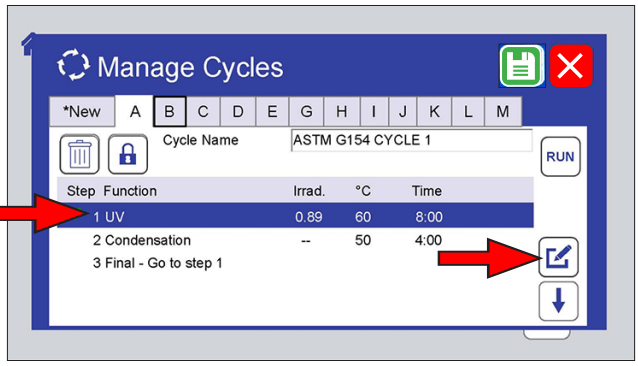



Figure 9.6.5a: To edit a step, touch the cycle ID tab, touch the step to select, then touch the pencil icon.

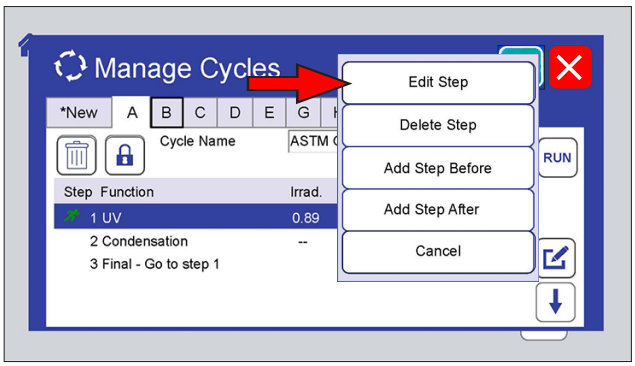



Figure 9.6.5b: Select Edit Step.

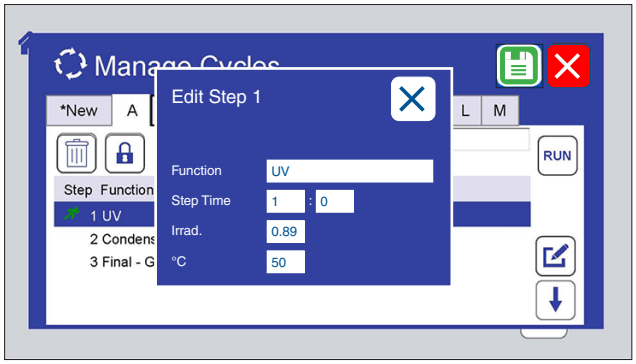



Figure 9.6.5c: Touch the Function, Step Time, Irradiance, or °C text boxes to select.

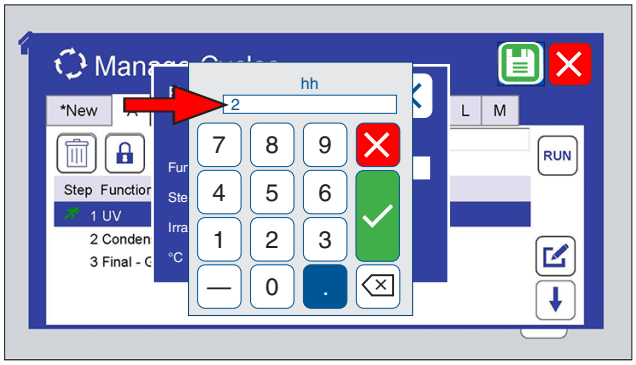



Figure 9.6.5d: Use the numeric keypad to enter the new values for the selected step. Touch the check mark button to accept those values or the X button to cancel.

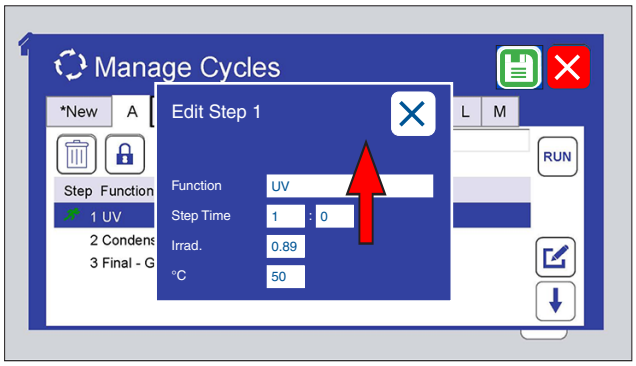



Figure 9.6.5e: Touch the save icon to save the edited step.

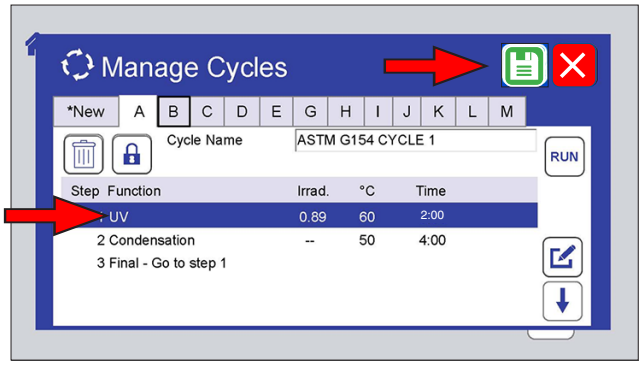



Figure 9.6.5f: The edited step is shown for the cycle. Touch the save icon to save the edited cycle.

## 9.6.6 Delete a Step

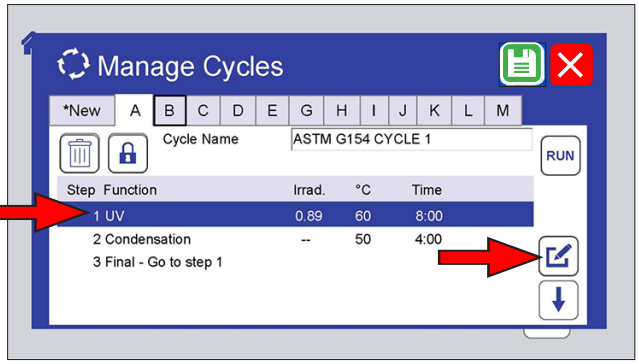



Figure 9.6.6a: To delete a step, touch the cycle ID tab, touch the step to delete, then touch the pencil icon.

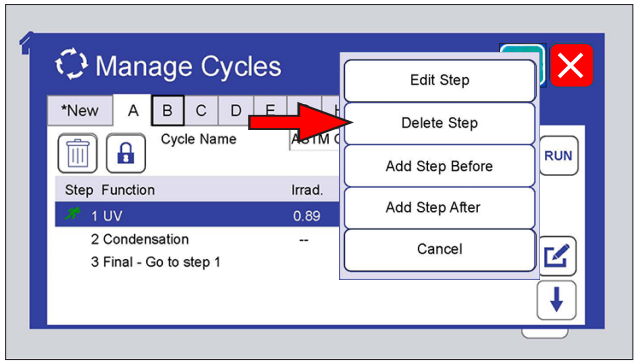



Figure 9.6.6b: Select Delete Step.

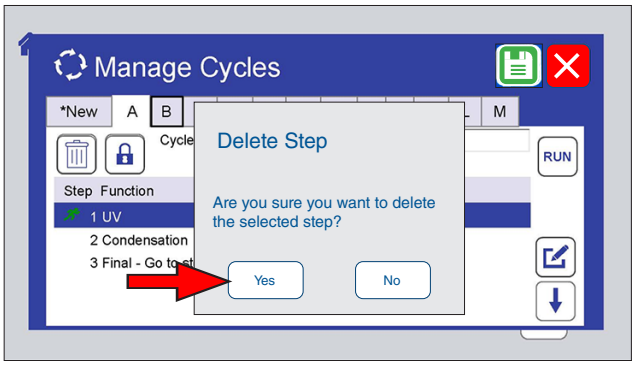



Figure 9.6.6c: Touch the Yes button to delete the step or touch No to cancel the delete.

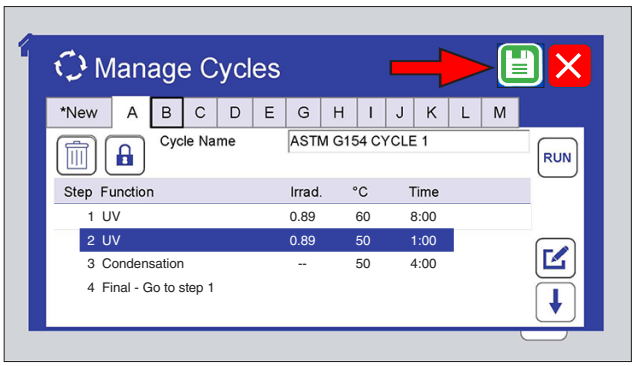



Figure 9.6.6d: Touch the save icon to save the edited cycle.

## 9.6.7 Create a New Cycle

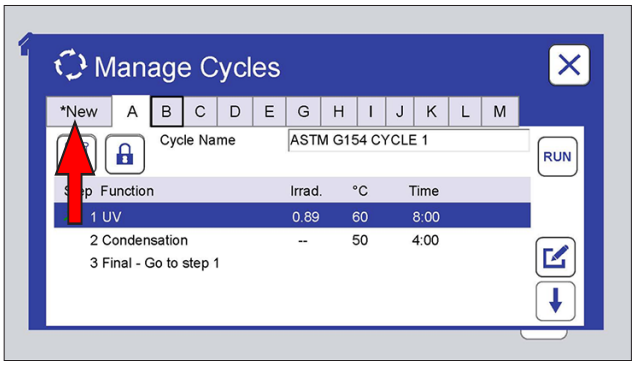



Figure 9.6.7a: To create a new cycle, touch the *New tab.

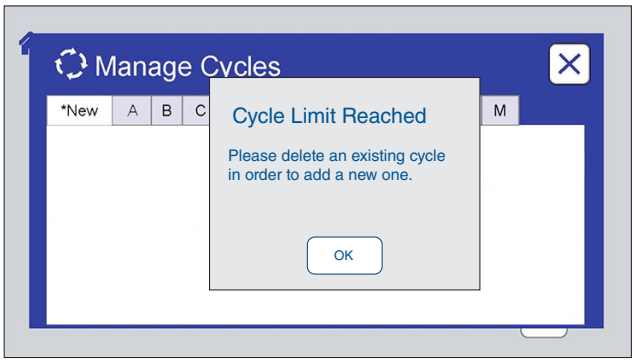



Figure 9.6.7b: If all available cycles are programmed, this message is displayed Touch OK.

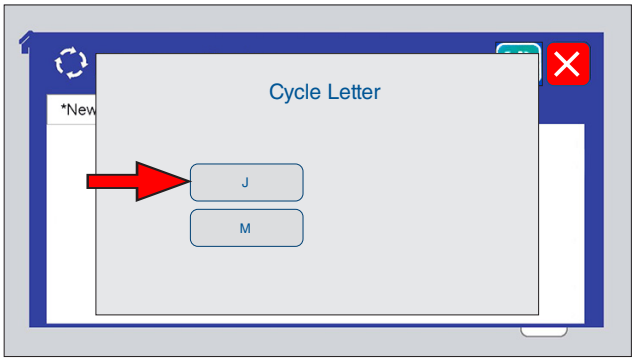



Figure 9.6.7c: If there are open cycles, the available cycle letters are displayed. Touch a letter to program that cycle.

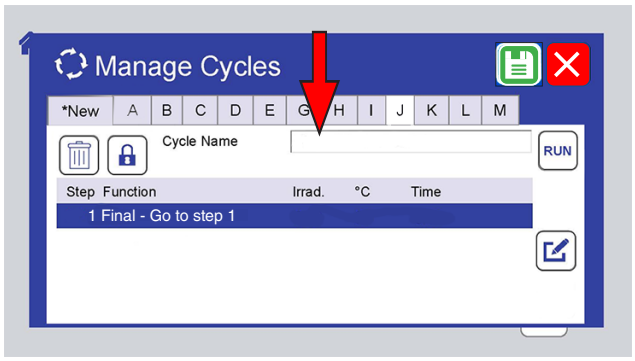



Figure 9.6.7d: An empty cycle is created with only a final step. Enter a name for the new cycle.

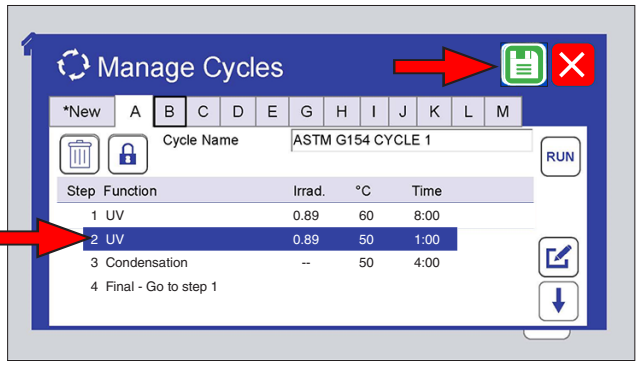



Figure 9.6.7e: Follow Figure 9.6.4a through Figure 9.6.4h to add steps and save the new cycle.

## 9.6.8 Run From Step

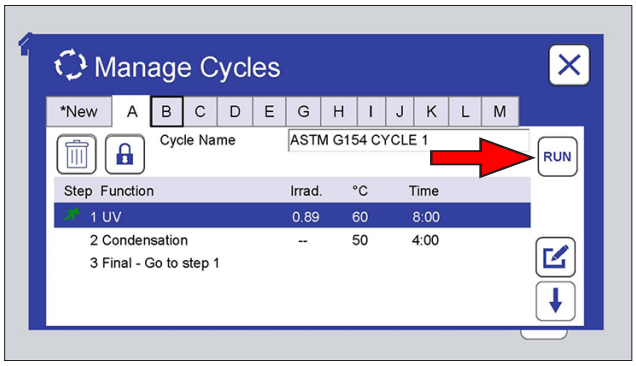



Figure 9.6.8a: A cycle can be run from a specified time in one of its steps. Select the step, then touch the Run icon.

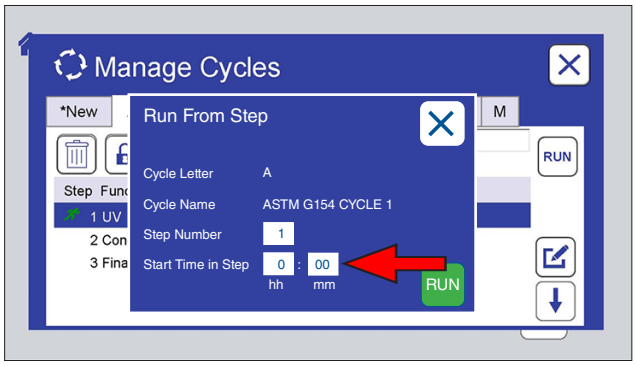



Figure 9.6.8b: Touch the start time hh (hours) text box or the mm (minutes) text box to set the time.

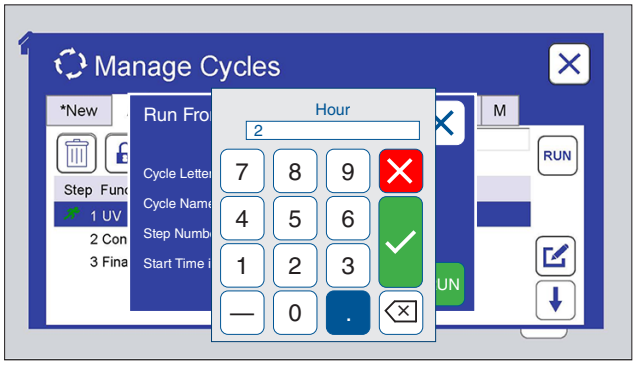



Figure 9.6.8c: Use the numeric key pad to set the time. Touch the check mark button to accept those values or the X button to cancel.

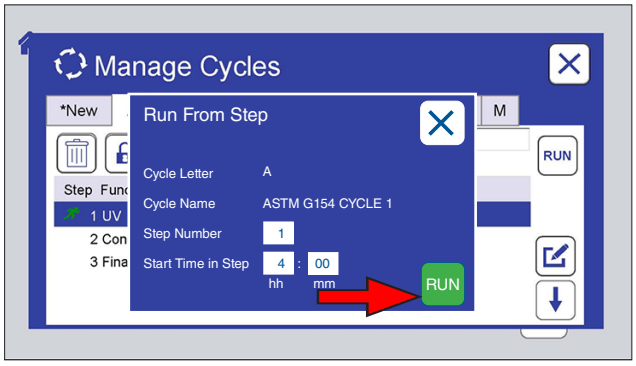



Figure 9.6.8d: Touch the Run icon to run the step from the time entered.

## 9.7. Settings (Aug 2020)

- On the Main Menu screen touch the Settings icon (Figure 9.7a) to display the Settings screen.
- The Settings screen displays user-selectable machine parameters (Figure 9.7b)
  - o Volume (Figure 9.7c).
    - Alarm
    - Touch
  - o Display Options (Figure 9.7e)
    - Status Screen Brightness
    - Main Menu Screen Brightness
    - Sleep Time
  - o Language & Date/Time (Figure 9.7i & Figure 9.7m). Languages available are English, French, Spanish, German, Italian, Chinese, Japanese, and Korean.
  - o Ethernet (Figure 9.7q).
  - o Machine Configuration (Figure 9.7u). Contact Q-Lab Repair and Tester Support for more information on using this setting.
- The QUV can be operated using just one screen.
  - o In the event of the failure of either screen, the controller will automatically reconfigure to use just the functioning screen to maintain full operation of the tester. This will be indicated by the appropriate error message M900, M901, or M902 (see Section 15.1).
  - o A button appears in the upper right corner of the screen to toggle the remaining screen between Main Menu and Status displays.

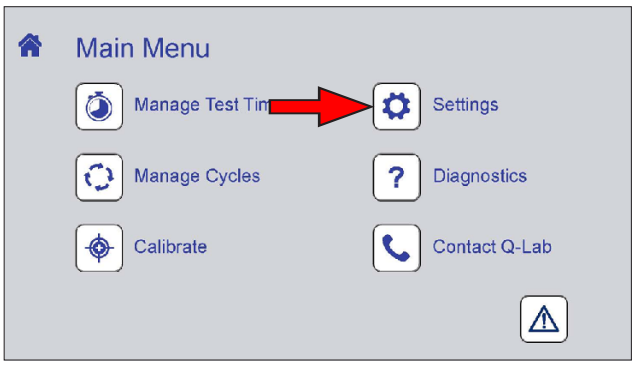



Figure 9.7a: Touch the Settings icon on the Main Menu screen to display settings controls.

**Settings**

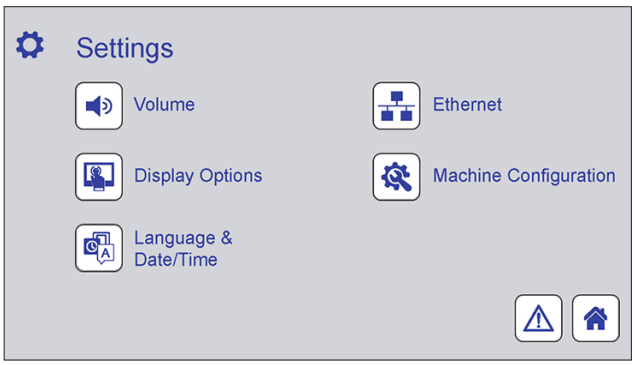



Figure 9.7b: Settings screen. Touch any icon to display controls for that function. The notification screen (Section 9.4) and the home screen can also be displayed.

## Volume

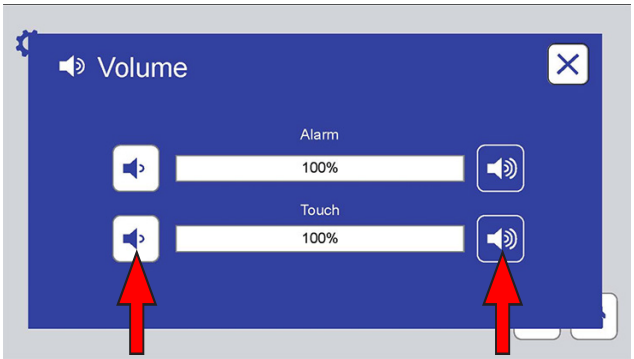



Figure 9.7c: The Volume screen provides controls to set volume (0 to 100) for machine alarms and for the screen touch indicator. Touch a volume icon to adjust.

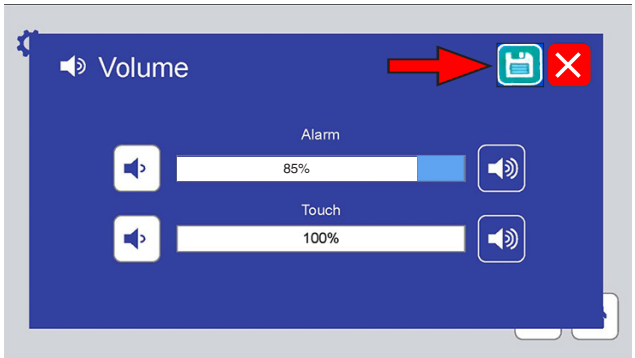



Figure 9.7d: If a volume is changed, touch the save icon to save the new volume level.

## Display Options

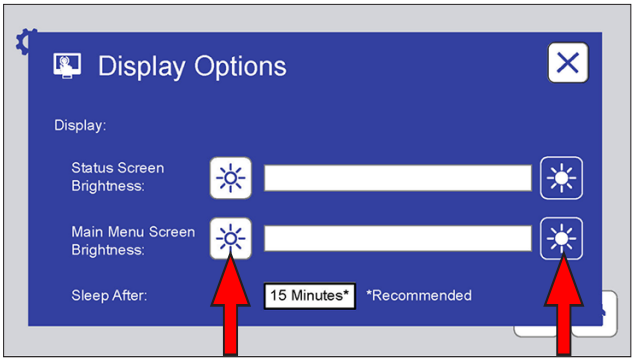



Figure 9.7e: The Display Options screen provides controls to adjust the brightness of the status and menu screens. Touch a brightness icon to adjust.

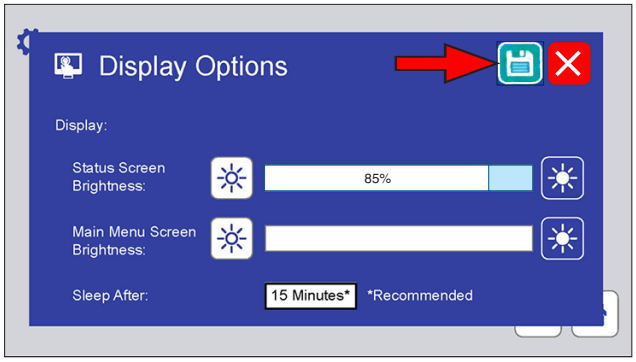



Figure 9.7f: If a brightness is changed, touch the save icon to save the new volume level.

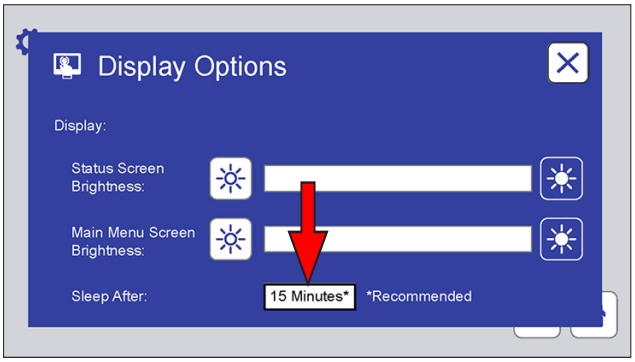



Figure 9.7g: The Display Options screen can also be used to adjust the inactive time that elapses before the screens “go to sleep” (i.e. deactivate). 15 minutes is recommended.

