OPERATING MANUAL

# Triaxial / Permeability Master Control Panel

## HM-350M/350MF • HM-350A


**Model HM-350M**

Rev: 11/2021


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## 1.0 SYSTEM COMPONENTS

### 1.1 Master Air Pressure Regulator and Air Filter

On the right rear of the panel, there is a master air pressure regulator and air filter. This regulator is used to set the maximum supply pressure to the panel.

### 1.2 System Pressure Readout

This readout is used to set the pressure of the cell, lower pedestal and upper cap storage/burette chambers. The accuracy of this readout is 0.25%. It is provided with an "on/off" switch on the front of the panel and a power supply with a lead that is connected to the rear of the readout.

### 1.3 Pore Pressure Readout

This readout is used to measure the pore water pressure in the sample to determine if the sample is saturated. The accuracy of this readout is 0.25%. It is provided with an "on/off" switch on the front of the panel and a power supply with a lead that is connected to the rear of the readout.

### 1.4 Storage Chamber, Burette and Pipette Assembly

The chambers provide an air/water interface between the regulated chamber pressures and the triaxial/permeability cell and soil sample. The CELL storage tube is located in the middle of the chamber assembly. The LOWER PEDESTAL storage/burette/pipette chamber assembly is located on the left and the UPPER CAP storage/burette/pipette chamber assembly is located on the right side. The storage/burette/pipette chamber assembly contains a 50 cc burette graduated to 0.1 cc and a 4 cc pipette (located to the left of the burette) that uses the graduations on the burette (0.0082 cc/division. The burette and pipette are located inside a storage chamber that has an additional capacity of approximately 420 cc. The graduations on the burettes are used to measure the change in fluid volume in the burette or the storage chamber.

### 1.5 System Pressure Read Toggle Valves

These valves are the toggle type with "ON" in the up position and "OFF" in the down position. With all the valves in the off position, the pressure transducer vents to atmosphere. The "up" positions are used to monitor/regulate the pressures from the individual pressure regulators. If more than one valve is turned on, only the valve on the left is able to read the pressure. This is also true when two or three panels are connected using the same readout.

### 1.6 Precision Regulators

There are two types of regulators on the panel: the CELL/BIAS Regulator and the LOWER PEDESTAL and UPPER CAP Regulators. The CELL/BIAS regulator has a dual purpose. It can be used independently to regulate the cell pressure. In addition, it can be used to set a fixed pressure differential (BIAS) pressure between the cell and the UPPER CAP and LOWER PEDESTAL. This set BIAS pressure is kept constant while loading the sample to the desired pressure. This feature is used when back pressuring a sample. The BIAS regulator can be set at an initial pressure (2 to 5 psi) and pressure to the cell, lower pedestal and upper cap can be controlled by the LOWER PEDESTAL regulator alone. The CELL BIAS valve will need to turned on for the regulator to operate in this mode.

### 1.7 System Control Valves

> **NOTE:** All ball valves have an "OFF" position pointing to the left for an easy visual interpretation. It should also be noted that all valves above the "CELL", "LOWER PEDESTAL" and "UPPER CAP" headings are for air control. All valves below the headings are for water control.

**CELL BIAS (1) -** Valve has two (2) positions: OFF and CELL BIAS. The OFF position is used when independent regulation of cell pressure is required. The CELL BIAS position is used to set and maintain the bias pressure when using the lower pedestal regulator to simultaneously increase the cell and cap pressures.

**CAP BRIDGE (1) -** Valve has two (2) positions: OFF and CAP BRIDGE. The OFF position is used when independent regulation of lower pedestal and upper cap pressures is required. The CAP BRIDGE position is used when identical end cap pressures are required during saturation. The lower pedestal regulator controls both the lower pedestal and upper cap pressure in this position. The upper cap System pressure control valve needs to be off when using the cap bridge.

**MAIN PRESSURE (3) -** Valves have four (4) positions: OFF, PRESSURE, VENT and VAC . The OFF position is used to prevent any change in pressure from occurring within the burette/pipette/storage chambers during the switch over from back pressuring a sample to introducing a gradient across the soil sample. The PRESSURE position passes the air pressure from the regulators to the top of the storage chamber for the CELL or, storage chamber, burette and pipette in the LOWER PEDESTAL and UPPER CAP. The VENT position vents the top of the storage chamber, burette and pipette to atmosphere. The VAC position directs vacuum from an external source to the top of the storage chamber, burette and pipette for filling, purging of air, and vacuum saturation of the soil sample.