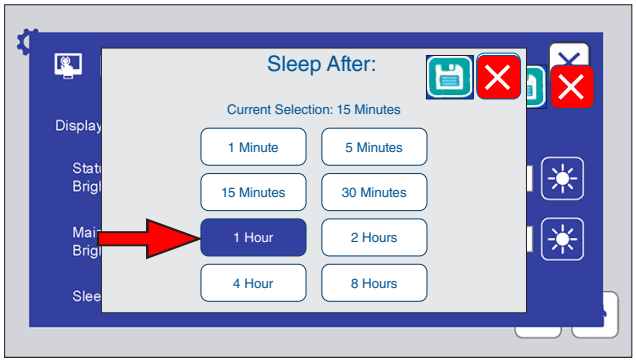



Figure 9.7h: Touch a time button to change the time before screens go to sleep. If changed, touch the save icon to save the new time.

## Language

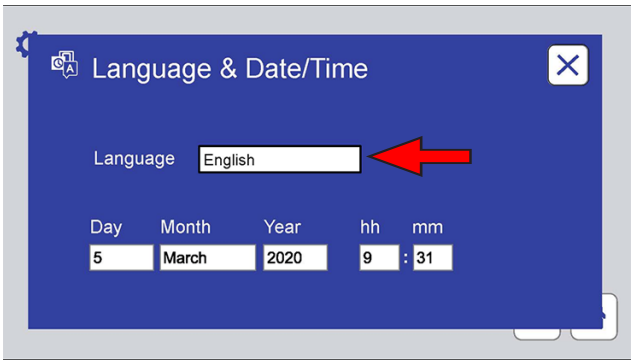



Figure 9.7i: This screen displays controls to select the control interface language.


Figure 9.7j: Touch the language text box to display the possible display languages.


Figure 9.7k: Touch the text box for the desired language.


Figure 9.7l: All text on both screens will be in the selected language. Touch the save icon to save the selection.

## Date/Time

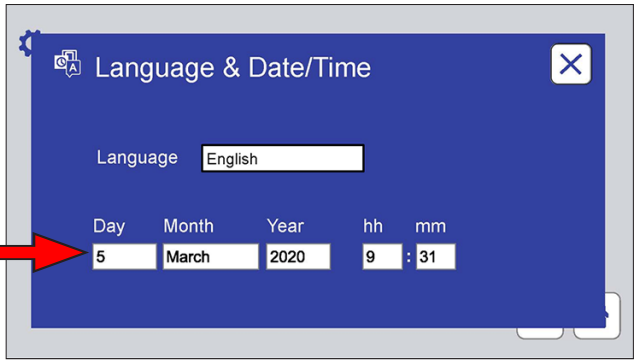



Figure 9.7m: This screen displays controls to set the date and time. Touch a text box to set Day, Month, Year, hh (hour) or mm (minute). hh display is always 24 hour time.

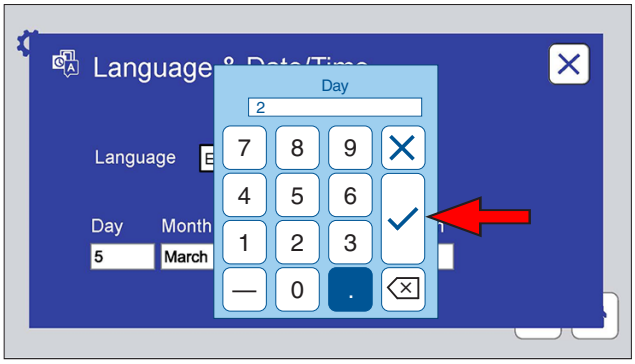



Figure 9.7n: The numeric keypad is used to set Day, Year, hh, and mm. Enter the number, then touch the check mark button.

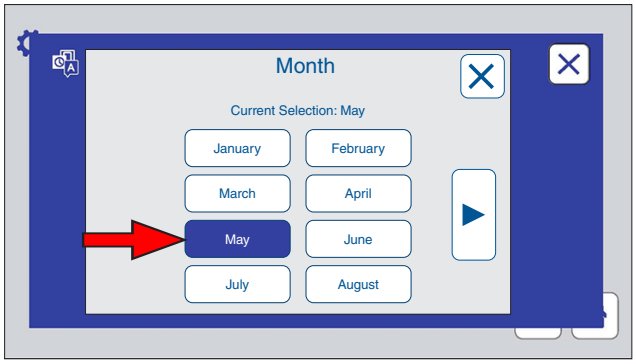



Figure 9.7o: Touch the month button to select the month on this display. Touch the right arrow button to display the remaining months.

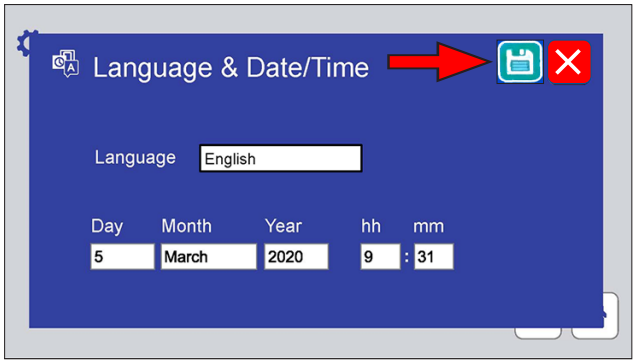



Figure 9.7p: Touch the save icon to save any changes to the Language & Date/Time.

## Ethernet

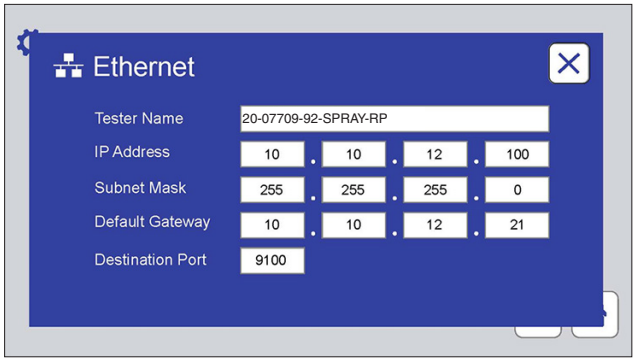



Figure 9.7q: This screen displays and provides text boxes to enter ethernet connection parameters.

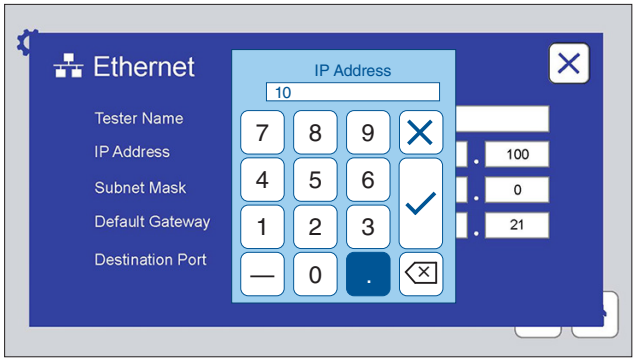



Figure 9.7r: Touch any text box to use the numeric keypad to input the parameter.

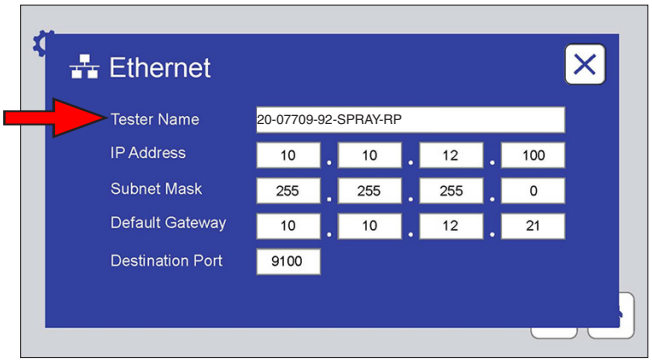



Figure 9.7s: Additionally, this screen has the name of the tester as it would appear on a network, if using the VIRTUAL STRIPCHART network version.

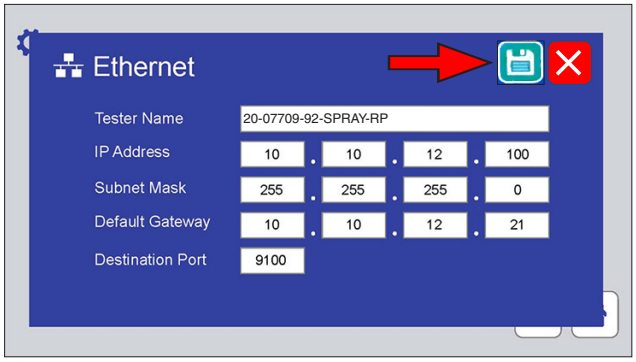



Figure 9.7t: Touch the save icon to save any changes to Ethernet parameters.

## Machine Configuration

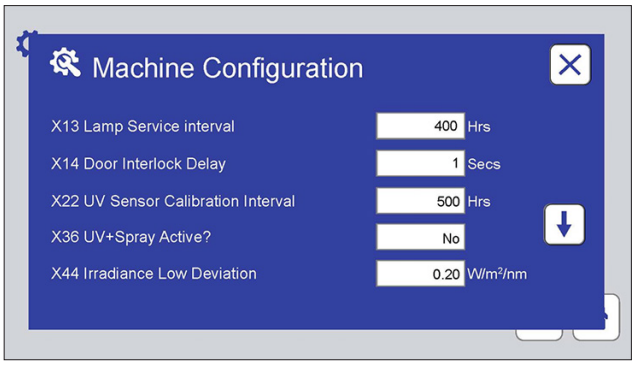



Figure 9.7u: Machine Configuration includes several customizable parameters. Please contact Q-Lab Repair with questions about parameters. Touch the down arrow to display additional parameters.

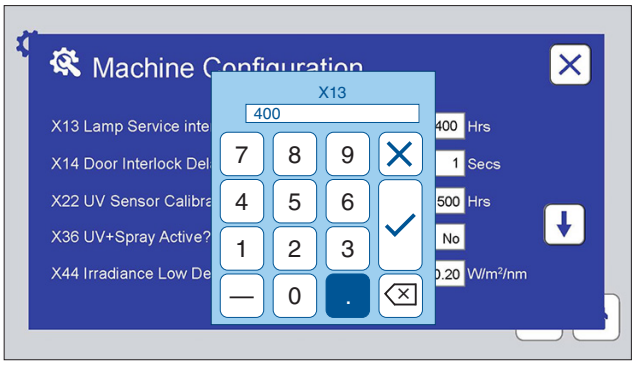



Figure 9.7v: Touch the parameter text box to use the numeric keypad to enter a value. Contact Q-Lab Repair and Tester Support for more information.

| No. | Name | Unit | Range | Default | Description |
|---|---|---|---|---|---|
| X14 | Door Interlock Delay | Secs | 1-99 | 1 | This is a delay that will prevent the “M1 Door is Open” alarm from sounding when an open door is detected before a designated amount of time. This delay is used to prevent nuisance alarms. |
| X22 | UV Sensor Calibration Interval | Hrs | 0-999 | 500 | This is the allowed duration that the UV sensors can be used before the sensors must be calibrated. Once the time limit has been reached, the “M66 Calibrate UV sensors” alarm will sound. |
| X36 | UV+Spray Active? | | Yes/No | No | This enables the tester to perform the UV + spray function. The UV + spray function is used in QUV/spray model. |
| X44 | Irradiance Low Deviation | $W/m^2$ | 1-100 | 0.20 | This is the amount the irradiance value must be below the set point to produce the “M51 UV Irradiance Channel X Too Low” alarm. |
| X49 | Spray On Time | Secs | 5-999 | 5 | This determines the length of time that water is sprayed. Water will be sprayed continuously unless X50 Spray Off Time is non-zero. This parameter describes how long the spray relay will be turned on. |
| X50 | Spray Off Time | Secs | 0-999 | 0 | This determines the length of time that the spray relay will be turned off during a spray step. |
| X500 | Serial Number Year | | ## | | Two-digit year of tester manufacture from serial number |
| X501 | Serial Number Unique ID | | ##### | | Five-digit unique tester ID from serial number |
| X502 | Serial Number Series | | ### | | Two- or three-digit tester series from serial number |

Figure 9.7w: Complete list of accessible essential parameters.

## 9.8. Diagnostics (Aug 2020)

- Diagnostics are a list of tester current operating conditions (Figure 9.8b).
- Diagnostics are an important tool to assist in troubleshooting tester conditions.
- On the Main Menu screen, touch the Diagnostics icon (Figure 9.8a) to display the Diagnostics screen (Figure 9.8b).
- Press the UP or DOWN arrows to scroll through the diagnostics.
- There are no editable values on these screens.
- Checking the diagnostic information will not interrupt the test cycle in any way.

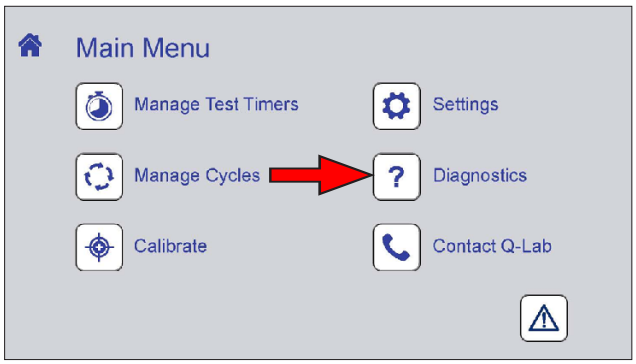



Figure 9.8a: Touch the Diagnostics icon on the Main Menu screen to display diagnostic information.

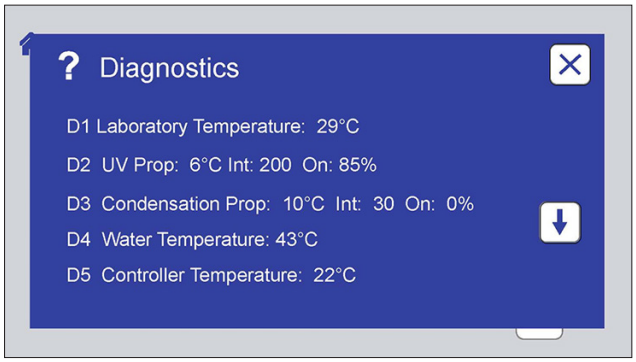



Figure 9.8b: The Diagnostics screen displays current machine operating conditions.

| No. | Name | Description |
|---|---|---|
| D1 | Laboratory temperature= XX °C | The current laboratory temperature. |
| D2 | UV Prop=XX °C, Int=XX On = XX% | The settings for controlling the panel temperature in a UV step and the percentage of time the chamber heater is on. |
| D3 | Cond Prop=XX °C, Int=XX, On=XX% | The settings for controlling the chamber temperature in a condensation step and the percentage of time the water heater is on. |
| D4 | Water temperature= XX °C | The current temperature of the water in the water pan. |
| D5 | Controller Temperature = XX °C | The current temperature of the controller. |
| D7 | Version X.XXX Checksum=XXXX | The software version and checksum. The checksum can be used by the software programmer to determine if there is a compiling error. |
| D9 | Joules/$m^2$ = XXX,XXX,XXX | The accumulated energy dosage. |
| D10 | XXXX Hours Since UV Sensor Cal | The elapsed time since the last “M66 Calibrate UV Sensors” alarm was cleared. |
| D11 | UV% CH1=XXX CH2=XXX CH3=XXX CH4=XXX | The output to each channel during UV, UV+spray, and UV+condensation steps. |
| D12 | Dark Prop=XX °C, Int=XX On = XX% | The settings for maintaining the panel temperature at the UV temperature set point during a dark step and the percentage of time the chamber heater is on. |
| D13 | UV+COND Prop= XXX °C Int=XXX On=XXX% | The settings for controlling the panel temperature in a UV+condensation step and the percentage of time the water heater is on. |
| D14 | Serial Number= XX-XXXXX-XX-XXXXX | The tester serial number as input either at Q-Lab or during a main controller replacement or reset operation. |
| D15 | MAC Address= XX-XX-XX-X-X-XX | The media access control (MAC) address for the tester. |

Figure 9.8c: Complete list of diagnostic numbers, names, and descriptions.

## 9.9. Contact Q-Lab (Aug 2020)

- The Contact Q-Lab screen displays the link to Q-Lab Repair and Tester Support on the web site.

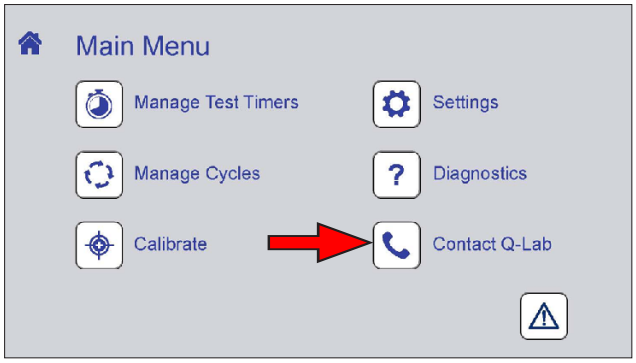



Figure 9.9a: Touch the Contact icon on the Main Menu screen to display Q-Lab contact information.

**Contact Q-Lab**


Figure 9.9b: Scan the code on this screen for Q-Lab contact information.

# 10. Running a Test

- Tests can be run using standard test cycles pre-programmed into the tester, or custom cycles can be constructed.
- Standard test cycles pre-programmed in the QUV are shown in Section 10.1.
- For instructions on modifying cycles or creating custom cycles see Section 9.6.
- Guidelines for choosing settings for custom cycles are given in Section 10.2.
- Various methods for mounting test specimens are illustrated in Section 10.3.
- Recommendations for repositioning test specimens are provided in Section 10.4.

## 10.1. Standard Test Cycles (Aug 2020)

- See Section 9.6 for detailed information on test cycle programming.
- The tables below list standard test cycle names, lamp type used, QUV models programmed with the cycle, and the test cycle step parameters. For models not shown in "Programmed in Models", the cycle will be blank.

| **Cycle A: ASTM G154 CYCLE 1** | | | | |
|---|---|---|---|---|
| Lamp Type: UVA-340, UVA-340+ | | | | |
| Programmed in Models: QUV/se, QUV/spray, QUV/spray/rp | | | | |
| STEP | FUNCTION | Irradiance (W/m²/nm) | Temperature (°C) | Time (hh:mm) |
| 1 | UV | 0.89 | 60 | 8:00 |
| 2 | Condensation | N/A | 50 | 4:00 |
| 3 | Final Step - Go to Step 1 | | | |

| **Cycle B: ASTM G154 CYCLE 2** | | | | |
|---|---|---|---|---|
| Lamp Type: UVB-313EL, UVB-313EL+ | | | | |
| Programmed in Models: QUV/se, QUV/spray, QUV/spray/rp | | | | |
| STEP | FUNCTION | Irradiance (W/m²/nm) | Temperature (°C) | Time (hh:mm) |
| 1 | UV | 0.71 | 60 | 4:00 |
| 2 | Condensation | N/A | 50 | 4:00 |
| 3 | Final Step - Go to Step 1 | | | |

| **Cycle C: SAE J2020 (also ASTM G154 CYCLE 3)** | | | | |
|---|---|---|---|---|
| Lamp Type: QFS-40, UVB-313EL, UVB-313EL+ | | | | |
| Programmed in Models: QUV/se, QUV/spray, QUV/spray/rp | | | | |
| STEP | FUNCTION | Irradiance (W/m²/nm) | Temperature (°C) | Time (hh:mm) |
| 1 | UV | 0.48 | 70 | 8:00 |
| 2 | Condensation | N/A | 50 | 4:00 |
| 3 | Final Step - Go to Step 1 | | | |

| **Cycle D: ASTM G154 CYCLE 4** | | | | |
|---|---|---|---|---|
| Lamp Type: UVA-340+ | | | | |
| Programmed in Models: QUV/se, QUV/spray, QUV/spray/rp | | | | |
| STEP | FUNCTION | Irradiance (W/m²/nm) | Temperature (°C) | Time (hh:mm) |
| 1 | UV | 1.55 | 70 | 8:00 |
| 2 | Condensation | N/A | 50 | 4:00 |
| 3 | Final Step - Go to Step 1 | | | |

| **Cycle E: ASTM G154 CYCLE 5** | | | | |
|---|---|---|---|---|
| Lamp Type: UVB-313EL, UVB-313EL+ | | | | |
| Programmed in Models: QUV/se, QUV/spray, QUV/spray/rp | | | | |
| STEP | FUNCTION | Irradiance (W/m²/nm) | Temperature (°C) | Time (hh:mm) |
| 1 | UV | 0.62 | 80 | 20:00 |
| 2 | Condensation | N/A | 50 | 4:00 |
| 3 | Final Step - Go to Step 1 | | | |

| **Cycle F: ASTM G154 CYCLE 6** | | | | |
|---|---|---|---|---|
| Lamp Type: UVA-340+ | | | | |
| Programmed in Models: QUV/se, QUV/spray, QUV/spray/rp | | | | |
| STEP | FUNCTION | Irradiance (W/m²/nm) | Temperature (°C) | Time (hh:mm) |
| 1 | UV | 1.55 | 60 | 8:00 |
| 2 | Condensation | N/A | 50 | 4:00 |
| 3 | Final Step - Go to Step 1 | | | |

| **Cycle G: ASTM G154 CYCLE 7** | | | | |
|---|---|---|---|---|
| Lamp Type: UVA-340+ | | | | |
| Programmed in Models: QUV/spray, QUV/spray/rp | | | | |
| STEP | FUNCTION | Irradiance (W/m²/nm) | Temperature (°C) | Time (hh:mm) |
| 1 | UV | 1.55 | 60 | 8:00 |
| 2 | Spray | N/A | N/A | 0:15 |
| 3 | Condensation | N/A | 50 | 3:45 |
| 4 | Final Step - Go to Step 1 | | | |

| **Cycle H: ISO 11507 METHOD A** | | | | |
|---|---|---|---|---|
| Lamp Type: UVB-313EL, UVB-313EL+, UVA-340, UVA-340+, UVA-351 | | | | |
| Programmed in Models: QUV/se, QUV/spray, QUV/spray/rp | | | | |
| STEP | FUNCTION | Irradiance (W/m²/nm) | Temperature (°C) | Time (hh:mm) |
| 1 | UV | 0.71* | 60 | 4:00 |
| 2 | Condensation | N/A | 50 | 4:00 |
| 3 | Final Step - Go to Step 1 | | | |
| | * The irradiance set point is not specified in ISO 11507, 0.71 was chosen because it represents the approximate average irradiance in non-irradiance control QUV testers. | | | |

| **Cycle I: EN 927-6** | | | | |
|---|---|---|---|---|
| Lamp Type: UVA-340, UVA-340+ | | | | |
| Programmed in Models: QUV/spray, QUV/spray/rp | | | | |
| STEP | FUNCTION | Irradiance (W/m²/nm) | Temperature (°C) | Time (hh:mm) |
| 1 | Condensation | N/A | 45 | 24:00 |
| 2 | Subcycle repeat steps 3-4 48x | | | |
| 3 | UV | 0.89 | 60 | 2:30 |
| 4 | Spray | N/A | N/A | 0:30 |
| 5 | Final Step - Go to Step 1 | | | |

| **Cycle J: Cool White** | | | | |
|---|---|---|---|---|
| Lamp Type: Cool White | | | | |
| Programmed in Models: QUV/cw | | | | |
| STEP | FUNCTION | Irradiance (W/m²/nm) | Temperature (°C) | Time (hh:mm) |
| 1 | UV | 0.60 | 40 | 24:00 |
| 2 | Final Step - Go to Step 1 | | | |

| **Cycle K: ISO 4892-3 Cycle 1** | | | | |
|---|---|---|---|---|
| Lamp Type: UVA-340, UVA-340+ | | | | |
| Programmed in Models: QUV/se, QUV/spray, QUV/spray/rp | | | | |
| STEP | FUNCTION | Irradiance (W/m²/nm) | Temperature (°C) | Time (hh:mm) |
| 1 | UV | 0.76 | 60 | 8:00 |
| 2 | Condensation | N/A | 50 | 4:00 |
| 3 | Final Step - Go to Step 1 | | | |

| **Cycle L: ISO 4892-3 Cycle 2** | | | | |
|---|---|---|---|---|
| Lamp Type: UVA-340, UVA-340+ | | | | |
| Programmed in Models: QUV/spray, QUV/spray/rp | | | | |
| STEP | FUNCTION | Irradiance (W/m²/nm) | Temperature (°C) | Time (hh:mm) |
| 1 | UV | 0.76 | 50 | 8:00 |
| 2 | Spray | N/A | N/A | 0:15 |
| 3 | Condensation | N/A | 50 | 3:45 |
| 4 | Final Step - Go to Step 1 | | | |

| **Cycle M: ISO 4892-3 Cycle 6** | | | | |
|---|---|---|---|---|
| Lamp Type: UVB-313EL, UVB-313EL+, QFS-40 | | | | |
| Programmed in Models: QUV/se, QUV/spray, QUV/spray/rp | | | | |
| STEP | FUNCTION | Irradiance (W/m²/nm) | Temperature (°C) | Time (hh:mm) |
| 1 | UV | 0.48 | 70 | 8:00 |
| 2 | Condensation | N/A | 50 | 4:00 |
| 3 | Final Step - Go to Step 1 | | | |

## 10.2. Custom Test Cycles (Jul 2019)

- See Section 9.6 for details on programming custom test cycles.
- The table below shows expected and warranted (see **NOTE**) lamp life for QUV lamp types at common irradiance set points.
- Lamp life hours shown are only for testers equipped with SOLAR EYE irradiance control.