### 1.8 Auxiliary Vacuum / Air Quick Connect

There is a quick connect on the front panel in which the quick connect tube can be attached for any other operations in your lab that require a vacuum source.

A five (5) foot length of 1/4" diameter tubing is provided with a quick disconnect on each end. This line is used to vent the top of the test chamber when filling with water and for quick draining of the test chamber under air pressure.

### 1.9 Fluid Flow Control Valves

**1.9.1** STORAGE CHAMBER (3) Valve for CELL water has two (2) positions: OFF and STORAGE. When turned to the STORAGE position it allows water to flow from the Cell Storage Chamber (center tube on the assembly) to the Test Chamber. Valves for UPPER CAP and LOWER PEDESTAL also have two (2) positions: OFF and STORAGE. When turned to the STORAGE position, water flows to or from the Storage Chamber to the sample.

**1.9.2** BURETTE/PIPETTE (2) valves for UPPER CAP and LOWER PEDESTAL have three (3) positions: OFF, BURETTE and PIPETTE. When in the BURETTE position water flows to or from the sample and can be measured with the 0.1cc burette graduations. When in the PIPETTE position, water flows to or from the sample and can also be measured on the burette graduations (each graduation on the burette equals 0.0082cc/division in the pipette).

### 1.10 Fill / Drain Valves

FILL/DRAIN (3) Valves have (3) positions: FILL, OFF and DRAIN. The FILL position allows for the filling of either the storage/burette chambers the triaxial/permeability cell. The DRAIN position allows for the draining of the storage/burette chambers on the panel or draining of the triaxial/permeability cell.

### 1.11 Test Chamber Connections

The Panel comes with tubing for connection to Triaxial or Flexwall Perm Cell

**1/4" TUBING INSTRUCTIONS:**

1. Simply insert the tubing into the Swagelok tube fitting. Make sure the tubing rests firmly on the shoulder of the fitting and the nut is finger tight.
2. Before tightening the Swagelok nut, scribe the nut at the 6 O'clock position.
3. While holding the fitting body steady with a back-up wrench, tighten the nut 1-1/4 turns. Watch the scribe mark; make one (l) complete revolution and continue to the 9 O'clock position.

**1/8" TUBING INSTRUCTIONS:**

Same as above instructions EXCEPT only a 3/4 turn is required (instead of 1-1/4 turns)

The Test Chamber has 5 Whitey ball valves

- The Center valve is for cell water
- The Valves on left are Lower Pedestal
- The Valves on right are Upper Cap

The Outer Valves on the Valve Bracket Connect to the Panel. The Pore Pressure Transducer connects to lower pedestal valve (next to cell). A stainless steel tube from the transducer connects to the upper cap valve (next to the cell valve). A quick connect type fitting is located on the top of the cell. This is used with the 5 foot length of tubing to vent the cell when filling and for quick draining of the cell through the panel when testing is complete. An auxiliary connection on the panel is used for this function.

### 1.12 Quick-Tite Fittings

These fittings are used on the Sample Cap with the 1/8" tubing that comes from the base of the chamber. Sealing is accomplished without wrenches by inserting the tubing through the fitting and then finger tightening the knurled fitting. An o'ring is compressed around the tube creating the seal.

It is recommended the end of the tube be burr free and have a slight taper. This can be done with a file.

#### 1.12.1 External Connection Lines (see figure 1)

There are five (5) 1/4" diameter external connection fittings located at the right rear of the panel. Failure to follow the tightening sequence could result in leaks.

1. Simply insert the tubing into the push to connect tube fitting. Make sure the tubing is inserted about 5/8" of an inch.
2. Gently tug on the tubing to make sure it is in all the, it should not be able to be pulled out of the fitting
3. To disconnect, push the outer ring on the fitting towards the fitting and pull , this should release the tubing from the fittings grips

**AIR -** The air connection should be attached to a regulated air compressor with an air filter and water trap. Water in the line can enter the precision regulators and can cause problems with excess air bleeding and erratic regulation. The maximum air pressure supplied to the panel should not exceed the maximum air rating of the Master Air Pressure Regulator (optional) or the precision regulators which are 150psi. The minimum pressure should be 20psi more than the highest test pressure. Each regulator will bleed 0.5scfm when running at 150psi.

**DRAIN -** Line running to a sink drain or floor drain. The DRAIN connection is for draining the triaxial/permeability cell and the storage/burette chambers. This line should connect to a user provided drainage container. Note that the line should be secured to prevent any injury when draining under pressure.

**CELL WATER -** Line from tap water source. The CELL connection is for the filling of the triaxial/permeability cell and storage chamber on the front panel.

**SAMPLE WATER -** Line from the de-airing water tank for filling the burette/pipette (lower pedestal and upper cap).

**VACUUM -** Line to vacuum pump. Make certain a water trap is installed in this line to prevent water from entering the vacuum pump.

## 2.0 SYSTEM OPERATIONS

### 2.1 Filling and Draining the Panel with Water

Filling the storage tubes, burettes and pipettes require the system control valve for the tube being filled be placed in the vent position. Next open the flow control valve for the tube being filled. Then turn the fill valve to fill and monitor the water level making sure it doesn't over flow the tube. Shut the fill valve off when it reaches the desired level. If the water level is filled to high in the burette or storage chamber it will vent through the valve to the back of the panel. This prevents water from entering the regulator. Fill the burettes, pipettes and storage chamber to mid level until you are familiar with the operation.

### 2.2 Filling and Draining the Test Chamber

Filling requires that you vent the top of the test chamber as you fill the chamber with water. Place the tube quick connect in the top of the chamber. The other end of the tube can positioned in a trash can to drain. Open the cell water valve. Make sure the Cell Storage valve is closed and then turn the fill/drain valve to fill. The cell will then fill with water. When completed, close the fill valve and then remove the quick connect tube at the top of the cell.
Draining the test chamber requires the pressure in the cell relieved to zero. Connect the quick connect tubing to the top of the cell and the other end to the Auxiliary VAC/AIR Quick Connect. Turn the Upper Cap control valve to Pressure and adjust the Upper cap regulator to 5 psi.

### 2.3 Vacuum Operation

The panel is connected to a vacuum pump and is used to remove air trapped in the water lines, valves and tubing in the panel. When first filling the storage chambers and burettes on the panel keep the water levels at mid level and apply a vacuum and watch the air being removed. WARNING - don't let the water level rise above the top of the chambers, this will send water into your vacuum pump.

There is also a quick connect on the front panel in which the quick connect tube can be attached for any other operations in your lab that require a vacuum source.

### 2.4 Deairing Tank Hookup and Operation

Designed to provide an economical source of de-aired water for use in soil mechanics laboratories, the De-airing Tank has no moving parts or complex procedures. The user need only to furnish water and a vacuum source. Air pressure is required to remove water from the tank if it is located lower than the top of the Perm Panel.

#### INSTALLATION

The most efficient operation is achieved if the tank is mounted higher than the water level at which the testing is to be conducted.

When mounting on a shelf or attaching to a wall, make certain that the shelf/brackets are adequate for the load.

#### CONNECTIONS

Water and vacuum connections are located at the base of the tank.

#### WATER IN VALVE

This is an "on/off" valve that allows water to enter the chamber under pressure and be sprayed in a mist while under a vacuum. Connect 1/4" tubing to this valve and the other end to a tap water source.

#### THREE-POSITION VALVE

The center position is "off". Connect 1/4" tubing between a vacuum source and the vacuum position on the valve. The vent/air position doesn't require tubing if the tank is mounted high enough for gravity feeding water to the logic Panel.

When the tank is mounted at bench top level or lower, an air source can be hooked to the vent/air side of the valve. Air pressure is then used to transfer fluid from the tank to the Perm Panel.

> **NOTE:** The pressure capacity of the deairing tank is 20 psi. The air pressure must be regulated so as not to exceed this pressure.

#### WATER OUT FITTING

Tubing has been provided for this fitting. The nut on the tubing has been preset so that the tube almost reaches the bottom of the tank. The other end of the tube connects to the Perm Panel fitting marked sample water.