### Lamp Life by Lamp Type and Irradiance

| Lamp Type | Typical Irradiance | | High Irradiance | | Maximum Irradiance | |
|---|---|---|---|---|---|---|
| | **Lamp Life** (Hours) | **Irradiance** (W/m²/nm) | **Lamp Life** (Hours) | **Irradiance** (W/m²/nm) | **Lamp Life** (Hours) | **Irradiance** (W/m²/nm) |
| UVA-340 | **8000** | 0.89 [1] | *~1000* | 1.55 [6] | — | — |
| UVA-340+ | | | **1500** | | **750** | 1.70 |
| UVA-351 | | 0.76 [2] | *~1000* | | — | — |
| UVB-313EL | | 0.71 [3] | *~1000* | 1.23 | — | — |
| UVB-313EL+ | | | **1500** | 1.55 | **750** | 1.70 |
| QFS-40 | | 0.48 [4] | *~1000* | 0.86 | — | — |
| Cool White | | 6,000 (lux) [5] | *~1000* | 20,000 (lux) | — | — |

[1] ASTM G154, Cycle 1 and EN-927-6
[2] ISO 4892-3, Cycle 5 and ISO 16474-3, Cycle 3
[3] ASTM G154, Cycle 2 and ISO 16474-3, Cycles 4-5
[4] SAE J2020
[5] ASTM D4674
[6] ASTM G154, Cycles 3, 6-7

**NOTE:** In the table above lamp life hours in **bold** are warranted at the irradiance shown. Lamp life hours shown with "~" and in italics are approximate only and not guaranteed.

#### Irradiance Set Point Considerations

**Correlation:** Tests run at typical irradiance may correlate with natural outdoor exposures better than tests run at high irradiance.

**Black Panel Temperature Range:** Black panel temperatures above 75 °C require high irradiance. Black panel temperatures below 55 °C require low irradiance.

#### Moisture Cycle Guide

**Condensation:** Minimum time is 2 hours. Minimum temperature is 40 °C.

**Spray and Condensation (QUV/spray models only):** Thermal shock is produced with a short period of water spray. A condensation step should follow for maximum acceleration of the damaging effects of moisture.

**Spray only (QUV/spray models only):** Mechanical erosion is produced with long periods of water spray requiring large volumes of Reverse Osmosis / Deionized water. See Section 5.4.

## 10.3. Mounting Test Specimens (Jul 2019)

The QUV specimen mounting system is highly adaptable. The standard QUV specimen holders are designed to hold two (2) 75 mm × 150 mm (3 × 6 inch) specimens. In addition, Q-Lab can provide 100 mm (4") or 150 mm (6") wide specimen holders upon request. See table below. For complete specimen mounting information see Specification Bulletin LU-8001, QUV Specimen Mounting Guidelines and Available Holders.

| Holder Size | Specimen Capacity |
|---|---|
| 75 × 150 mm (3 × 6") | 48 |
| 100 × 150 mm (4 × 6") | 32 |
| 150 × 150 mm (6 × 6") | 24 |

**75 mm (3") Panel Holder Kit V-131.3-K Includes 25 Specimen Holders (V-131.3-X) and 4 End Seals (V-60316-X)**

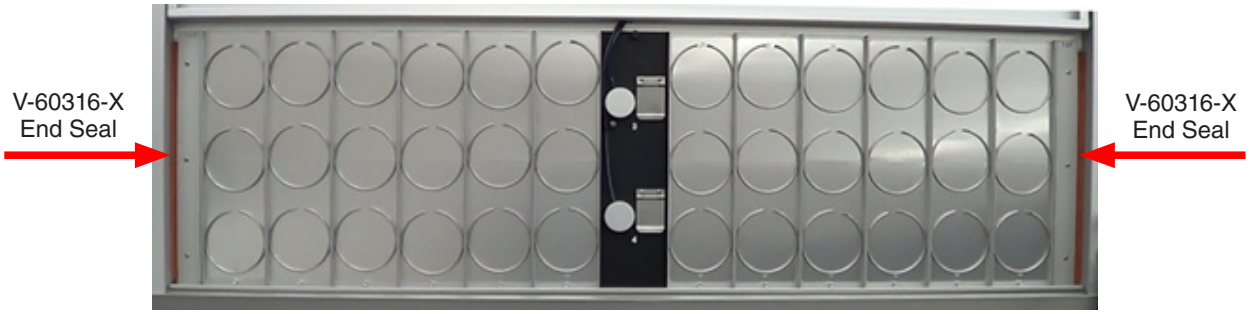



Figure 10.3a: QUV front view with 75 mm (3") wide specimen holders.

**100 mm (4") Panel Holder Kit V-131.4-K Includes 18 Specimen Holders (V-131.4-X), 2 End Seals (V-60316-X) and 4 End Seals (V-60317-X)**

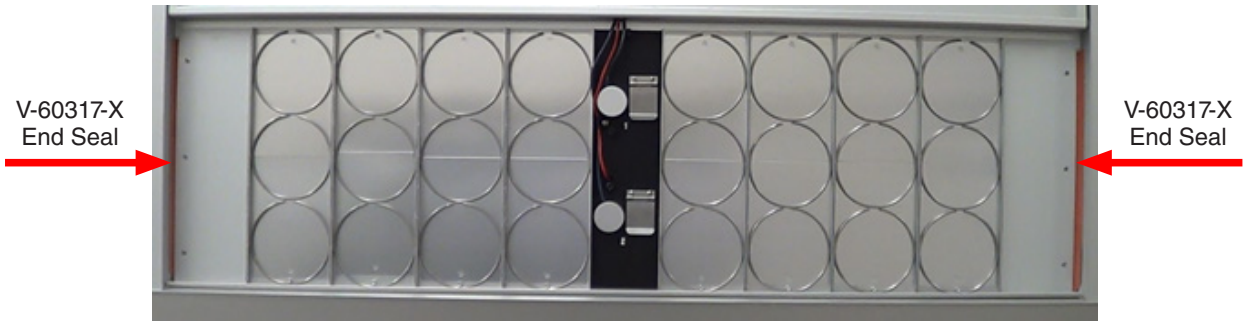



Figure 10.3b: QUV front view with 100 mm (4") wide specimen holders.

**150 mm (6") Panel Holder Kit V-131.6-K Includes 13 Specimen Holders (V-131.6-X), 4 End Seals (V-60318-X) and 2 End Seals (V-60319-X)**

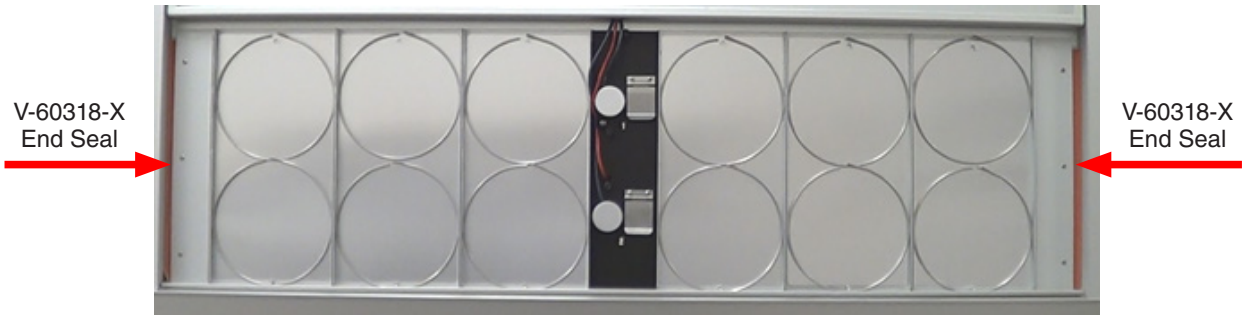



Figure 10.3c: QUV front view with 150 mm (6") wide specimen holders.

Figure 10.3d: Snap-in rings hold panels in place.

- Fasten flat panels up to 6 mm (1/4") thick to the holders with snap-in rings.
- Push the ring snugly against the panel.
- Keep the opening of the ring in the center of the holder.

- Install the panel holders on the QUV with the stop pin down.

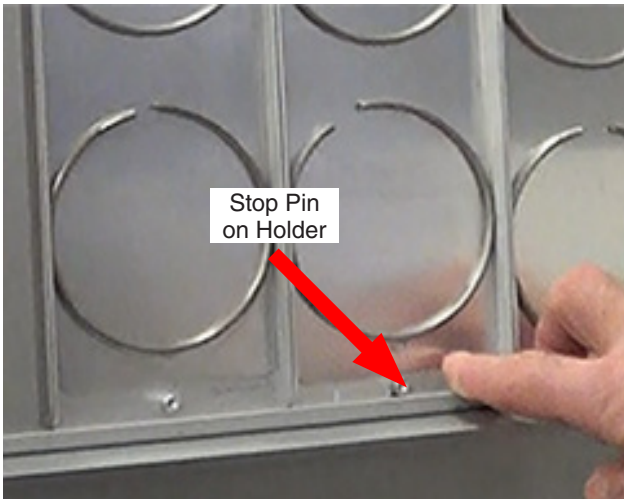



Figure 10.3e: Stop pin on bottom of panel holder.

- Thick panel retainer clips are available (Part No. V-133).

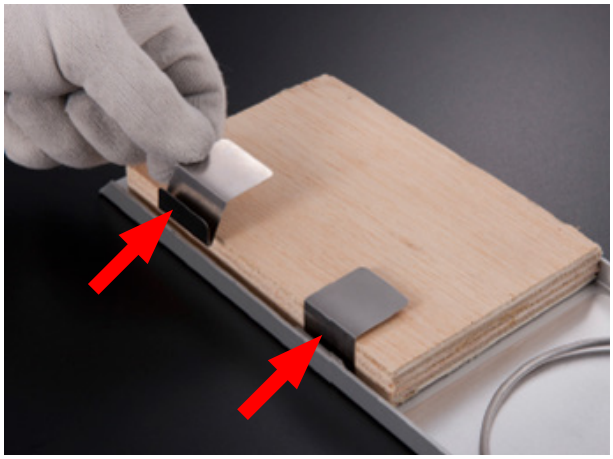
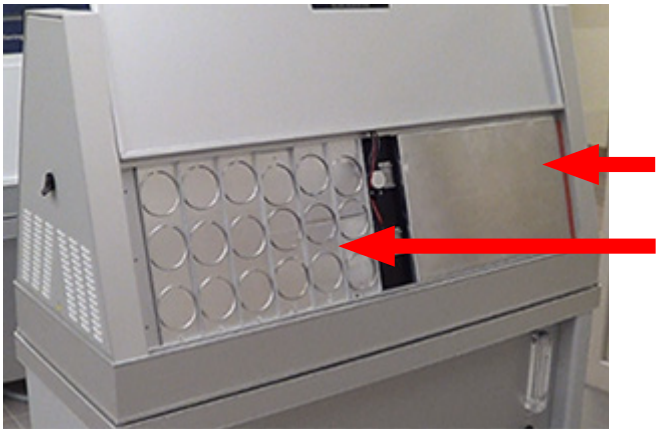


Figure 10.3f: Thick panel retaining clips.



- Mount large specimens on an aluminum panel 325 mm (12.75") high.
- The entire opening of the sample mounting area must be covered with panels to avoid loss of water vapor during the condensation cycle

Figure 10.3g: Large specimen mounting, entire sample area covered.

- Thin, flexible specimens are mounted by wrapping them around a panel.

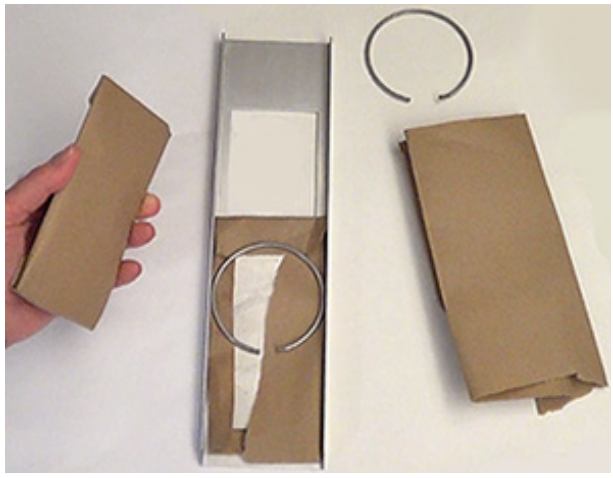


Figure 10.3h: Wrap flexible specimens around a panel.

**Three dimensional parts can also be mounted in a variety of different mounting boxes as shown below.**

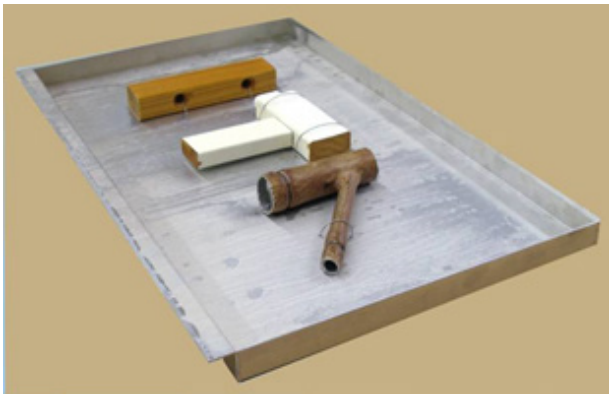


Figure 10.3i: Wide 3D specimen holder.

- 50 × 3 cm (19.5 × 1") specimen holder (Part No. V-4961-X).
- For best UV exposure, position specimens away from the edges of the 3D specimen holder. See Figure 10.3i.

- 8 x 3 cm (3.25 × 1") specimen holder (Part No. V-4960-X).

Figure 10.3j: Narrow 3D specimen holder.

- 8 × 2 cm (3.25 × 0.7") specimen holder with adjustable mounting clamps (Part No. V-4019-X).

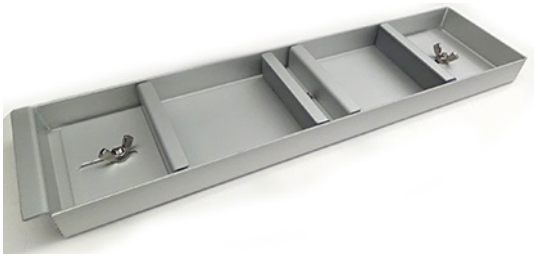


Figure 10.3k: Narrow 3D specimen holder with clamps.

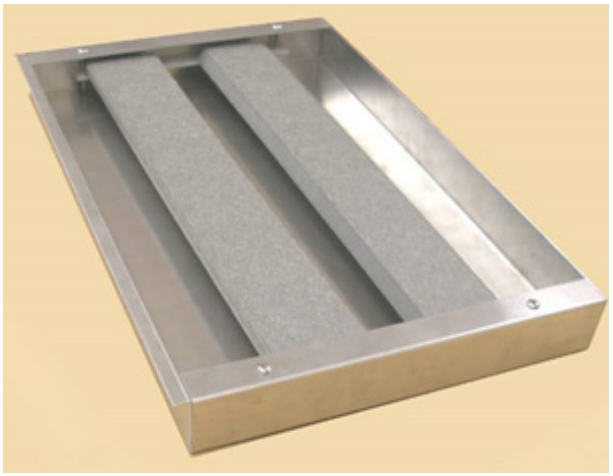


Figure 10.3l: Wide specimen holder with clamps.

- 50 × 5 cm (19.5 × 2") specimen holder with adjustable mounting clamps for specimens like artificial lumber (Part No. V-4962-K).

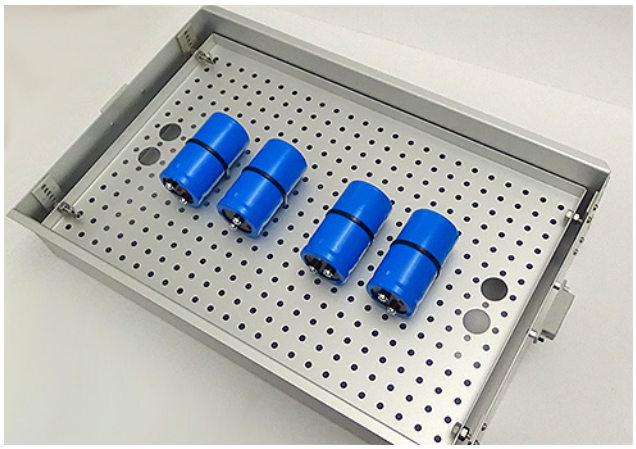


Figure 10.3m: Quadrant boxes with adjustable mounting trays hold large specimens.

- Quadrant boxes (Part Nos. V-60301-K and V-60292-K) have adjustable perforated trays for mounting large three dimensional specimens.
- For best UV exposure, position specimens away from the edges of the box. See Figure 10.3m.

- Panel holders stack conveniently for carrying by alternating flanges up and down.

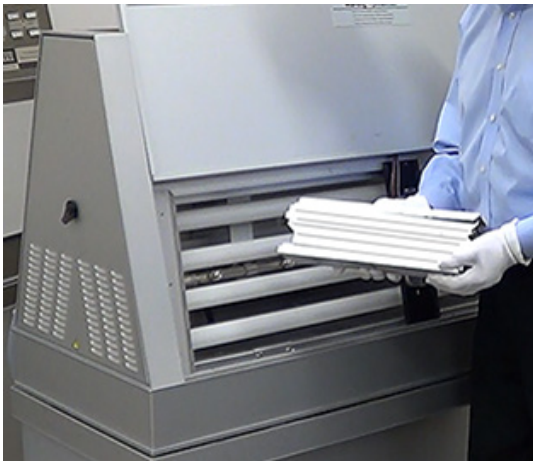


Figure 10.3n: Stacked panel holders.

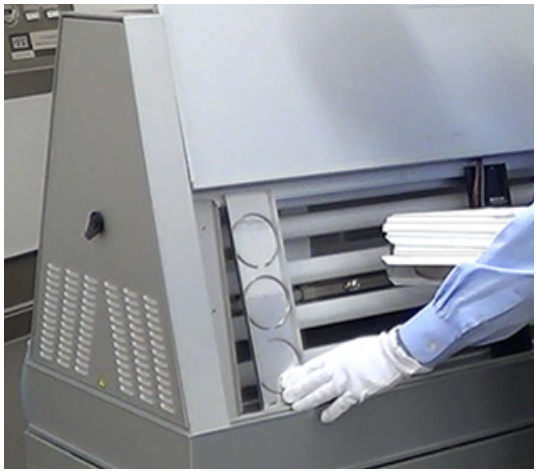


Figure 10.3o: End panel holders.

- The extreme right and left-hand panel holders receive less UV because they are at the ends of the lamps.
- ASTM G154 does not allow the use of the end holders.

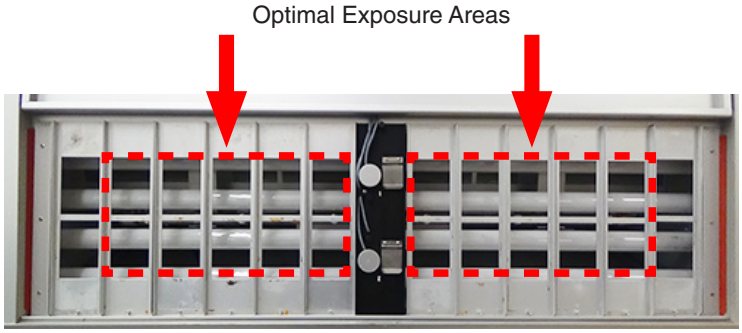



Figure 10.3p: Panels removed from holders to show optimal exposure areas.

- The optimal UV exposure areas are shown in Figure 10.3w. Specimens mounted outside these areas receive less UV.
- Specimens can be mounted in the far left and right specimen holders as long as these specimen holders are repositioned as shown in Section 10.4.

- The rubber end seals hold vapor in the chamber.
- Install the seals with the rubber strip against the end frame and the “OUT” arrow pointing away from the specimen holders.

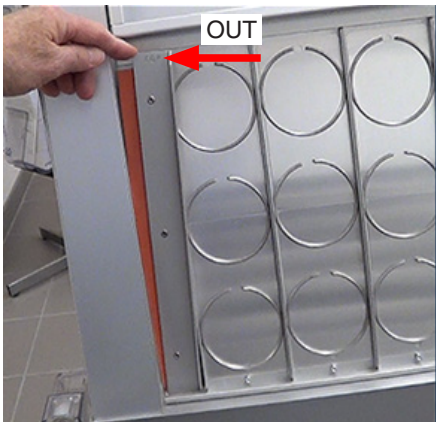



Figure 10.3q: Correct end seal installation.

- The test panels form the side walls of the QUV test chamber.
- All the panel holders must be in place.
- All holders must be filled with test specimens or blank panels.
- Missing panel holders allow vapor loss and affect temperature control.
- Gaps larger than 1 mm (1/32") are not acceptable.