#### 2.4.1 Operation

#### FILLING THE TANK

Make sure the three-way valves on the panel(s) for filling are in the "off" position. With the water valve in the off position, turn on your vacuum source and turn the three-way valve on the tank to the vacuum position. When you have achieved maximum vacuum, turn ON the water valve and monitor the water level in the tank. The water valve must be turned off when the level is approximately 1" below the spray nozzle or water may enter the vacuum pump. Continue using vacuum on the water until minimal bubbles appear in the tank.

#### DRAINING WATER FROM THE TANK

When vacuuming has been completed, de-aired water may be transferred from the tank to the Perm Panel by turning the three-way valve to the vent/air position. Select the method of transfer from below choices.

**1. GRAVITY METHOD OF TRANSFER**

Once the water line out of the tank to the panel has been primed with water, it will flow from the tank when the three-way valve on the tank is in the "vent" position and the "fill" valve on the panel has been turned on. The burettes on the panel can be filled by opening the proper valves on the test chamber.
The tank may require a slight air pressure in order to prime the water line to the panel.

**2. PRESSURIZED TRANSFER**

If the tank is at table top level or below, a source of air pressure is required to force the water to flow from the tank. With the air source connected to the vent/air side of the valve, turn the valve to this position. The burettes on the panel can be filled by opening the proper valves on the test chamber.

**NOTE:** The pressure capacity of the deairing tank is 20 psi. The air pressure must be regulated so as not to exceed this pressure.

Triaxial or Permeability testing can be broken into two (2) processes, namely:

- Process 1 - Backpressure/Consolidation
- Process 2 - Introduction of a Gradient Across the Sample

**2.5 Process l - Backpressure/Consolidation**

The user will determine the initial cell pressure and sample head (LOWER PEDESTAL & UPPER CAP) pressures to be used during the consolidation/back pressure loading of the soil sample.

In terms of the air regulation of the triaxial/permeability panel, PROCESS 1 involves a DEPENDENT pressure regulation during loading. This means that after setting an initial cell bias pressure (the difference in pressure between the cell pressure and the sample cap pressure), the pressure can be dependently increased in the CELL, LOWER PEDESTAL and UPPER CAP by using the lower pedestal regulator alone to apply and increase the pressure to all three chambers at once.

The specific steps to achieve this loading are:

1. Fill and prepare panel, sample, and triaxial/permeability cell.

2. Position toggle and control valves to the OFF position.

3. To activate the DEPENDENT pressure regulation, turn the System Control Valves to the CELL BIAS and CAP BRIDGE positions. This will enable the increase in pressure in the CELL and the UPPER CAP to be regulated by the LOWER PEDESTAL pressure regulator.

4. Turn the MAIN PRESSURE -CELL control valve to PRESSURE. Turn the Cell Pressure Toggle Valve on to read the pressure and set the bias pressure regulator to 2 to 5psi . Turn the Toggle Valve to OFF when finished.

5. Open the BURETTE chamber fluid valves for the CELL, LOWER PEDESTAL and UPPER CAP.

6. Turn the CELL and LOWER PEDESTAL control valve to the PRESSURE position. Keep the UPPER CAP control valve in the OFF position. This will introduce the bias pressure into the CELL storage/burette chamber, and direct the same pressure into the LOWER PEDESTAL and UPPER CAP chambers as regulated by the lower pedestal pressure regulator.

7. Turn the LOWER PEDESTAL Toggle Valve to on and increase the lower pedestal pressure regulator to the desired pressure. Note the bias pressure will remain constant. Record fluid levels in burettes at convenient time intervals.

**2.5.1 Pore Pressure Measurement**

If measuring pore pressure, see manual for HM-521.

**2.5.2 Measuring Volume Change**

Flow into and out of the sample can be measured using the storage chamber, the 50cc burette with resolution to 0.1cc or the pipette with resolution to 0.0082 cc.

**2.6 Process 2 - Introduction of a Gradient Across the Sample**

Once the soil sample reaches equilibrium from the consolidation/ Back pressure loading of PROCESS 1, the pressure regulation of the CELL, LOWER PEDESTAL and UPPER CAP must be switched from a DEPENDENT mode to an INDEPENDENT mode in order to introduce a pressure gradient across the soil sample.