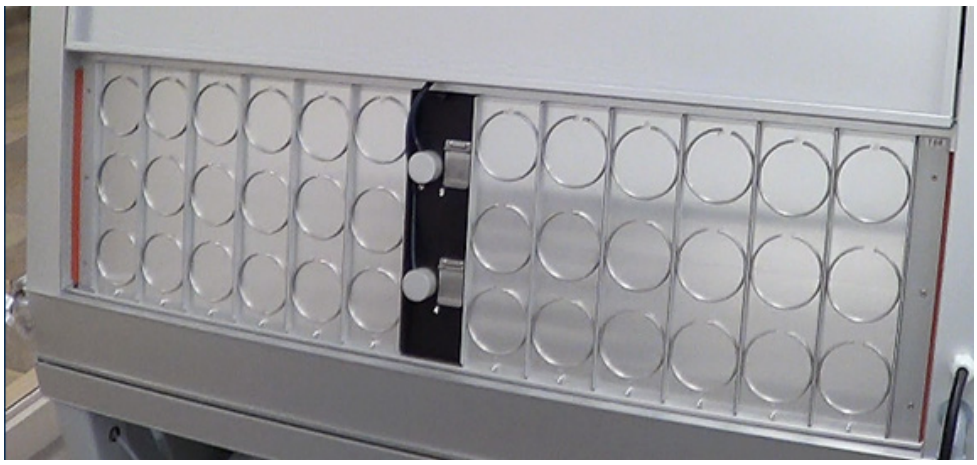


Figure 10.3r: Correct specimen configuration with no gaps between panel holders.

## 10.4. Repositioning Test Specimens (Feb 2014)

- Reposition the test specimens to obtain the most uniform results.
- Reposition at least 5 times for each test.
- This means that specimens should be repositioned every day for a one week test and once a week for a 5 week test.
- For tests shorter than one week, reposition specimens 2 times per day.
- Shut off the QUV and remove the two panel holders on the left end (Figure 10.4a).
- Slide all the other holders to the left and replace the two that were removed on the right end (Figure 10.4b).
- For ASTM G154, leave the end panels in place and shift the inner panels.
- For best results, also reposition specimens from top to bottom.

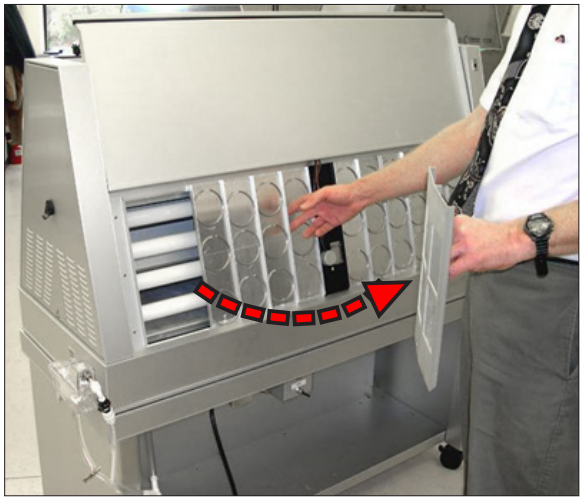


Figure 10.4a: Remove two panels from left end.

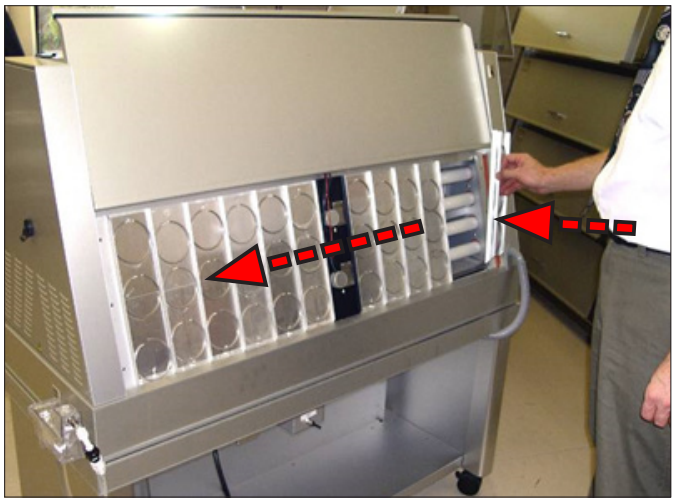


Figure 10.4b: Slide panels to the left, place two panels at right end.

# 11. Calibration

- Irradiance for all models is calibrated with the UC10 Smart Sensor (Section 11.1).
- Black panel temperature for all QUV models is calibrated with a reference thermometer (Section 11.2).
- The table below lists onboard sensor re-calibration requirements.
- Please contact Q-Lab for more information. See Section 18 for contact information.

| Sensor | Calibration Frequency | Calibration Instrument |
|---|---|---|
| Irradiance | 500 hours[1] | UC10 Smart Sensor |
| Black Panel Temperature | 6 months[2] | Calibrated Reference Thermometer |

1. Or whenever the lamps, irradiance sensors, or test cycle conditions are changed.
2. Or whenever the lamps, panel temperature sensors, or test cycle conditions are changed.

## 11.1. Calibrate Irradiance (Jul 2020)

### Overview

- Irradiance is calibrated with a UC10/UV or UC10/CW Smart Sensor (Figure 11.1a and Figure 11.1b).
  - The UC10/UV sensor is used to calibrate UVA lamps at 340nm and UVB lamps at 310nm in W/m²/nm.
  - The UC10/CW sensor is used to calibrate cool white fluorescent lamps in a QUV/cw tester only.
- Smart Sensors are calibrated at Q-Lab and the calibration information is stored in the Smart Sensor.
- Calibration information is shown on the sensor calibration certificate and on a Smart Sensor case label (Figure 11.1d and Figure 11.1e).
- Calibration information can also be displayed on the QUV menu screen when the Smart Sensor is connected (Figure 11.1f).
- The UC10/UV Smart Sensor will give a notification on-screen when plugged-in if calibration is due in the next 90 days or overdue.
- Upon calibration expiration, Smart Sensors should be discarded and replaced with an inexpensive new sensor. See the Replacement Parts List, Section 16.
- Optionally, Smart Sensors can be returned to Q-Lab for recalibration. Contact Q-Lab Repair and Tester Support for more information.
- Clean the Smart Sensor face with alcohol and a soft cloth before calibrating irradiance (Figure 11.1c).
- Store the Smart Sensor in its case when not in use to avoid any contamination.

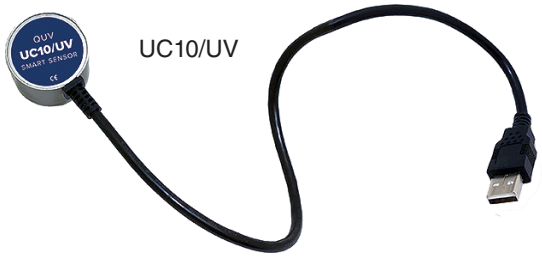



Figure 11.1a: UC10/UV Smart Sensor.

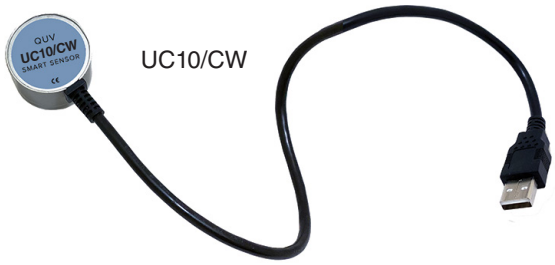



Figure 11.1b: UC10/CW Smart Sensor.

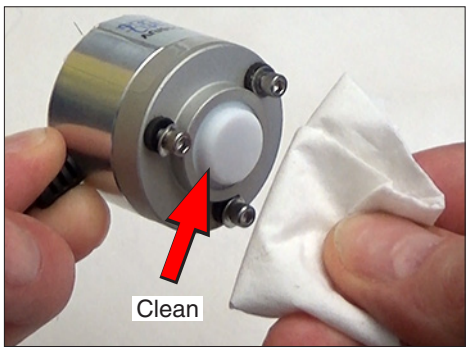



Figure 11.1c: Clean the sensor face with alcohol and a soft cloth.

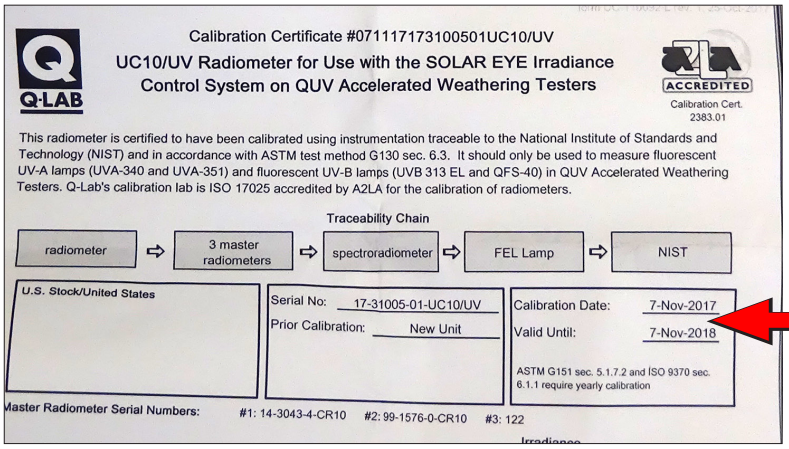



Figure 11.1d: UC10/UV Calibration certificate.

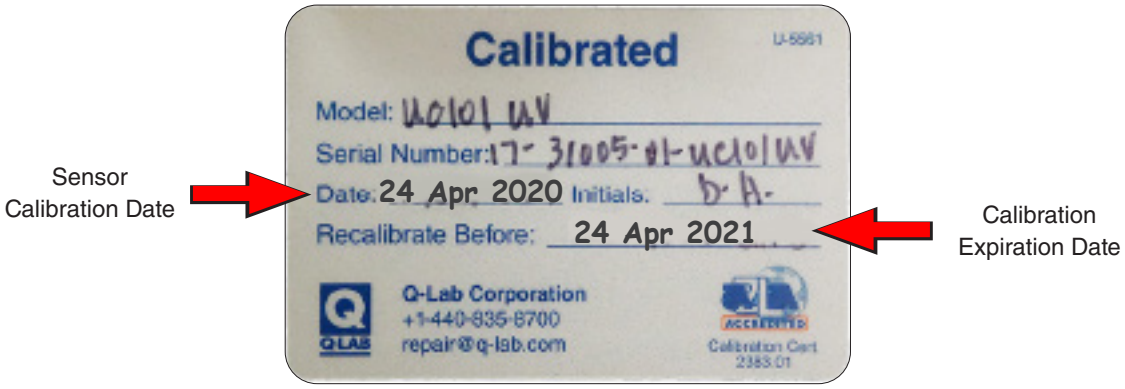



Figure 11.1e: Smart Sensor calibration label on case.

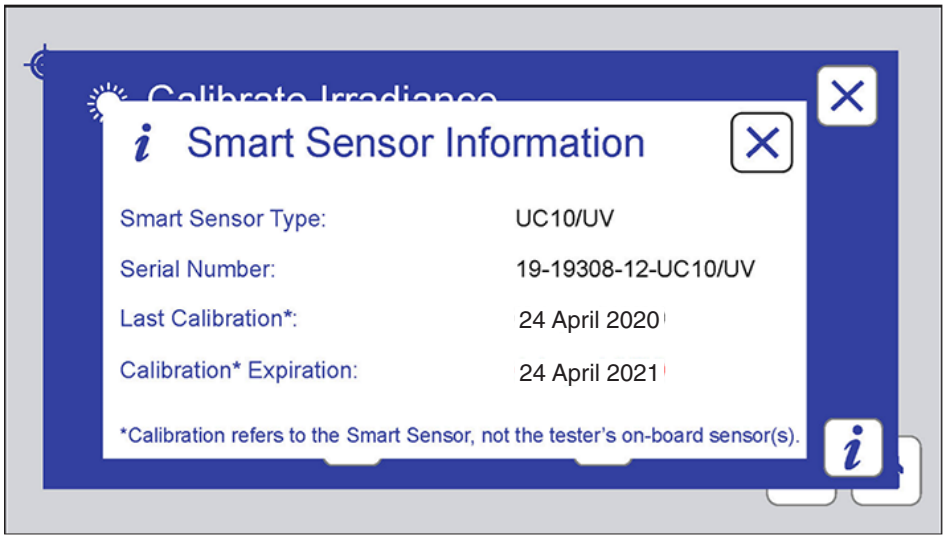
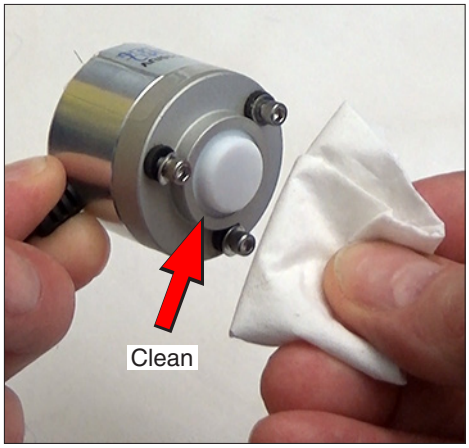



Figure 11.1f: Smart Sensor information displayed on QUV menu screen.

## Irradiance Calibration Procedure

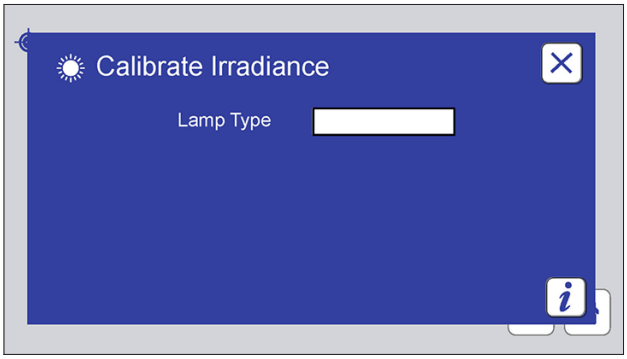
- QUV testers are equipped with door interlocks. The UV lamps normally turn off when the door is opened.
- However, when the smart sensor is connected to the QUV, a special override feature has been incorporated that allows the lamps to remain on. This prevents unintended interruption of the calibration process.

**1.** Remove the Smart Sensor from the case.

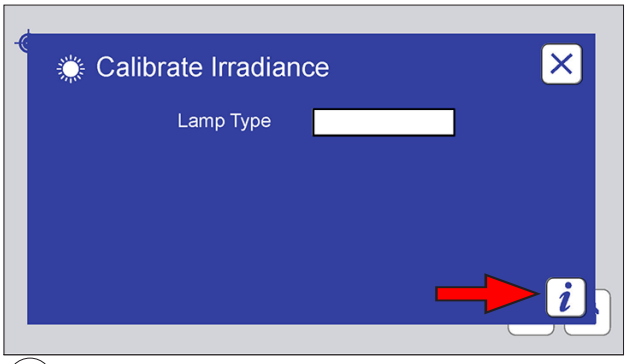



**2.** Clean the sensor face with alcohol and a soft cloth.

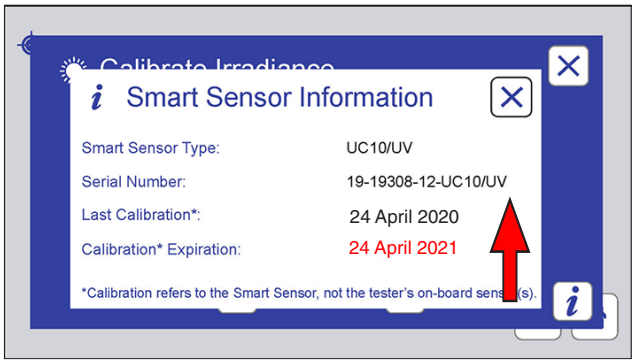
**3.** Plug the Smart Sensor into USB connector on the QUV control panel.



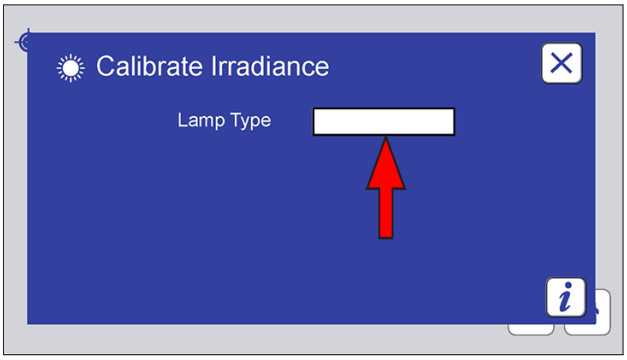

▶ The calibrate irradiance screen is displayed.



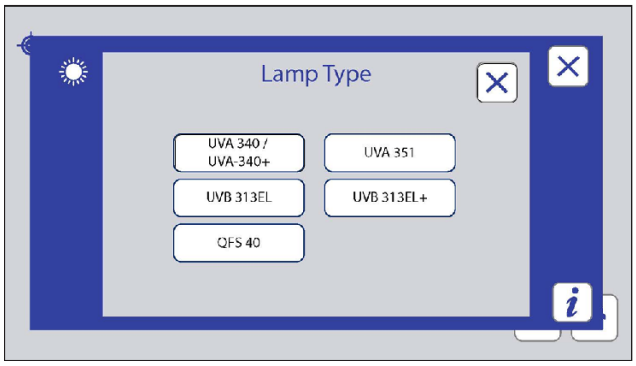

**4.** **Optional:** to display the Smart Sensor calibration information, touch the information icon.



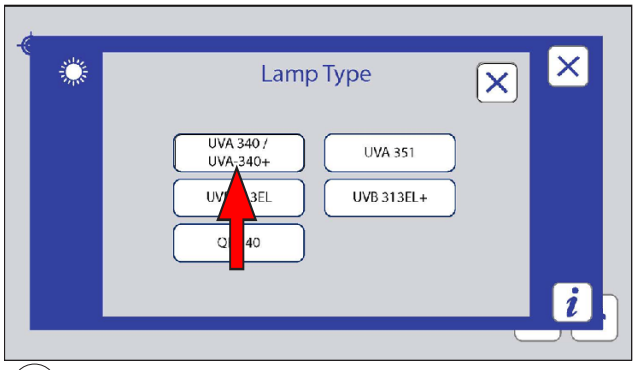

▶ The Smart Sensor information screen is displayed. Touch the close icon to close the information screen.



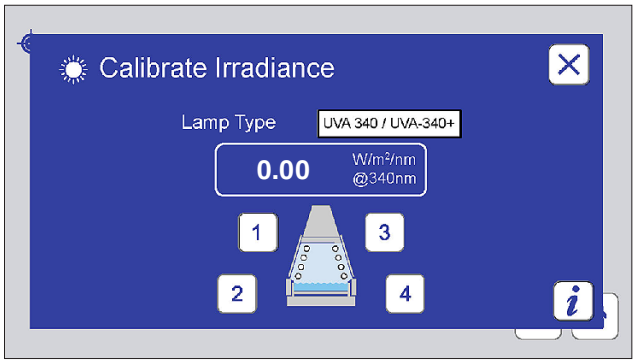

5. Touch the lamp type text box.



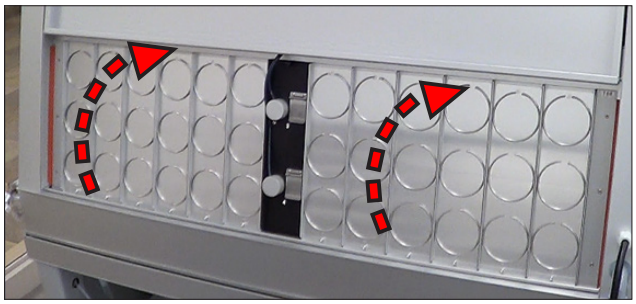

▶ The lamp type screen is displayed.



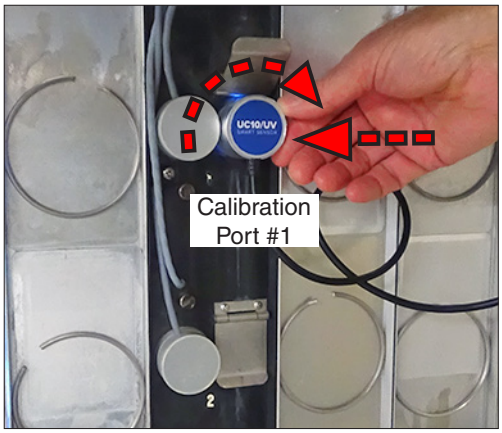

6. Touch the lamp type button that matches the lamp type installed in the QUV tester. The UVA 340 lamp is used in this example.




▶ The irradiance calibration screen is displayed.

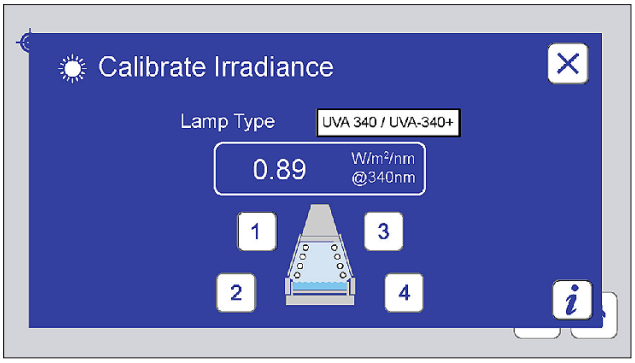


7. Lift the front specimen door. Make sure all specimen holders are in place.

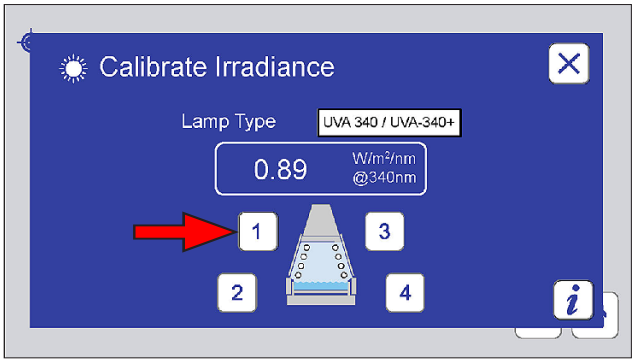



8. Place the Smart Sensor sensor into the QUV calibration port #1. Twist the sensor clockwise until it locks in place.

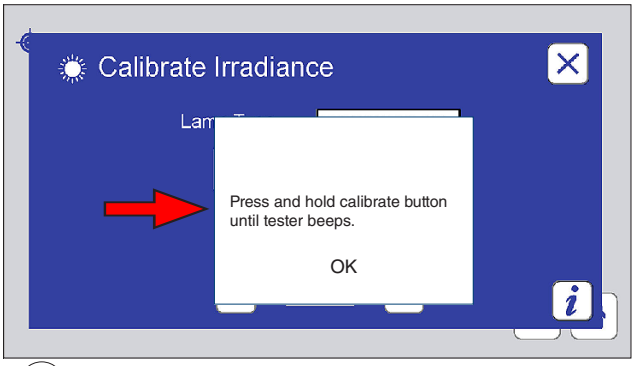
Wait for the irradiance to stabilize.



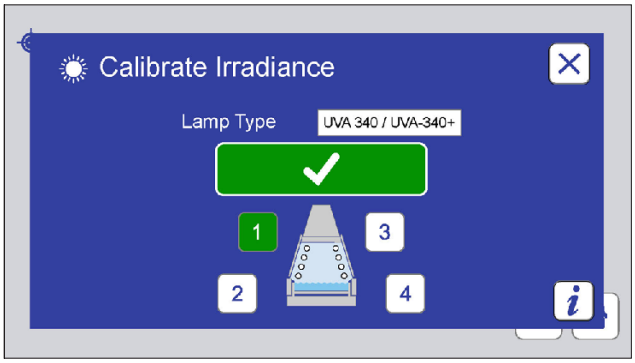

**9.** Wait a few seconds to allow the irradiance to stabilize.



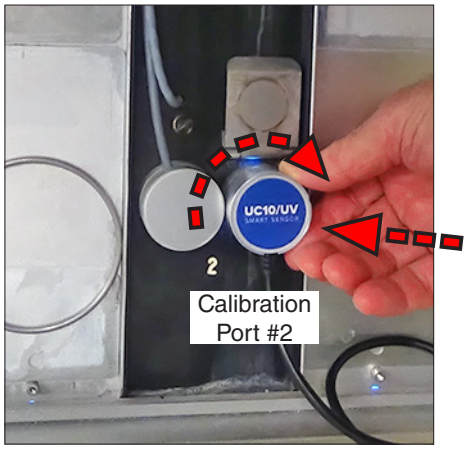

**10.** Press and hold the channel 1 calibration button until the tester beeps.



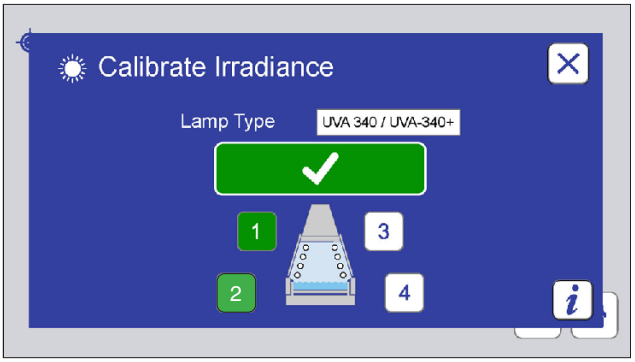

**11.** If the button is not pressed long enough, this message is displayed. Touch the OK button to close the message. Press and hold the channel 1 button again until the tester beeps.



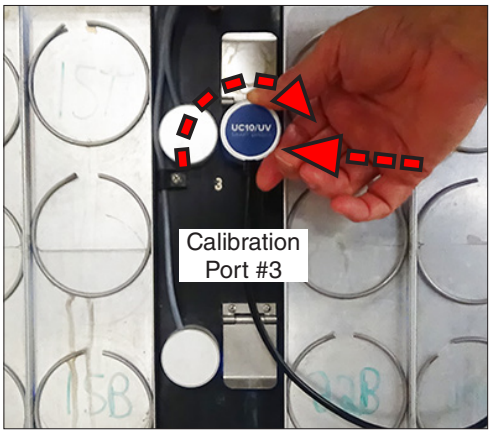

**12.** The channel button turns green and a check mark is displayed indicating the successful calibration of channel 1.



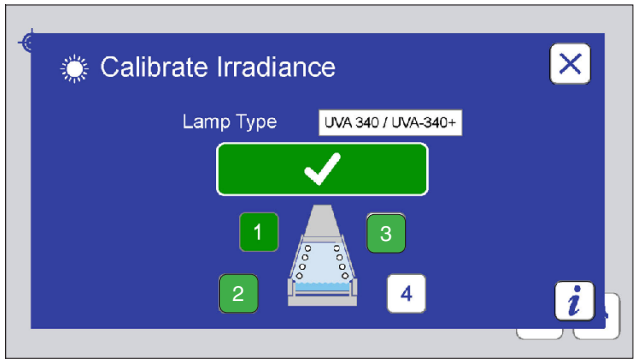

**13.** Place the Smart Sensor into calibration port #2.



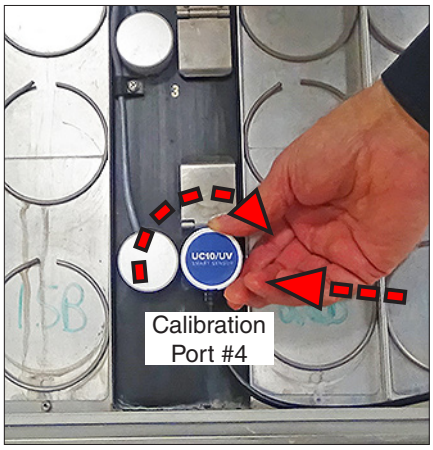

**14.** Repeat Step 9 - Step 12 to calibrate channel 2.



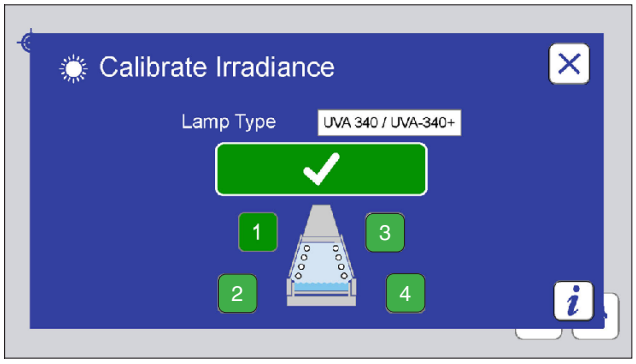

**15.** Move to the rear of the tester, open the specimen door and place the Smart Sensor into calibration port #3.



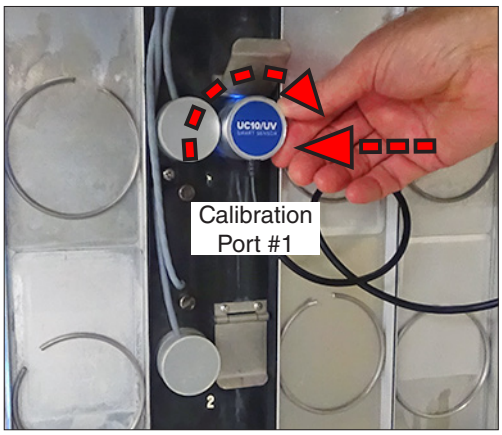

**16.** Repeat Step 9 - Step 12 to calibrate channel 3.




**17.** Place the Smart Sensor into calibration port #4.




**18.** Repeat Step 9 - Step 12 to calibrate channel 4.

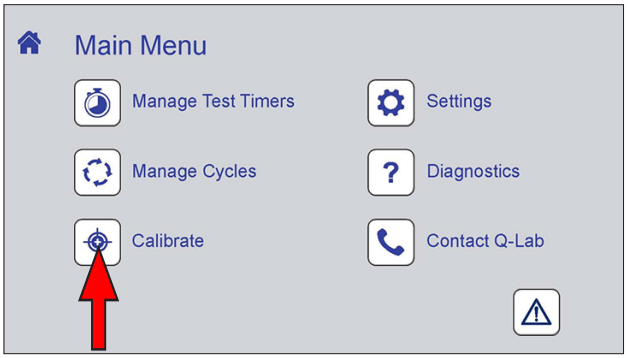



**19.** **Optional:** Repeat Step 7 through Step 18 to make sure that the Smart Sensor and the QUV actual irradiance values have stabilized.

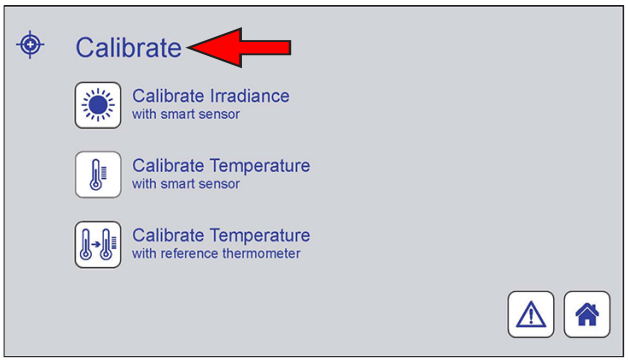
- Complete the calibration at each calibration port within approximately 5 minutes.
- If you are unable to complete the procedure in this time frame due to interruption, remove the Smart Sensor from the calibration port, wait 5 minutes, and repeat the calibration procedure.
- Never leave the Smart Sensor in a calibration port for more than 5 minutes.

## Access Calibrate Functions Through the Main Menu

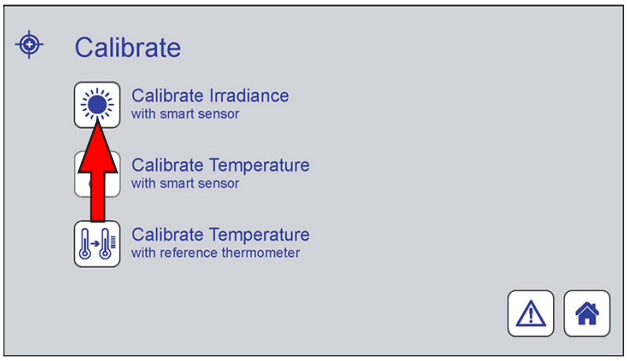
- The calibrate screens can also be accessed through the Main Menu.




▶ Calibrate functions can also be accessed by touching the calibrate icon on the QUV main menu screen.




▶ The calibrate screen is displayed.




▶ Touch the calibrate irradiance icon.

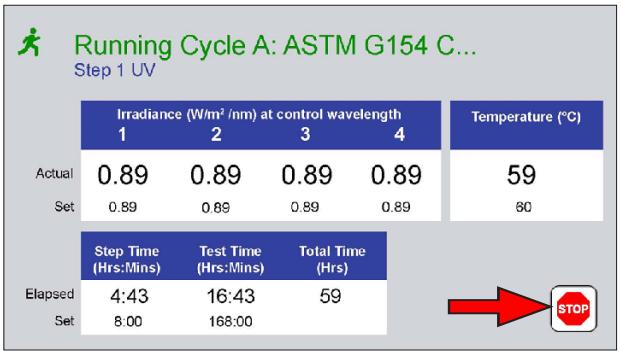
## 11.2. Panel Temperature Sensor (Jul 2020)

### Overview

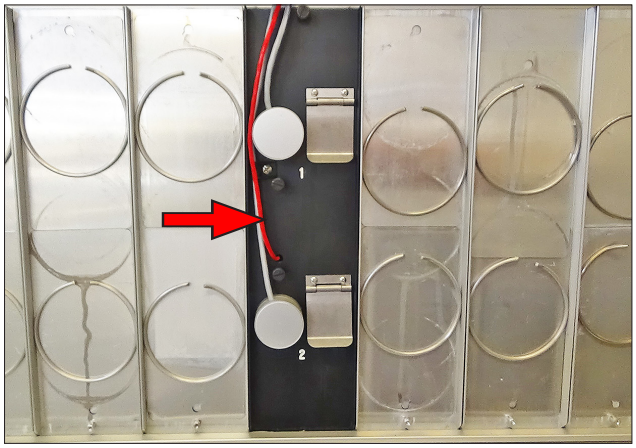
- For accurate temperature readings, calibrate the panel temperature sensor (sometimes referred to as a black panel temperature sensor) every six months in accordance with ASTM E220.
- The following tools are needed to calibrate the panel temperature sensor:
  - Calibrated reference thermometer
  - Phillips screwdriver
  - Insulated container
  - Hot water
- Q-Lab offers an optional Temperature Calibration Kit (U-41085-K) which includes an easy-to-use insulated container.

### Calibration Procedure

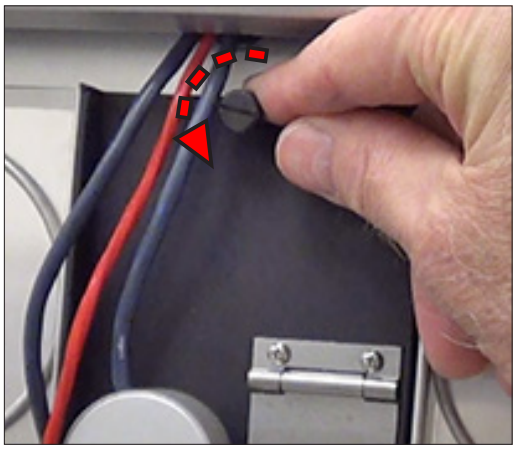
- Follow the steps below to calibrate the panel temperature sensor.
- The calibration procedure is the same for uninsulated and insulated panel temperature sensors.



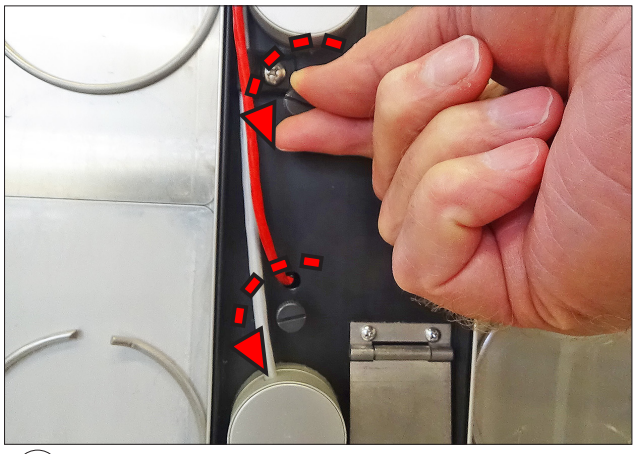

1. If a test is running, touch the STOP icon on the status screen to suspend the test.



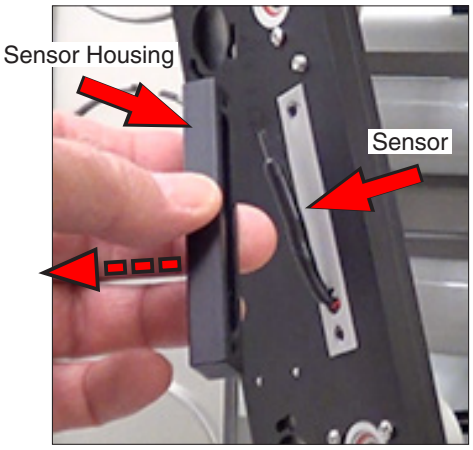

2. Locate the black sensor panel mounted in the front sample area of the QUV tester.



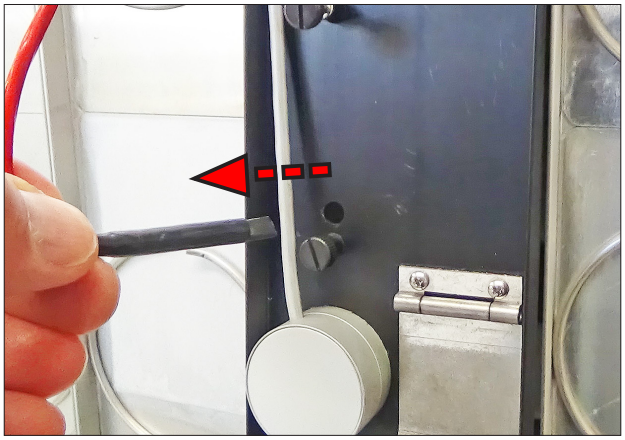
3. Unfasten the black sensor panel by loosening the thumbscrew at the top center.



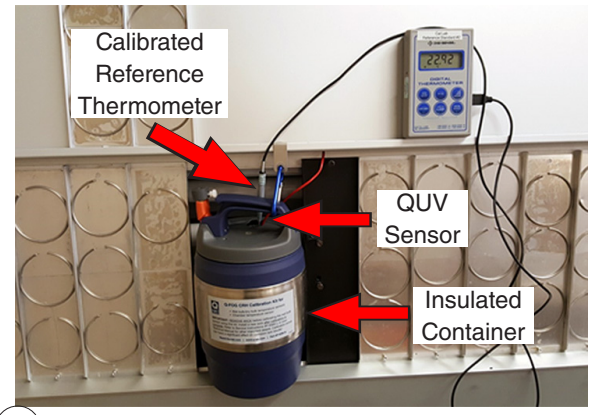
4. Loosen the 2 thumbscrews holding the sensor housing.




**5.** Turn the panel over. Remove the sensor housing from the back side of the sensor panel.

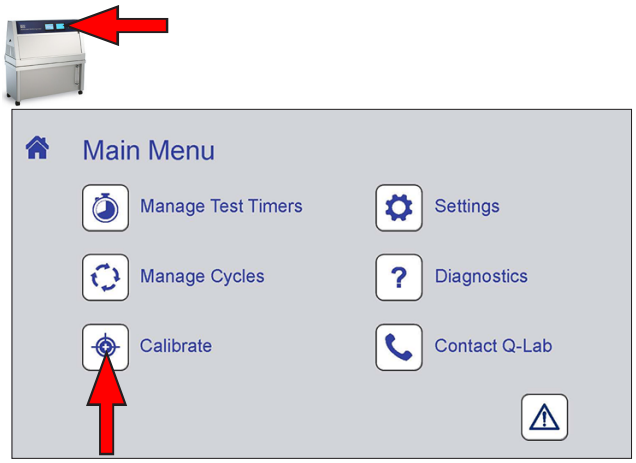


**6.** Carefully, pull the temperature sensor through the panel.

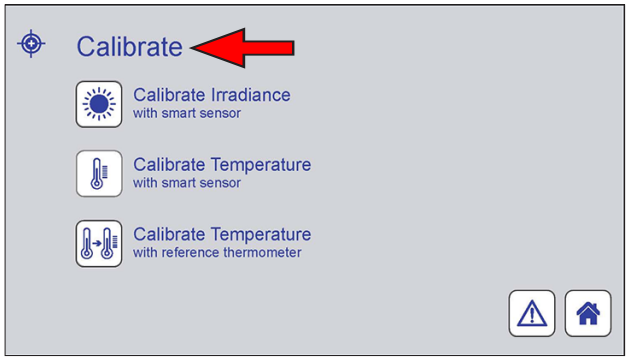



**7.** Place the QUV temperature sensor and a calibrated reference thermometer in an insulated container of water at approximately the highest temperature called for in the test cycle.

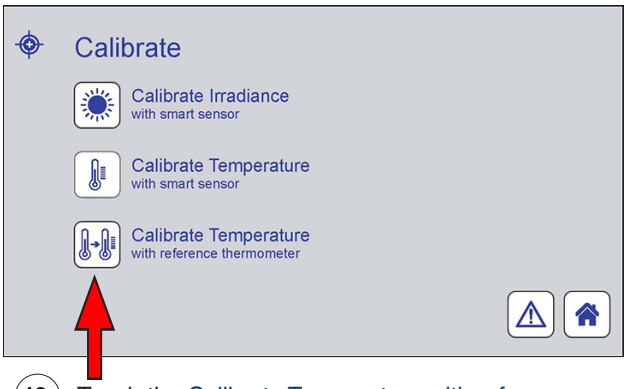

**8.** Wait 10 minutes for the sensors to stabilize.



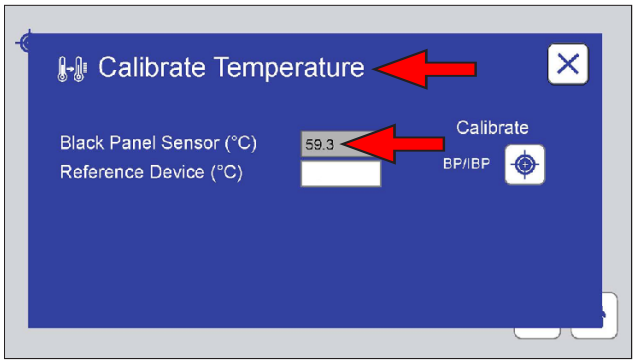

**9.** Touch the calibrate icon on the QUV menu screen.



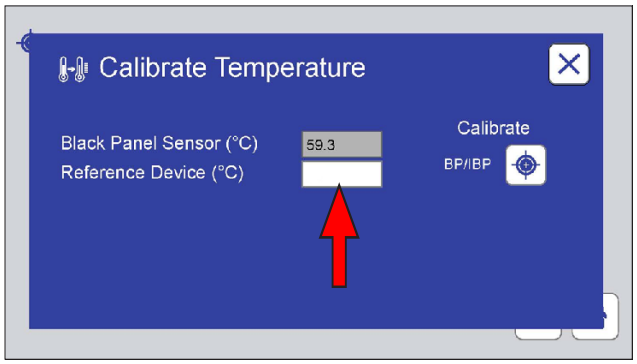

▶ The calibrate screen is displayed.
**NOTE:** The Calibrate Temperature with Smart Sensor is for a future enhancement, the UC101 Panel Temperature Smart Sensor.



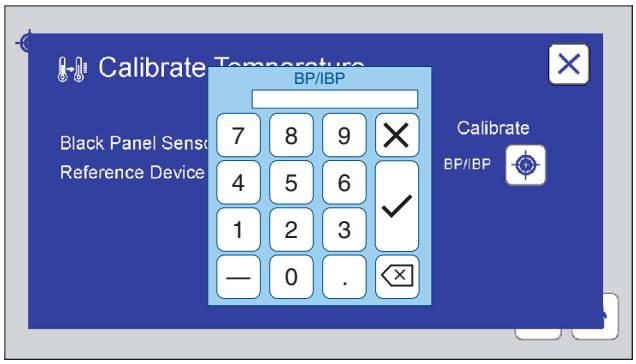

**10.** Touch the Calibrate Temperature with reference thermometer icon.




▶ The Calibrate Temperature screen is displayed. The current reading of the QUV panel temperature sensor is shown.

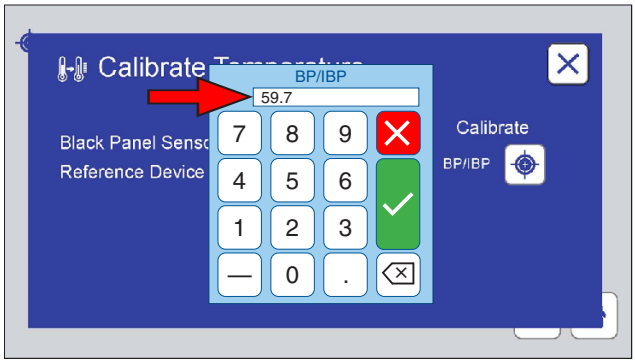



**11.** Touch the Reference Device text box.

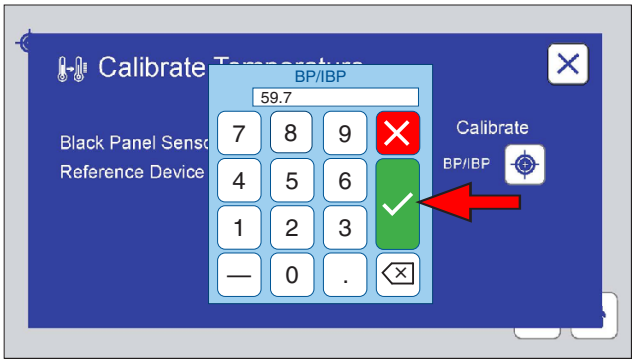



▶ The BP/IBP temperature enter keypad is displayed.