The specific steps to achieve this loading are:

1. Turn the CELL and LOWER PEDESTAL control valves to the OFF position (pointing to the left).

2. Turn the CELL Toggle Valve to the ON position.

3. Turn the Air System Control Valve from the CELL BIAS to the CELL position (this disengages the CELL and LOWER PEDESTAL pressure regulation dependency). Set the CELL pressure regulator to the same cell pressure currently in the triaxial/permeability cell.

4. Turn the CELL Toggle Valve to the OFF position and the UPPER CAP Toggle Valve to the ON position.

5. Turn the Air System Control Valve from the CAP BRIDGE position to the OFF position (this disengages the LOWER PEDESTAL and UPPER CAP pressure regulation dependency). Set the UPPER CAP pressure regulator to the desired sample pressure.

6. Turn the UPPER CAP Toggle Valve to the OFF position and the LOWER PEDESTAL Toggle Valve to the ON position.

7. Set the LOWER PEDESTAL pressure regulator to the desired LOWER PEDESTAL sample pressure.

8. Turn the CELL Air System Control Valve to the PRESSURE position. There should be no change in pressure to the triaxial/ permeability cell.

9. Record fluid levels in all CELL burettes.

10. Switch the LOWER PEDESTAL and UPPER CAP control valve to the PRESSURE position simultaneously. Record fluid levels in burettes at prescribed time intervals.

## 3.0 MAINTENANCE

### 3.1 Cleaning & Disassembly of Storage, Burette & Pipette Assembly

With the unit laying flat on a workbench, remove the top two bolts (9/16" socket wrench required). Slightly twist the top manifold to break the seal of the airings around the chambers. With two common screwdrivers, gently pry the manifold from the two connecting rods. Once movement has started, it should be easy to remove the manifold without the use of screwdrivers.

> **NOTE:** Springs inside the chamber assembly will push the assembly apart once the chambers are past the o-ring seals.

Next remove the springs and caps from the tops of the burettes. The outer chambers can now be removed. Slightly twist and move the chamber from side to side to break the o-ring seal and remove the chamber being careful not to damage the glass burette. The burette may now be removed from the base manifold seal. Remove the burette seals from the bottom of the manifold and the chamber seal o-rings from the top and bottom manifolds.

> **NOTE:** Cleaning may be accomplished with a mild soap solution. Do not use ammonia based cleaners as this will promote crazing of the polycarbonate.

### 3.2 Assembly of Storage, Burette and Pipette Assembly

Assembly can be accomplished with the chambers in the vertical position, but care should be taken to avoid damage to the burettes