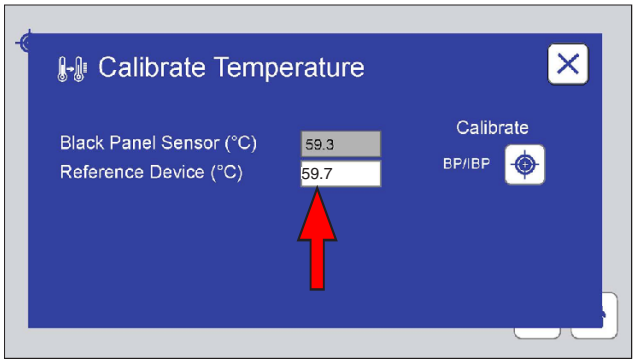

**12.** Read the temperature displayed on the reference thermometer.



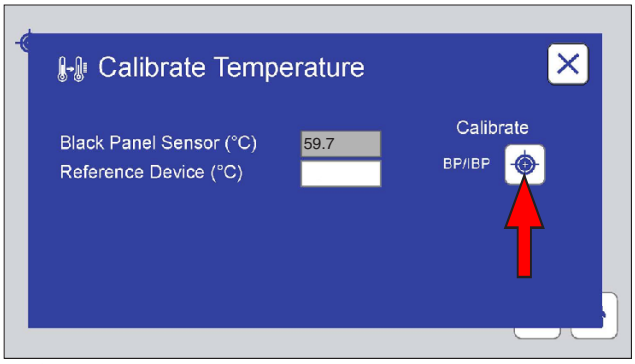

**13.** Use the keypad to enter the reference temperature into the reference device text box.



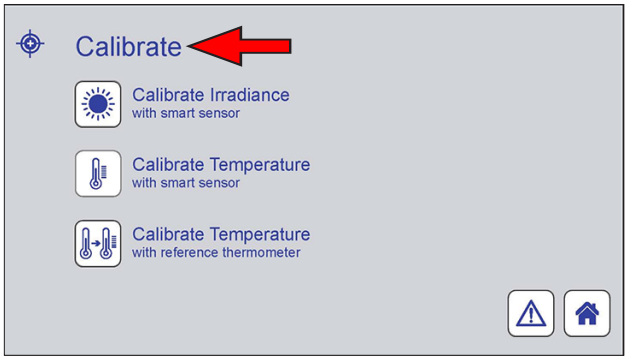

**14.** Touch the check mark button.



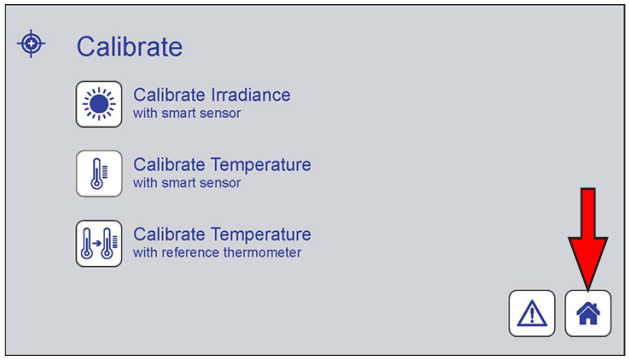

▶ The keypad is removed. The reference temperature is displayed in the reference device text box.



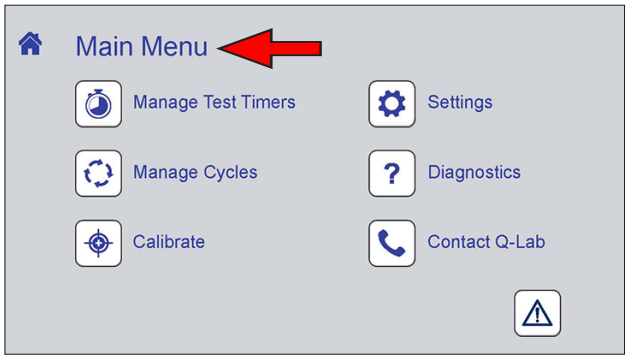

**15.** Touch the calibrate icon to complete the calibration process.




▶ The calibrate screen is displayed.




**16.** Touch the home icon.




▶ The main menu screen is displayed.

# 12. Data Storage and Transfer

## 12.1. Ethernet Communications

- The QUV main controller has the capability to transfer data via Ethernet (Figure 12.1).
- Q-Lab can supply a VIRTUAL STRIPCHART (VSC) program that runs on a PC. Contact Q-Lab Repair and Tester Support.
- The strip chart program will be able to setup communications, request data groups, and save and display that data.


Figure 12.1: Ethernet port located on right rear of tester frame.

## 12.2. Secure Digital (SD) Card

- All tester information, i.e. timers, expert parameters, error messages, setpoints, actuals, test cycles, and other system configuration information is written to an SD card every minute.
- All tester operating parameters written to the SD card are automatically being saved.
- The operating parameters can be viewed by the customer or by Q-Lab Repair and Tester Support (see Section 18) using the export features later in this section.
- If the main controller fails, the SD card can be transferred to a new controller and all tester information will be preserved.
- The user does not have to reenter the serial number and date/time, test cycles, expert parameters, or timer values.
- The information on the SD Card can also be copied and emailed to Q-Lab Repair and Tester Support.
- That information can be copied to another SD Card so the original tester's configuration can be "cloned" by Q-Lab Repair and Tester Support for analysis.

## 12.3. Export Diagnostics

- The Export Diagnostics function transfers the full set of VSC parameters.
- These include the most recent two weeks (tester time) of data, recorded every minute as a .vsc file.
- The complete system configuration is also transferred in this operation.
- This includes tester operational information like timers, expert parameters, setpoints, actuals, heater and blower percentages, calibration factors, test cycles, and error messages.
- A USB flash drive is used to export diagnostic parameters (Figure 12.3c)
- Connect the USB drive to the USB port of the QUV control panel (Figure 12.3d).
- The USB Options screen will be displayed (Figure 12.3a).
- Touch the Export Diagnostics button to begin the export process (Figure 12.3b).
- The exported files (Figure 12.3e and Figure 12.3f) can be uploaded to the Q-Portal Asset Center where customers can view basic operational data (Figure 12.3g and Figure 12.3h) and Q-Lab personnel can view extended operational data.


Figure 12.3c: USB drive needed to export diagnostics.

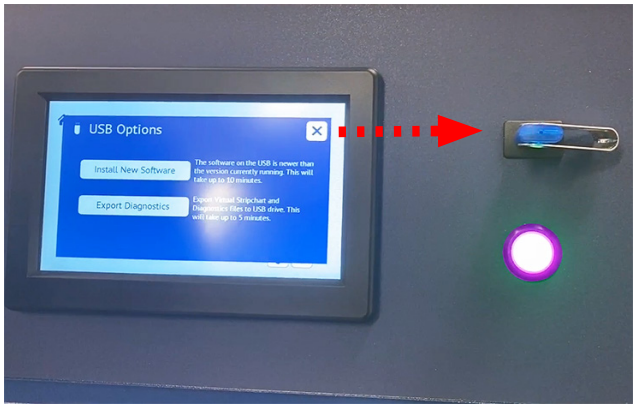



Figure 12.3d: Connect the drive to the USB port of the QUV control panel.

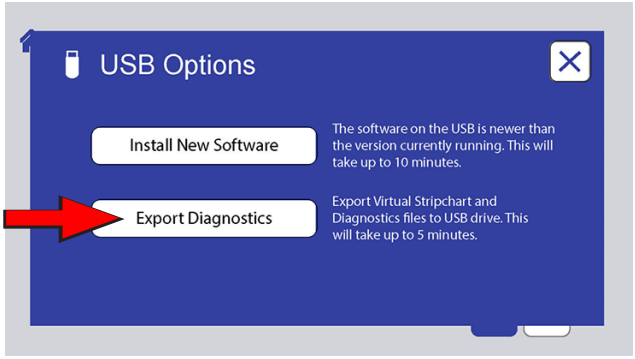



Figure 12.3a: USB Options screen showing the Export Diagnostic button.


Figure 12.3b: Touch Export Diagnostics then the Yes button to begin export.

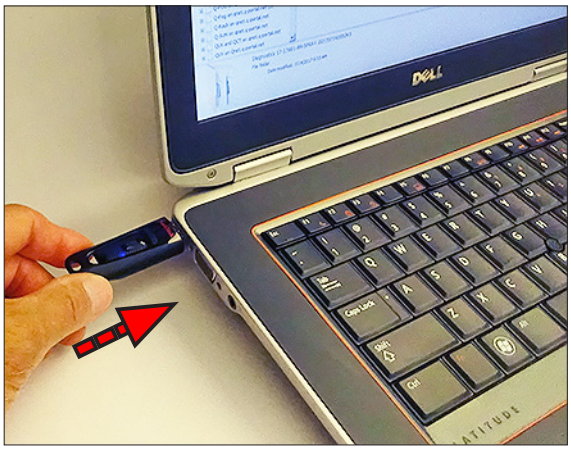


Figure 12.3e: Insert the USB drive into a Windows computer to display the list of files

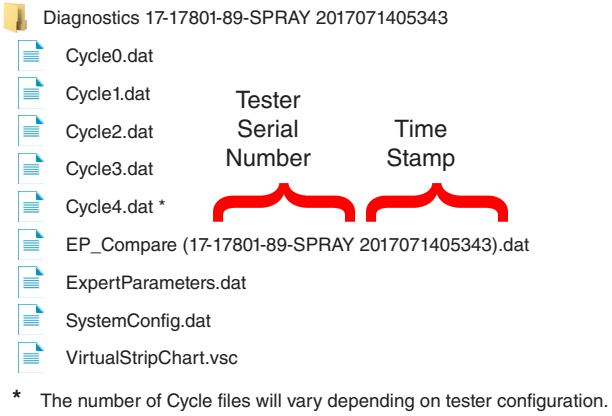



Figure 12.3f: The USB drive will have a folder with the diagnostic data files exported from the tester.

**IMPORTANT NOTE:** All files except EP_Compare are readable only by the tester. Do not try to open the other files on a PC.

- The .vsc file is the most important file because it contains the actual tester operational data.
- See Section 12.4 or contact Q-Lab Repair and Tester Support for instructions on importing .vsc files to the Q-Portal Asset Center for analysis.

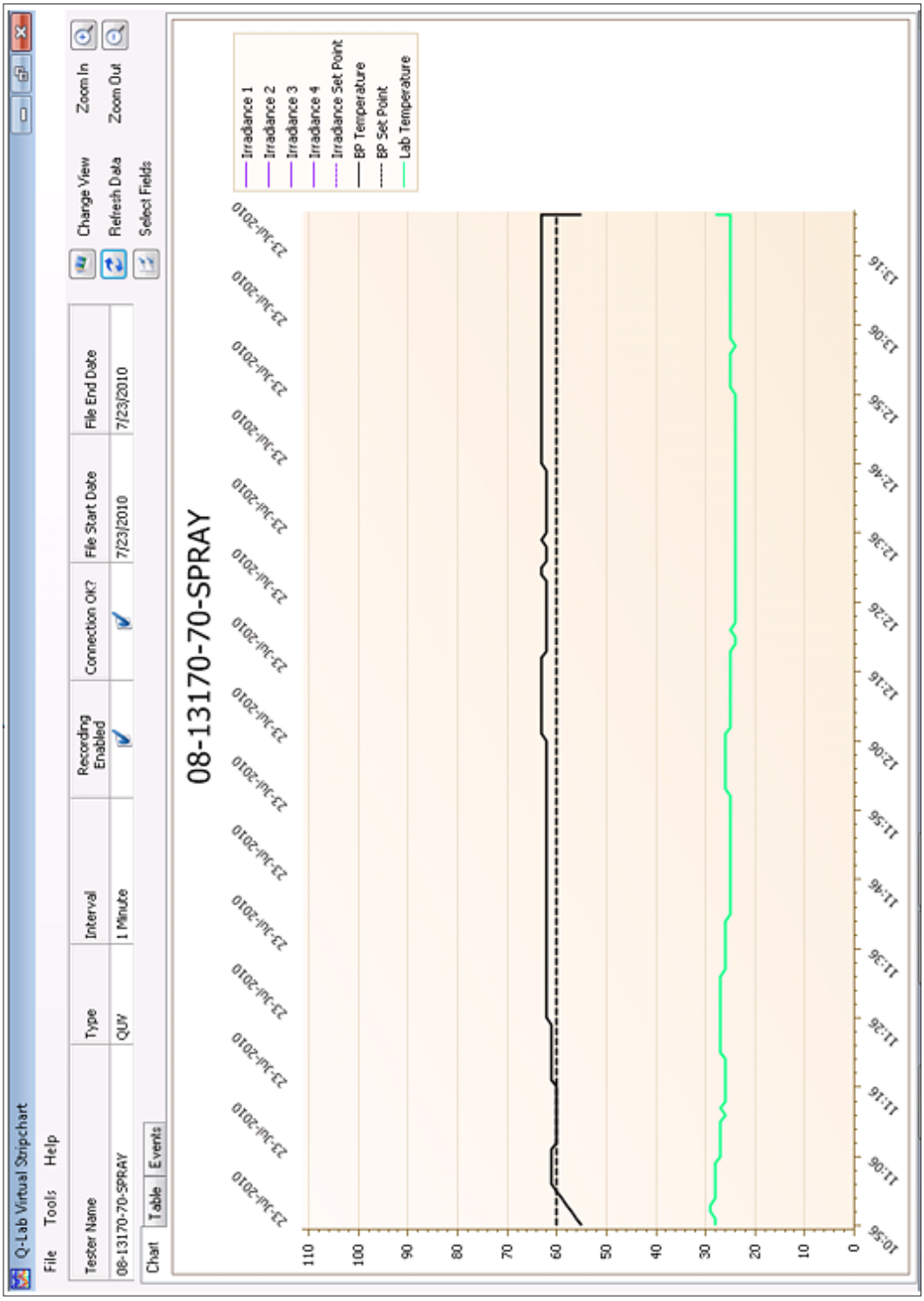



Figure 12.3g: Stripchart view of QUV operational data.

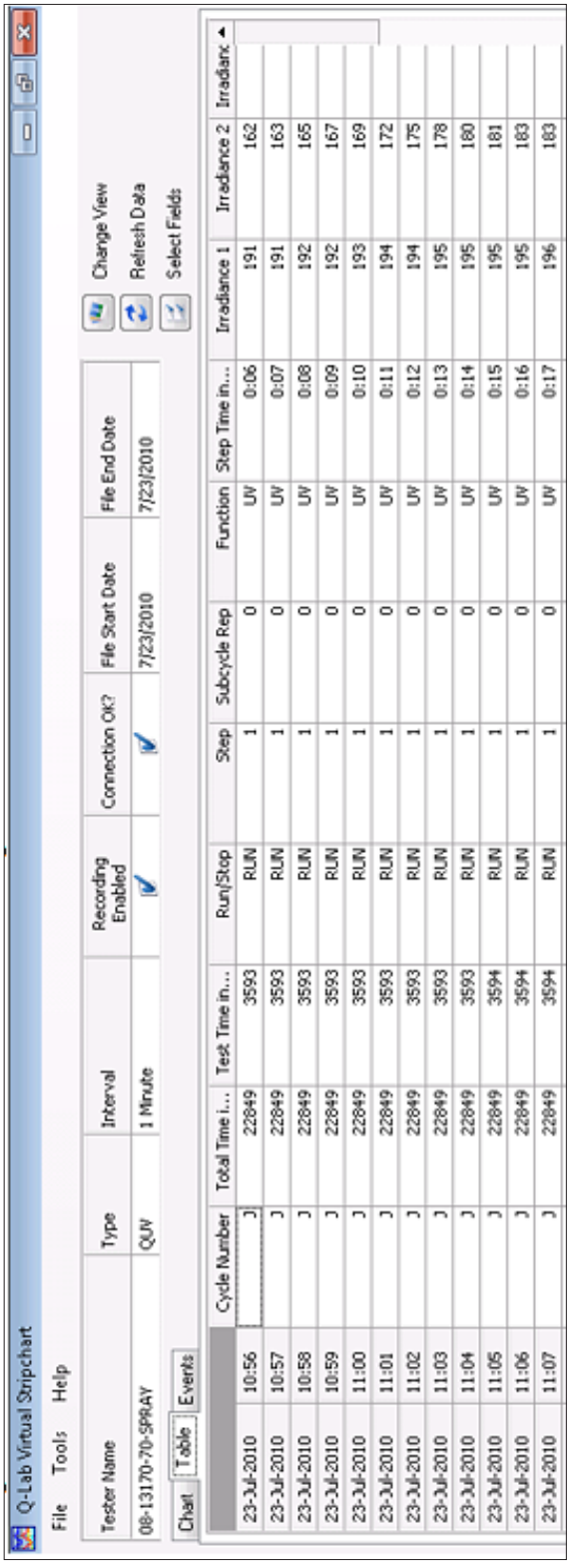



Figure 12.3h: Table view of QUV operational data.

## 12.4. Import VIRTUAL STRIPCHART Data (Aug 2020)

- At the Q-Lab Q-Portal Asset Center, customers can register their QUV testers.
- Once a tester is registered, customers can access important information relating to the tester as well as view, customize, export, and create .pdf files of their virtual stripchart data .
- The .vsc files must first be downloaded using the Export Diagnostics function (see Section 12.3). Contact Q-Lab Repair and Tester Support (Section 18) for more information.

# 13. Options

## 13.1. Space Saver Frame (Mar 2014)

- Q-Lab offers a space saver frame to stack two QUV testers on top of each other to save floor space (Figure 13.1a and Figure 13.1b).
- See Specification Bulletin LU-0820 for space saver frame specifications and part numbers.


Figure 13.1a: QUV testers without spray on space saver frame.

Figure 13.1b: QUV testers with spray on space saver frame.

## 13.2. Water Pump (Jan 2011)

- Q-Lab offers a water inlet pump for labs that do not have sufficient water pressure.
- The pump will boost low pressure or draw water from a reservoir.
- The pump operates on either 120 or 230 volts.
- It turns on automatically when needed to supply water to the QUV water feed for condensation and/or the spray nozzles for water spray.

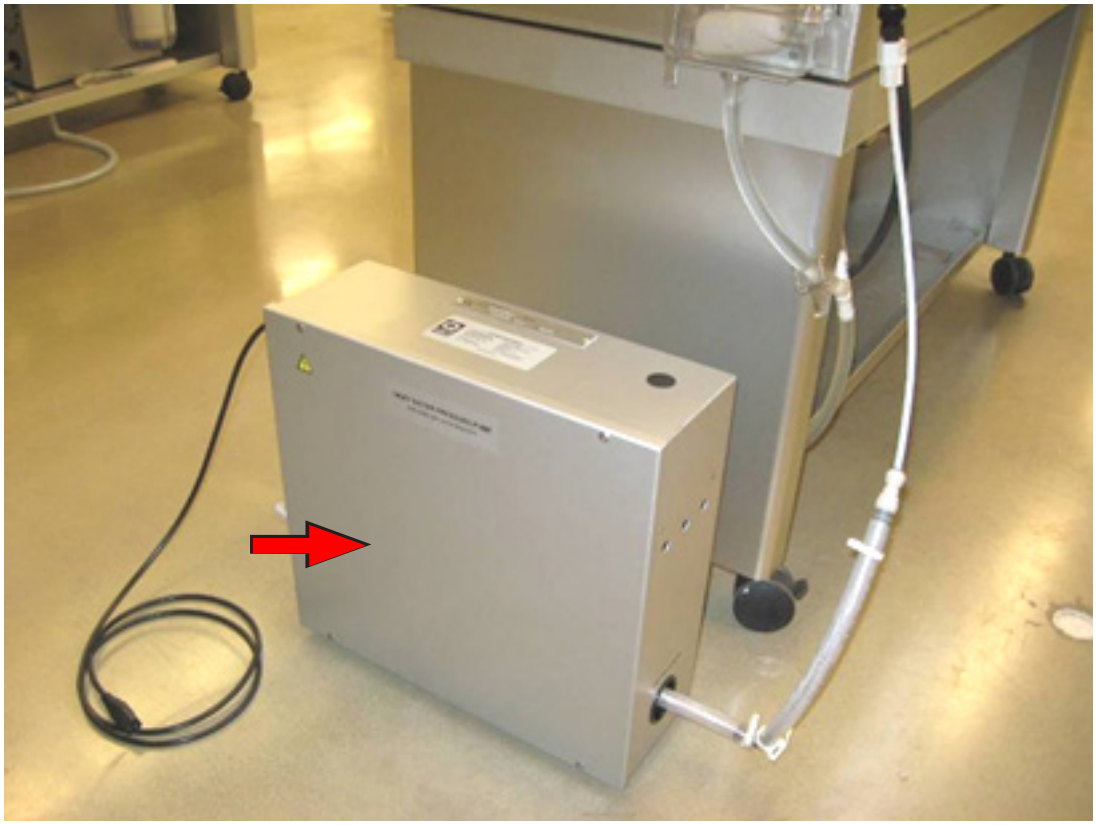


Figure 13.2: Water pump (part no. X-10570-K).

## 13.3. Water Repurification System (Aug 2020)

### Repurification Conserves Purified Water

- The Q-Lab optional water repurification systems conserve purified water.
- The water repurification systems re-purify and re-circulate tester spray water instead of letting it go down the drain.
- A repurification system is not a primary purification system. It is a *re-purification* system. Purified water must still be supplied to the tester.
- Repurification can save over 1,500 liters of expensive purified water per day if you are running a test cycle that calls for several hours of water spray.
- The QUV spray system uses 7 liters per minute (lpm) of water during spray steps.
- If tests spray 4 hours per day, that amounts to 7 lpm × 60 min/hr × 4 hr/day = 1,680 liters per day.

### Repurification System Options

- Q-Lab offers two types of water repurification system.
- A water repurification system can be purchased as an integrated factory installed option (QUV/spray/rp), Figure 13.3a.
- The water repurification system can also be purchased as a retrofit kit (part no. V-60007-K) for installing an integrated unit in the QUV/spray under the test chamber.
- A standalone water repurification system (part no. V-60160-K) in a separate external housing is also available (Figure 13.3c and Figure 13.3d).

### System Operation

- During a spray step the repurification system pump turns on and draws water out of the reservoir. The water then goes through a flow adjustment valve (Figure 13.3b) which sends 7 lpm to the spray nozzles (and some back to the reservoir).
- The flow adjustment valve must be set so that the flow meter reads 7 lpm during spray (Figure 13.3b).
- The water goes through a re-purification cartridge and other filters to remove any contaminants (Figure 13.3a).
- After the water is sprayed on the test specimens it drains back into the reservoir.
- A float valve automatically adds water to the reservoir to replenish water lost to evaporation (typically 5 liters per day) – NO MANUAL FILLING IS NEEDED.
- Since the water is recycled, a drain is not mandatory. However, a drain is recommended so that if the float valve sticks open, the overflow will go down the drain instead of on the floor.
- See Section 14.5 for important repurification system filter maintenance information.

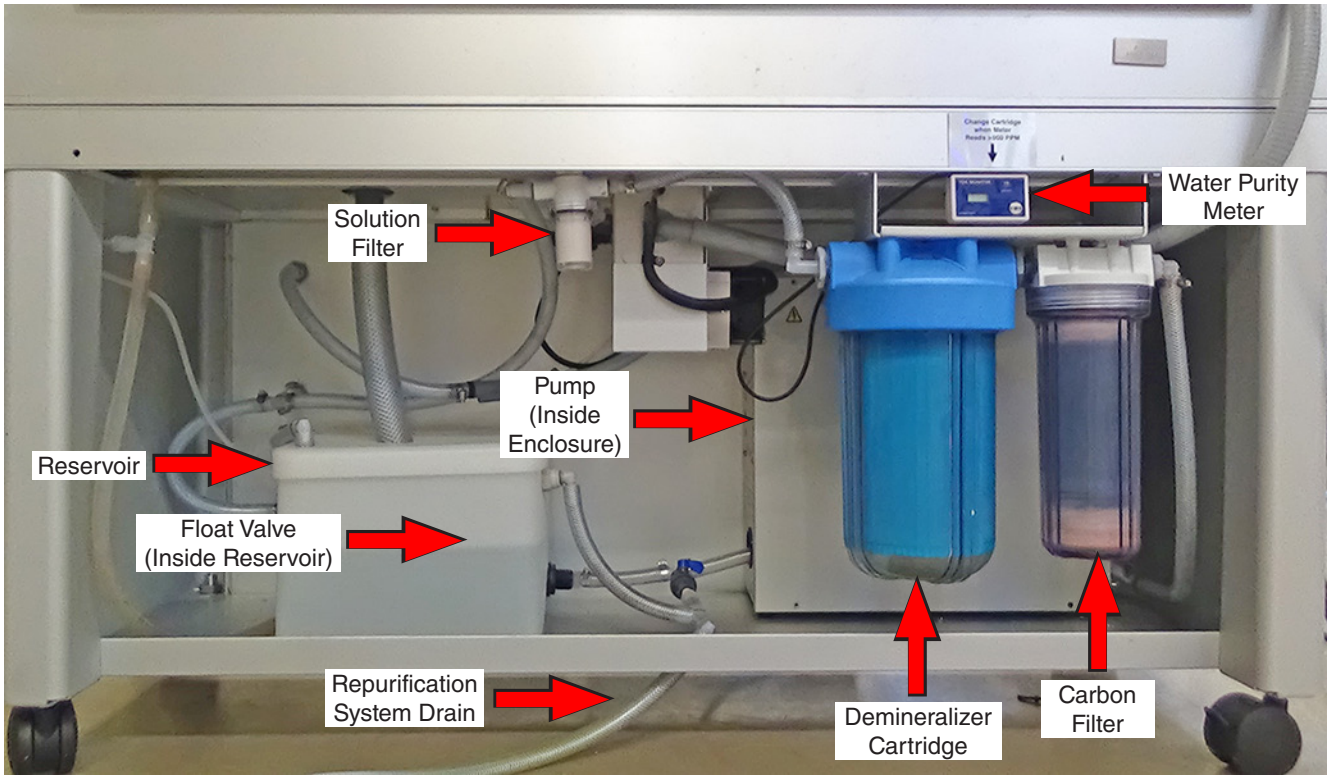



Figure 13.3a: QUV rear view showing integrated water repurification system.


Figure 13.3b: Flow adjustment valve and flow meter location.


Figure 13.3c: QUV with standalone water repurification system (part no. V-60160-K)

- The standalone water repurification system can also be used with QUV/spray testers mounted on a space saver frame (Figure 13.3d).
- If both QUV testers on the space saver frame are QUV/spray models, then two water repurification kits are stacked on top of each other.

Figure 13.3d: Water repurification systems (V-60160-K × 2) stacked for QUV/spray testers on space saver frame.

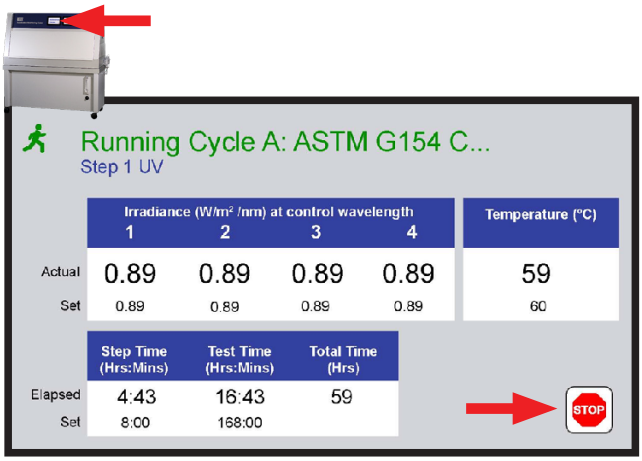
# 14. Maintenance

## 14.1. Lamps (Aug 2020)

- The SOLAR EYE Irradiance control automatically maintains the programmed irradiance.
- As lamp output declines, the controller automatically increases power to the lamps.
- The lamps generally need to be changed only once a year.
- To prevent excessive buildup of dirt on lamps, wipe them with a clean cloth dampened in alcohol every six months.
- An error message is displayed if irradiance falls 0.10 ($W/m^2/nm$) below the set-point.
- The pair of lamps that is low should be replaced.  It is not necessary to replace all the lamps.

**Always re-calibrate after changing lamps.**

## Lamp Replacement




1. Touch the **STOP** icon.


2. Power **OFF**

**OFF**

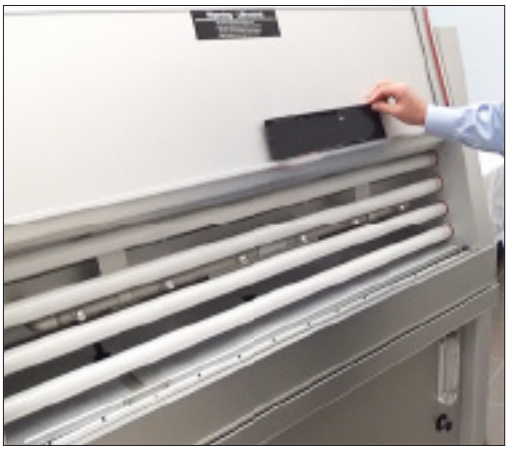
3. Main power **OFF**.

4. Disconnect power supply.

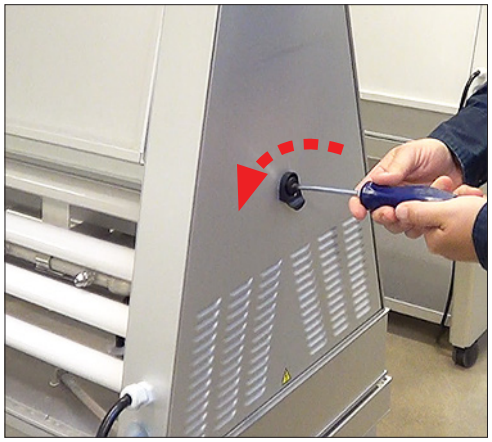
5. Open the front and back doors.


6. Remove all specimen holders from both sides of the QUV test chamber. Set holders aside.

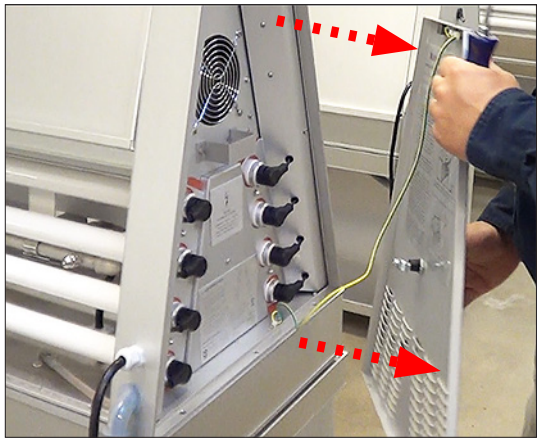
**7.** Loosen the thumb screws at the top of the detector panels on the QUV tester.



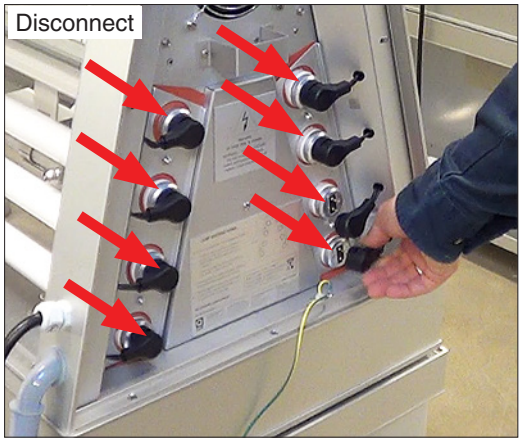
**8.** Place the detector panels on door ledge.



**9.** Open the end cover latches.

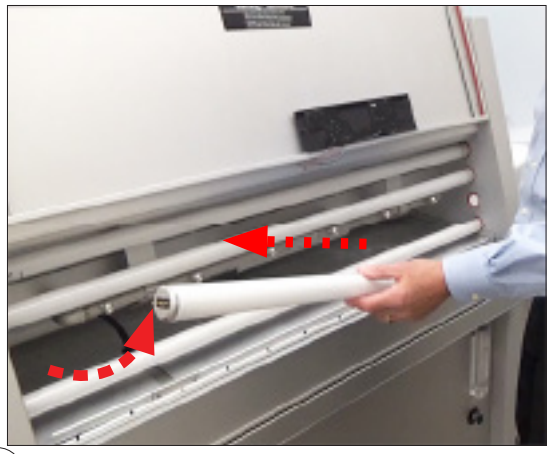


**10.** Remove the end covers.

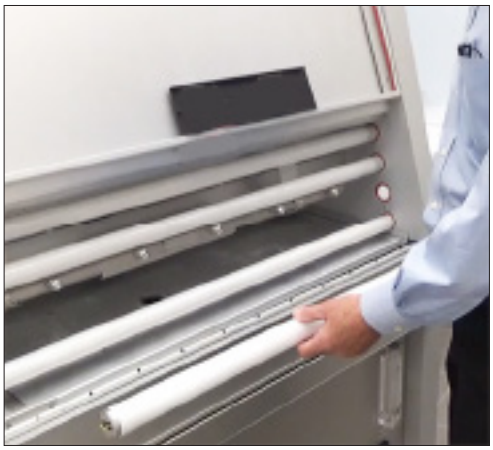



**11.** Disconnect the lamps on both ends.

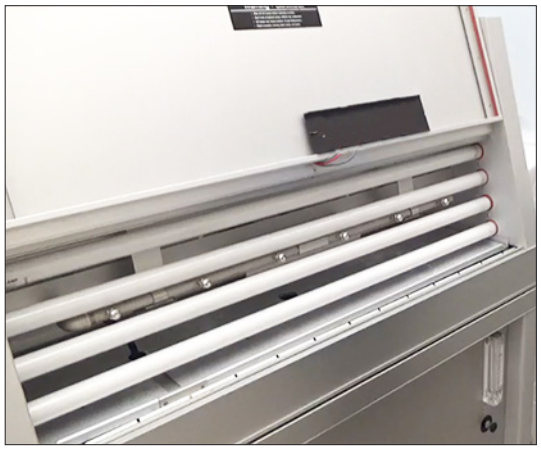
**12.** Hold the lamp and carefully slide it to one end until it pulls out of the lamp gasket.



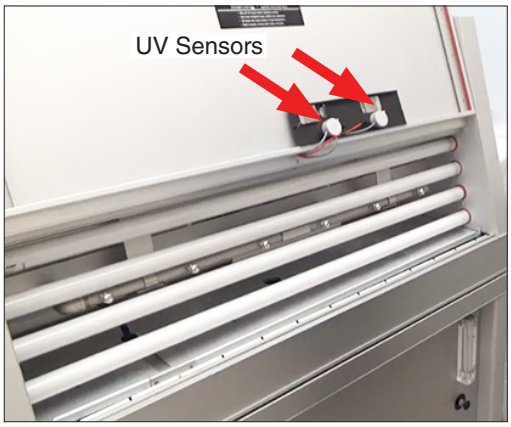
**13.** Carefully rotate the lamp outward, slide out of the other lamp gasket. Remove the lamp.



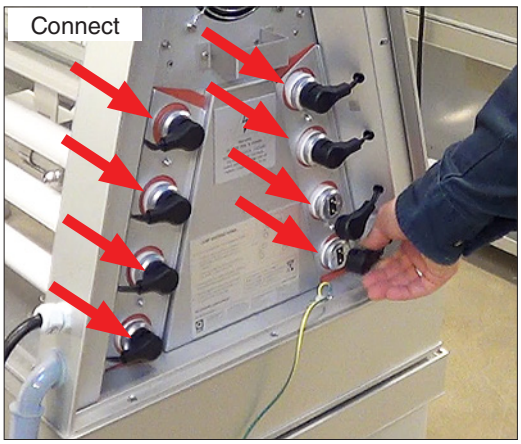
**14.** Repeat **Steps 12 and 13** to remove additional lamps as required.



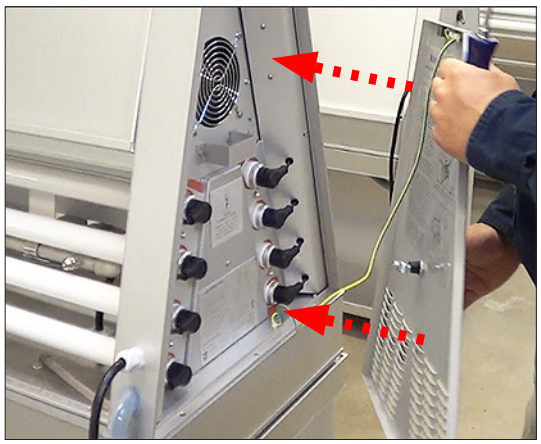
**15.** Install new lamps.



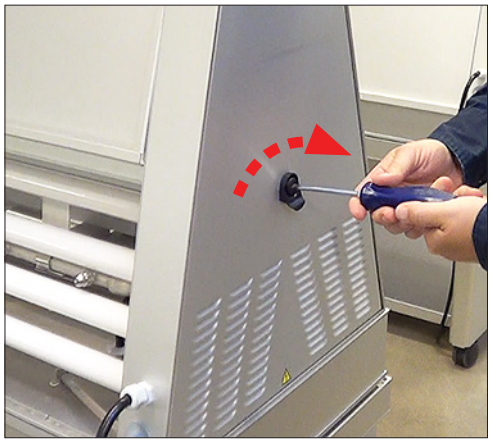

**16.** After replacing lamps, the UV sensors must re-calibrated. See **Section 11.1**.



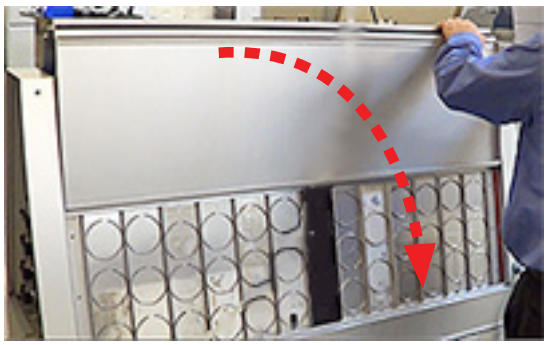

**17.** Re-connect the lamps on both ends.



**18.** Replace the end covers.



**19.** Close the end cover latches.

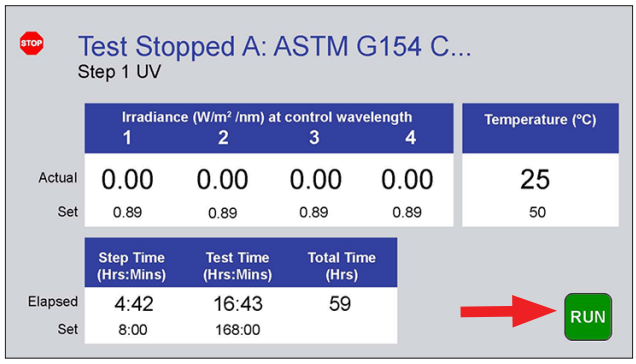


**20.** Replace detector panels and specimen holders. Close doors.

**21.** Connect power supply.


**22.** Main power **ON**.


**23.** Reconnect and power on main power. Power QUV ON.




**24.** Touch the **RUN** icon

## 14.2. Water Pan (Apr 2016)

- Inspect and clean the water pan every 6 months.
- If tap water is used in a QUV/se, inspection and cleaning should be performed more frequently.

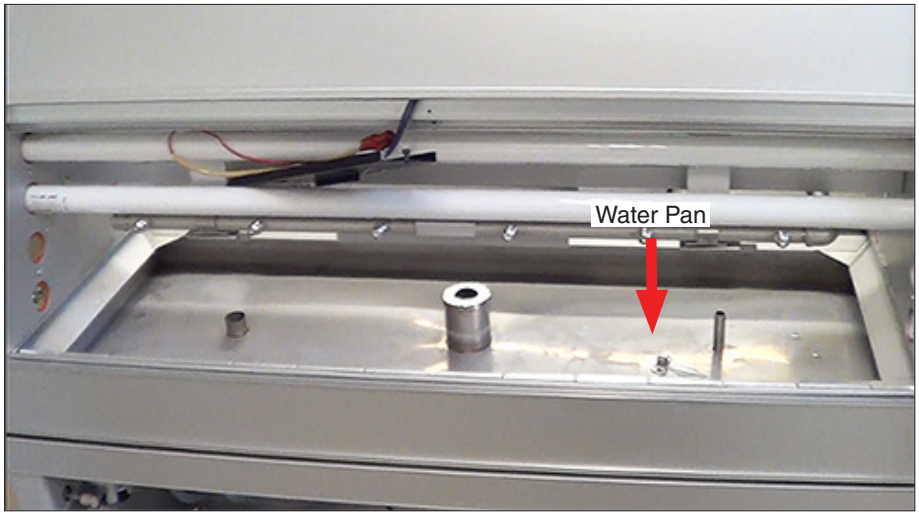



Figure 14.2: QUV water pan shown with lamps and water pan cover removed.

## 14.3. Check QUV/spray Spray Nozzles (Mar 2015)

- Spray inspection windows are supplied with every QUV/spray tester.
- The left and right side spray inspection windows are used to check for clogged spray nozzles.
- Spray nozzles should be checked once a month.
- Remove all test panels from one side of the QUV tester and put the left and right side inspection windows in place (Figure 14.3a).
- Run a spray step and check for clogged nozzles by looking at the spray pattern on the windows
- The spray area defined on each window should be wet.
- Repeat the procedure on the other side of the QUV tester.

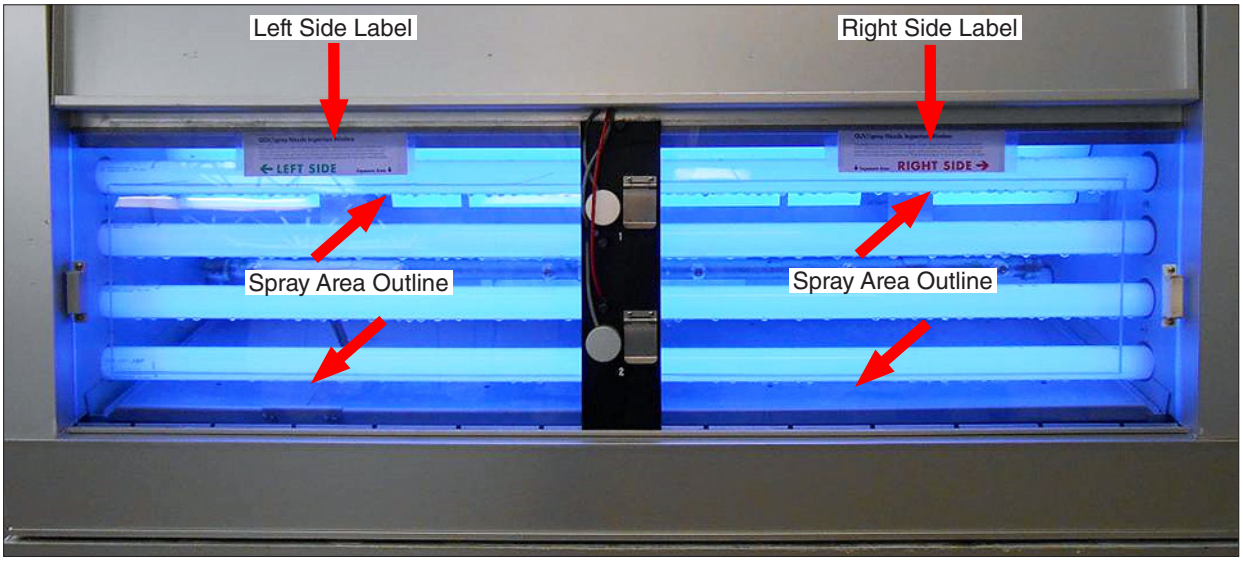



Figure 14.3a: Left side and right side spray inspection windows.

- If a portion of the defined spray area on each window is not wet, the spray nozzle in that area should be removed and cleaned.
- Remove the nozzle from the spray bar.
- Disassemble and clean the nozzle with a small brush and compressed air.

Figure 14.3b: Spray nozzle disassembled for cleaning.

## 14.4. Check QUV/spray Water Filter Solenoid Filter (Jul 2019)

- Inspect the water filter cartridge (Figure 14.4a) every 6 months.
- If it is dirty, replace the water filter cartridge (part number F-8066.5).

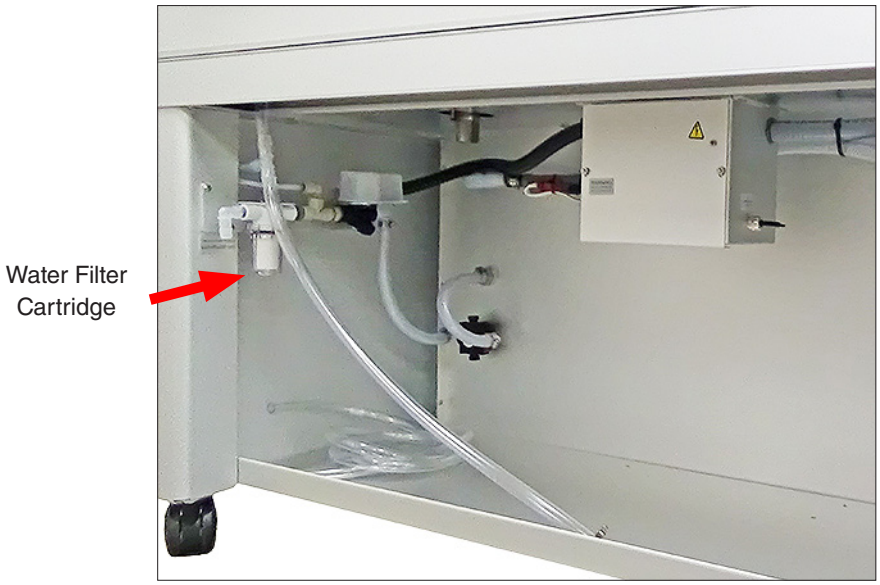



Figure 14.4a: Water filter cartridge location.

- Inspect the solenoid filter screen (Figure 14.4b) every 6 months.
- If dirty, use clean pure water and a small brush to clean the screen.

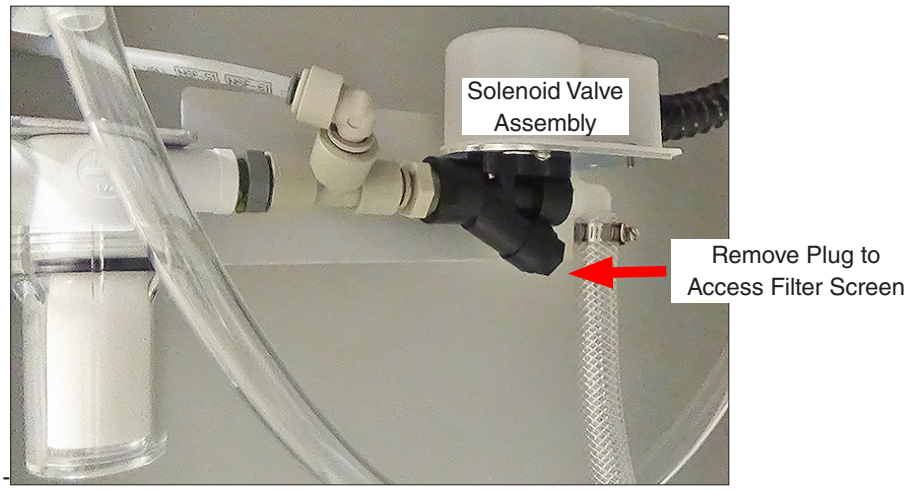



Figure 14.4b: Solenoid filter screen location.

## 14.5. Check Water Repurification System (Jul 2019)

- For QUV testers equipped with an optional integrated water repurification system.

### Solution and Carbon Filters

- Inspect the solution filter every 6 months (Figure 14.5a).
  - If dirty, replace with part number F-8066.5.
- Replace the carbon filter yearly with part number V-60335.
- See Section 16, Replacement Parts, for more information.

### Demineralizer Cartridge

- The water purity meter (Figure 14.5a) should be checked once a month, and when the Total Dissolved Solids are greater than 1 ppm the demineralizer cartridge should be replaced with part number V-4979.
- When the QUV is supplied with pure water the demineralizer cartridge should last several years.

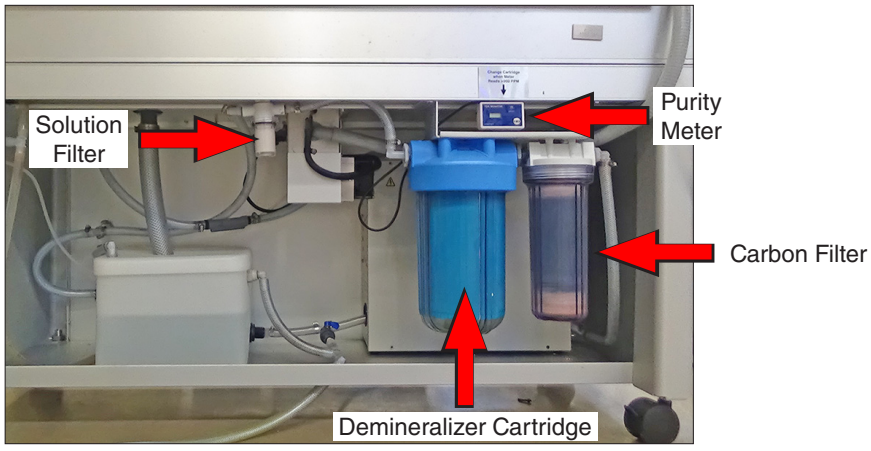



Figure 14.5a: QUV with integrated repurification system.

## Demineralizer Cartridge

- Run a spray step (seeSection 9.6).
- Locate the repurification system water purity meter (Figure 14.5b, Figure 14.5c).

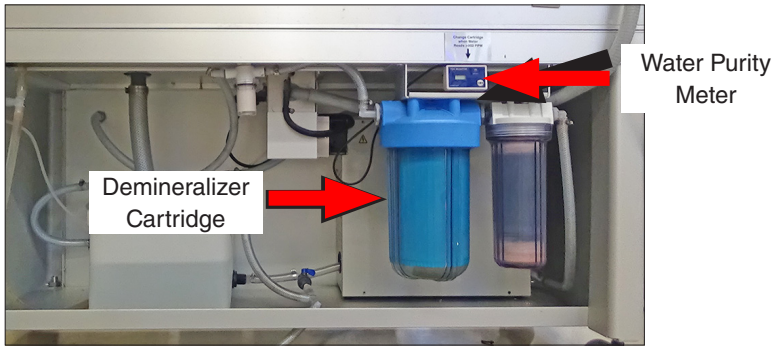



Figure 14.5b: Integrated water repurification system.


Figure 14.5c: Stand-alone water repurification system.

- Press the ON/OFF button on the water purity meter to turn it ON (Figure 14.5d).
- If the water purity meter reads > 001 the demineralizer cartridge should be replaced.
- Press the ON/OFF button again turn the meter OFF.

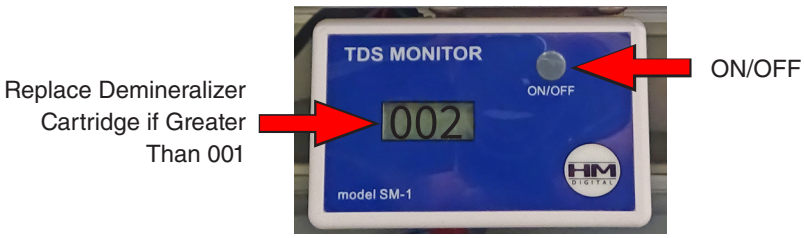



Figure 14.5d: Water purity meter reading.

## Water Reservoir

- Locate the repurification system water reservoir (Figure 14.5e and Figure 14.5f).
- Inspect the water reservoir and repurification system tubing for signs of discoloration.
- Mold will occasionally need to be cleaned from the water repurification system (Figure 14.5g).
- Cleaning can be done by running bleach through the system.
- Please contact Q-Lab Repair and Tester Support (Section 18) and request *Service Instruction V- 60010-L, How to Remove Mold from the QUV Water Re-Purification System*, for a detailed description of the cleaning procedure.

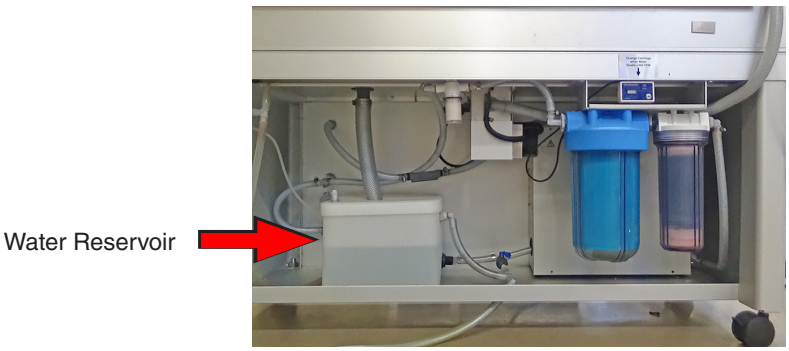



Figure 14.5e: Integrated water repurification system.


Figure 14.5f: Stand-alone water repurification system.

Figure 14.5g: Reservoir lid removed showing mold growth.

## 14.6. QUV Software Updates (Aug 2017)

- Q-Lab periodically updates the software that runs the QUV to improve tester performance.
- Q-Lab recommends that customers check www.q-lab.com/software for new software versions every year to determine if any required software updates have been released and should be installed.
- The files required to perform software updates can only be obtained by contacting Q-Lab (see Section 18).

### Software Version and Tester Serial Number

- The currently-installed QUV software version number and tester serial number are required to determine if a software update needs to be performed.
- The QUV serial number and the software version are listed in the diagnostics screen accessed from the controller main menu.
- See Section 9.8 for instructions to display the tester serial number (diagnostic D14) and software version (diagnostic D7). The serial number can also be found on the nameplate attached to the rear of the QUV control top.

### Software Types

- Once you have the tester serial number and software version number, visit www.q-lab.com/software.
- The most recent versions of QUV software will be listed and identified as either **Required**, **Recommended** or **Optional**.
    - **Required** updates must be installed immediately, as they address issues that may strongly affect tester performance and/or pose a safety concern.
        - If a Required software version is more recent than the version currently installed on the QUV (see previous section), that software needs to be installed.
        - More recent software versions are indicated by a higher version number (e.g. 5.101 and 5.200 would both be more recent than 5.100).
    - **Recommended** updates should be installed as soon as possible, as they offer a significant improvement and/or make an important correction.
    - **Optional** updates should not be installed unless Q-Lab personnel have directed you to do so.

## Software Update

- The appropriate software update file can be obtained either by contacting Q-Lab Repair directly or by filling out the web-based form on www.q-lab.com/software.
- Q-Lab Repair and Tester Support personnel will contact you to discuss your situation and, when applicable, provide you with necessary software files and instructions to perform an update.
- Copy the software files (file format must be .ff4) to a USB flash drive (Figure 14.6a).
- Connect the drive to the tester USB port of the control panel (Figure 14.6b).
- If a valid software file is on the USB drive, the controller will determine if that version is newer, the same as, or older than the software installed on the tester.
- On the USB Options screen, the software button label will reflect the relative software version (Figure 14.6c).
  - *Install New Software* means the software version on the USB drive is newer than the version on the tester
  - *Install Current Software* means the software version on the USB drive is the same as the version on the tester.
  - *Install Older Software* means the software version on the USB drive is older than the version on the tester.
- Touch the software install button to begin the software update process.
- Touch OK to confirm software installation (Figure 14.6d).
- If at any time during the software upgrade process a problem occurs with the USB drive or the data storage card on the main controller board, an error message will be displayed on the tester control panel.
- See Section 18 for Q-Lab Repair and Tester Support contact information.


Figure 14.6a: Copy QUV software to a USB drive.


Figure 14.6b: Connect the drive to the USB port of the QUV control panel.


Figure 14.6c: The USB Options screen displays the software installation button.

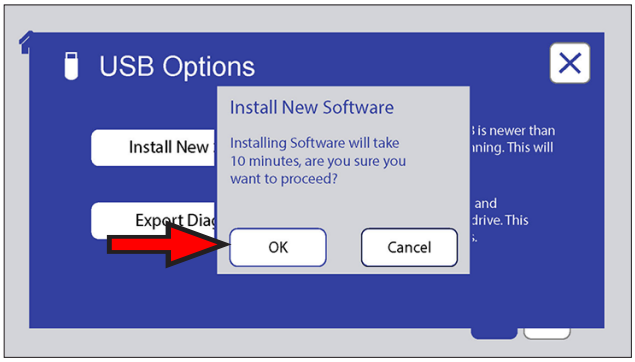



Figure 14.6d: Touch OK to proceed with software installation.

# 15. Troubleshooting and Repair

- The QUV is designed so that virtually all repairs can be made by the user.
- Use only parts that have been supplied or recommended by Q-Lab.
- Q-Lab accepts no responsibility for the consequences of the use of non-approved parts.
- Please contact Q-Lab Repair and Tester Support with any questions regarding tester troubleshooting and repair.
- The QUV software includes functions to export data that can be used to help diagnose tester problems (see Section 12.3).

## 15.1. Operational Error Messages (Mar 2018)

- Repair and Tester Support is available over the telephone Monday through Friday from 8:30 AM to 5 PM.
- Please contact the nearest international branch office by phone or email for technical support.
- You can also visit our website at www.q-lab.com to register your tester to access additional useful troubleshooting guides, operating manuals, and technical information.


For sales, technical, or repair support, please visit:

Q-Lab.com/support

Westlake, Ohio USA • Homestead, Florida USA • Buckeye, Arizona USA
Bolton, England • Saarbrücken, Germany • Shanghai, China

| Code | Message | Meaning |
|---|---|---|
| M1 | DOOR IS OPEN | Door is open |
| M2 | OUTER COVER IS OFF | Outer Cover is off |
| M10 | END OF TEST | Test completed (QUV continues to run with message only) |
| M11 | END OF TEST | Test completed (QUV continues to run with message and alarm) |
| M12 | END OF TEST SHUTDOWN | Test completed (QUV stops running without alarm) |
| M13 | END OF TEST SHUTDOWN | Test completed (QUV stops running with alarm) |
| M20 | PANEL TEMPERATURE TOO HOT XX°C | UV CYCLE:<br>Air heater relay is stuck closed.<br>Lab temperature is too hot.<br>CONDENSATION CYCLE:<br>Water heater relay is stuck closed.<br>Lab temperature is too hot. |
| M21 | PANEL TEMPERATURE TOO COLD XX°C | UV CYCLE:<br>Air heater relay is stuck open.<br>Air heater is broken.<br>Lower blower relay is stuck open.<br>Lower blower is broken.<br>Lab temperature is too cold.<br>CONDENSATION CYCLE:<br>Panel holders are missing.<br>Lower blower relay is stuck closed.<br>Water heater relay is stuck open.<br>Water heater is broken.<br>Lab temperature is too cold. |
| M22 | UV TEMPERATURE FAULT XX°C | Step time is too short. |
| M23 | CONDENSATION TEMPERATURE FAULT XX°C | Step time is too short. |
| M24 | PANEL TEMP RUNAWAY XX°C | UV CYCLE:<br>Air heater relay is stuck closed.<br>CONDENSATION CYCLE:<br>Water heater relay is stuck closed. |

| Code | Message | Meaning |
|---|---|---|
| M25 | LAB TEMPERATURE AT ALARM XX$^{O}$C | Lab temperature may be the cause of a chamber temperature fault. |
| M26 | UV +COND TEMPERATURE FAULT XXX$^{O}$C | If UV +COND step ends, and if temp never reached set point ±2$^{O}$. |
| M27 | DARK TEMPERATURE FAULT XXX$^{O}$C | If DARK step ends, and if temp never reached set point ±2$^{O}$ |
| M30 | REPLACE BATTERY | Battery voltage is low |
| M33 | WATER PAN TOO HOT XX$^{O}$C - MAY BE EMPTY | Water supply is shut off. |
| M34 | CONTROLLER TOO HOT XX$^{O}$C | Lab is too hot. |
| M43 | WATER SPRAY OFF: SHOULD BE ON | Water supply is shut off.<br>Spray nozzle clogged. See **Section 14.3**.<br>Pressure regulator faulty.<br>Solenoid valve is stuck in the closed position.<br>Spray relay is stuck in the open position.<br>Flow switch is stuck in the open position. |
| M44 | WATER SPRAY ON: SHOULD BE OFF | Solenoid valve is stuck open.<br>Spray relay is stuck closed.<br>Flow switch is stuck in the closed position. |
| M49 | POWER DISRUPTED | This message indicates power was off and then came back on during a **RUN** step.<br>The message appears if power goes out for any reason, including if the user turns power OFF when the tester is in RUN mode.<br>Always press **STOP** before powering the QUV off to prevent the M49 message from being displayed when the QUV is powered back on. |
| M50 | UV IRRADIANCE TOO HIGH | Ballast is broken.<br>UV sensor is broken.<br>Irradiance set point is too low. |
| M51 | UV IRRADIANCE TOO LOW | Rubber lamp socket is off or loose.<br>Lamp is burned out.<br>Lamps are old.<br>UV sensor is broken.<br>Irradiance set point is too high. |
| M52 | BALLAST OR BALLAST RELAY FAULT | Ballast is broken.<br>Ballast relay is stuck open. |
| M53 | BALLAST RELAY STUCK ON | Ballast relay is stuck closed. |
| M54 | RUN RELAY STUCK ON | Run relay is stuck closed. |
| M55 | RELAY CHECK IN PROGRESS | Controller is checking relays. |
| M60 | LAMP FAULT BALLAST 1 | Rubber lamp socket is off or loose.<br>Lamp is burned out.<br>Ballast is broken. |
| M61 | LAMP FAULT BALLAST 2 | Rubber lamp socket is off or loose.<br>Lamp is burned out.<br>Ballast is broken. |
| M62 | LAMP FAULT BALLAST 3 | Rubber lamp socket is off or loose.<br>Lamp is burned out.<br>Ballast is broken. |
| M63 | LAMP FAULT BALLAST 4 | Rubber lamp socket is off or loose.<br>Lamp is burned out.<br>Ballast is broken. |

| Code | Message | Meaning |
|---|---|---|
| M66 | CALIBRATE UV SENSORS | Time to calibrate UV sensors.<br>Occurs every 500 hours |
| M69 | LAMPS ON - SHOULD BE OFF | Ballast relay is stuck closed. |
| M70 | HEATER ON - SHOULD BE OFF | Run relay and heater relay are stuck closed. |
| M80 | FLASH MEMORY ERROR | Turn the QUV off and back on. If the problem persists, contact Q-Lab. |
| M81 | FLASH DATA CORRUPT | Turn the QUV off and back on. If the problem persists, contact Q-Lab Repair. |
| M82 | RAM CORRUPTED, RAM RELOADED | Indicates a problem with the controller. Press the clear and enter buttons, if the problem persists, contact Q-Lab Repair. |
| M92 | PANEL TEMPERATURE SENSOR FAIL | Panel temperature sensor is broken |
| M93 | WATER TEMPERATURE SENSOR FAIL | Water temperature sensor is broken |
| M94 | LAB TEMPERATURE SENSOR FAIL | Lab temperature sensor is broken |
| M101 | SD CARD MISSING | The SD card on the main controller board is missing or not seated properly. Contact Q-Lab Repair. |
| M103 | SYSTEM AUTO REBOOT: SEE TECH MANUAL | The QUV has restarted itself in order to avoid a potential problem in operation. Please contact Q-Lab Repair. |
| M104 | Software install completed successfully | Software has been installed without issue. |
| M900 | Status Screen communications failure | Communication lost between main controller and Status Screen, Tester will enter single-screen mode. |
| M901 | Menu Screen communications failure | Communication lost between main controller and Menu Screen, Tester will enter single-screen mode. |
| M902 | Main Controller communications | Message that appears on a screen that has experienced M900 or M901. |

## 15.2. Insufficient Water Volume (Jul 2019)

### QUV/spray without Water Repurification System

- Spray water flow in QUV testers without water repurification systems is controlled by a pressure regulator (Figure 15.2a).
- If the pressure regulator cannot be adjusted to obtain 7 liters per minute (lpm) reading on the flow meter, check that:
- Input water pressure is at least 45 pounds per square inch (psi) when running a spray step (water is flowing).
- Check the spray nozzles and water filter cartridge (see Section 14.3 and Section 14.4).
- If the M43 *Water spray off should be on* error message is displayed, see Section 15.1 for more information
- If 7 lpm still cannot be obtained, the pressure regulator (part number HS-4650-X) may need to be replaced.
- For more information contact Q-Lab Repair and Tester Support, see Section 18.

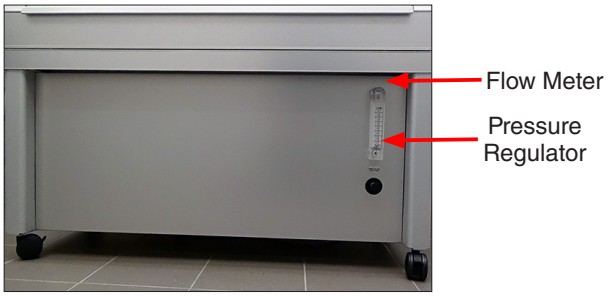



Figure 15.2a: QUV/spray pressure regulator and flow meter.

### QUV/spray with Water Repurification System

Spray water flow in QUV testers with water repurification systems is controlled by a water flow adjustment valve (Figure 15.2b and Figure 15.2c). If the flow adjustment valve cannot be adjusted to obtain 7 liters per minute (lpm) reading on the flow meter, check that:

- The spray nozzles and water filter cartridges are not dirty or clogged (see Section 14.3 and Section 14.5).
- There is water in the reservoir.
- The spray relay is not stuck in the open position.
- The flow switch is not stuck in the open position.
- The pump motor (part number X-10819-K) is not broken (see Section 13.3).
- For more information contact Q-Lab Repair and Tester Support, see Section 17.

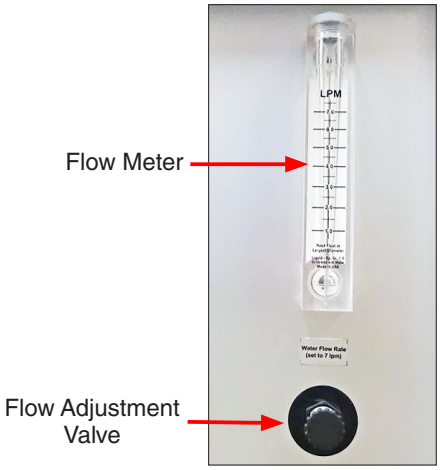



Figure 15.2b: Water flow adjustment on QUV/spray/rp integrated water repurification system.

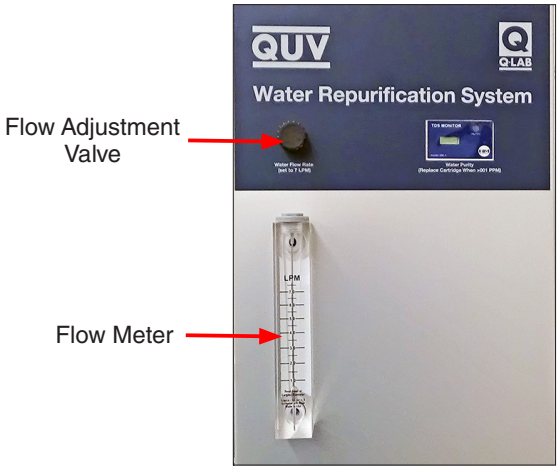



Figure 15.2c: Water flow adjustment on QUV/spray stand-alone water repurification system.

## 15.3. No Power (Aug 2008)

### No Power

- Main power switch is broken.
- Transformer is broken.

### Power Switch/Circuit Breaker Trips

- Main power switch is broken.
- Air and water heaters are on at the same time because the air or water heater relay is stuck closed.

## 15.4. Loose Lamp Sockets (Apr 2016)

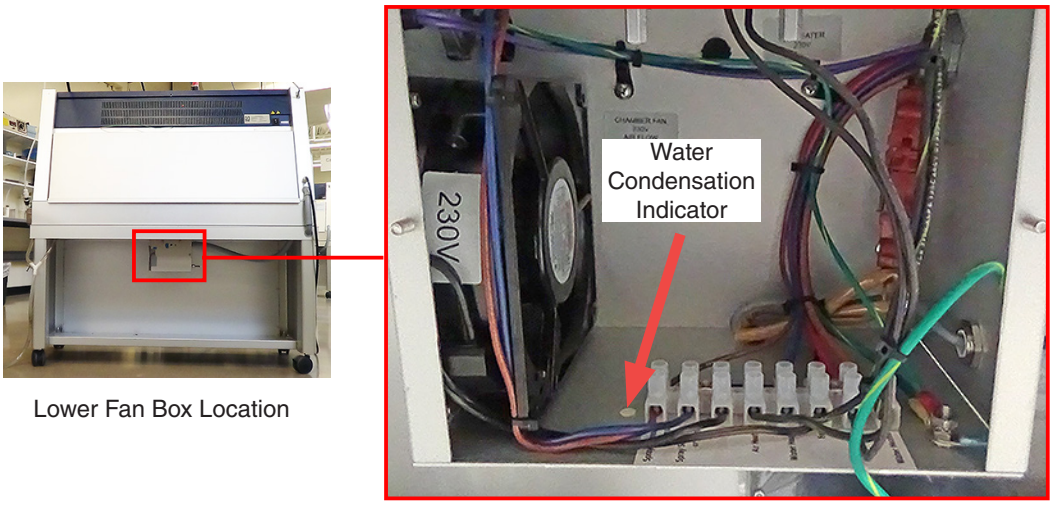
**Be sure the power is OFF before performing this procedure**

- If the rubber socket is loose and falls off the lamp pins:
- Squeeze the socket gently with a pair of pliers.
- This will tighten up the brass bushings inside the socket.
- Replace lamp sockets that appear worn or cannot be sufficiently tightened.

Figure 15.4: Squeeze gently to tighten socket.

## 15.5. Water Condensation in Lower Fan Box (May 2017)

- Water sometimes condenses in the lower fan box when the room temperature is cold and the QUV runs a hot condensation step.
- This could cause a premature failure of the air heater located in the lower fan box.
- A water detection indicator in located the bottom of the lower fan box. See Figure 15.7.
- The indicator turns red (and stays red) when it gets wet.
- To check for water condensation in the fan box, remove the fan box cover.
- If the indicator is red, contact Q-Lab to find out what can be done to prevent water condensation in the fan box.




Lower Fan Box Location

Figure 15.5: Water condensation indicator in lower fan box.