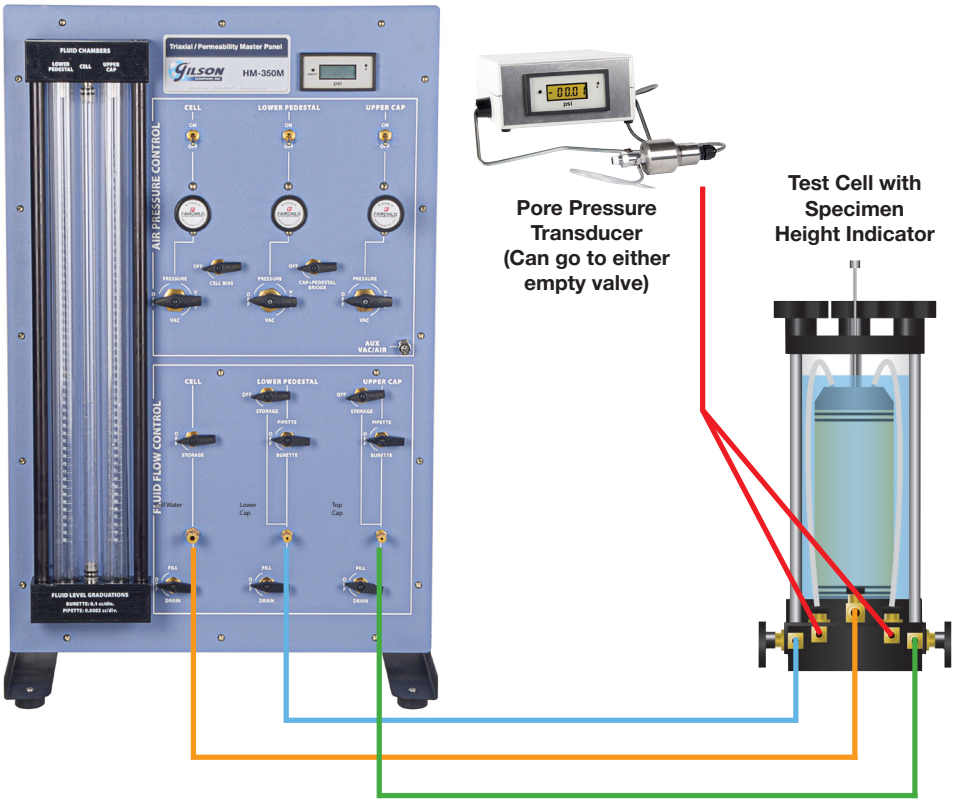
Replace any damaged or worn parts. O-rings and burette seals should be replaced as a precaution. Lightly lubricate the O-rings with Vaseline or lubricate before installing in the manifolds. With the base of the burette clean and dry, install the burette seal and install the burette in the base manifold. Slide the storage chamber over the burette and seat the chamber in the manifold. Repeat the procedure for the other burettes. With all chambers and burettes in place, install the burette caps and springs. Position the top manifold so that the springs are seated in the relief and then position the chambers to align with the manifold openings. Evenly push the manifold over the chambers and install the hex bolts and washers. Allow the assembly to lie flat on the workbench before tightening the bolts.

Install to panel, hook up air and water lines and check for leaks under pressure.

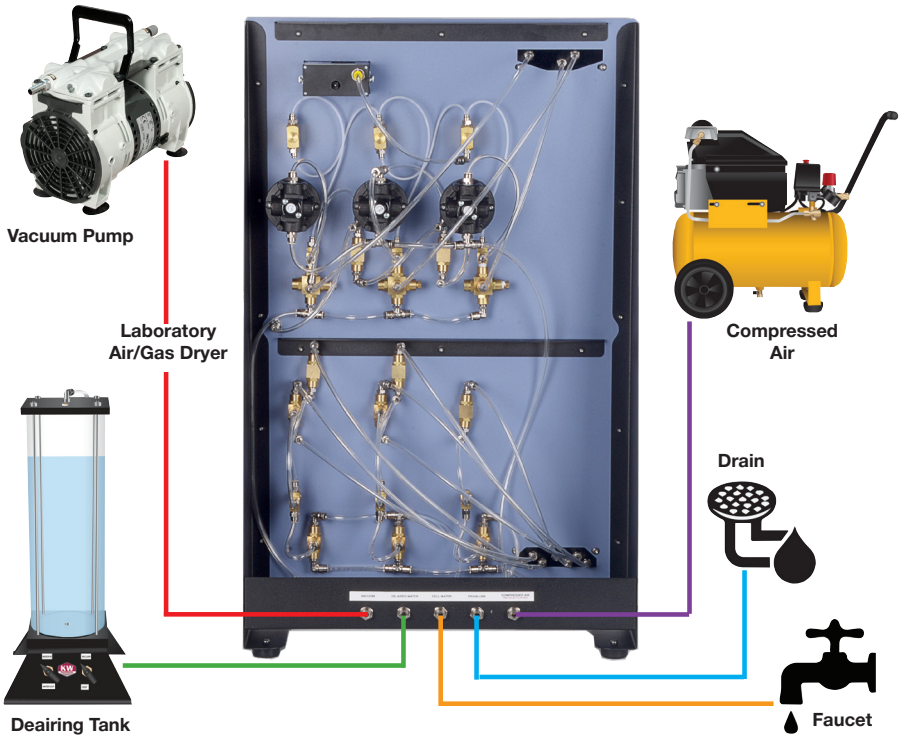
# TRIAXIAL / PERMEABILITY TYPICAL SETUP

*Figure 1*

**(Front Panel View)**




**(Back Panel View)**



# TRIAXIAL / PERMEABILITY PANEL HOOKUP

(View from Rear of Cabinets)

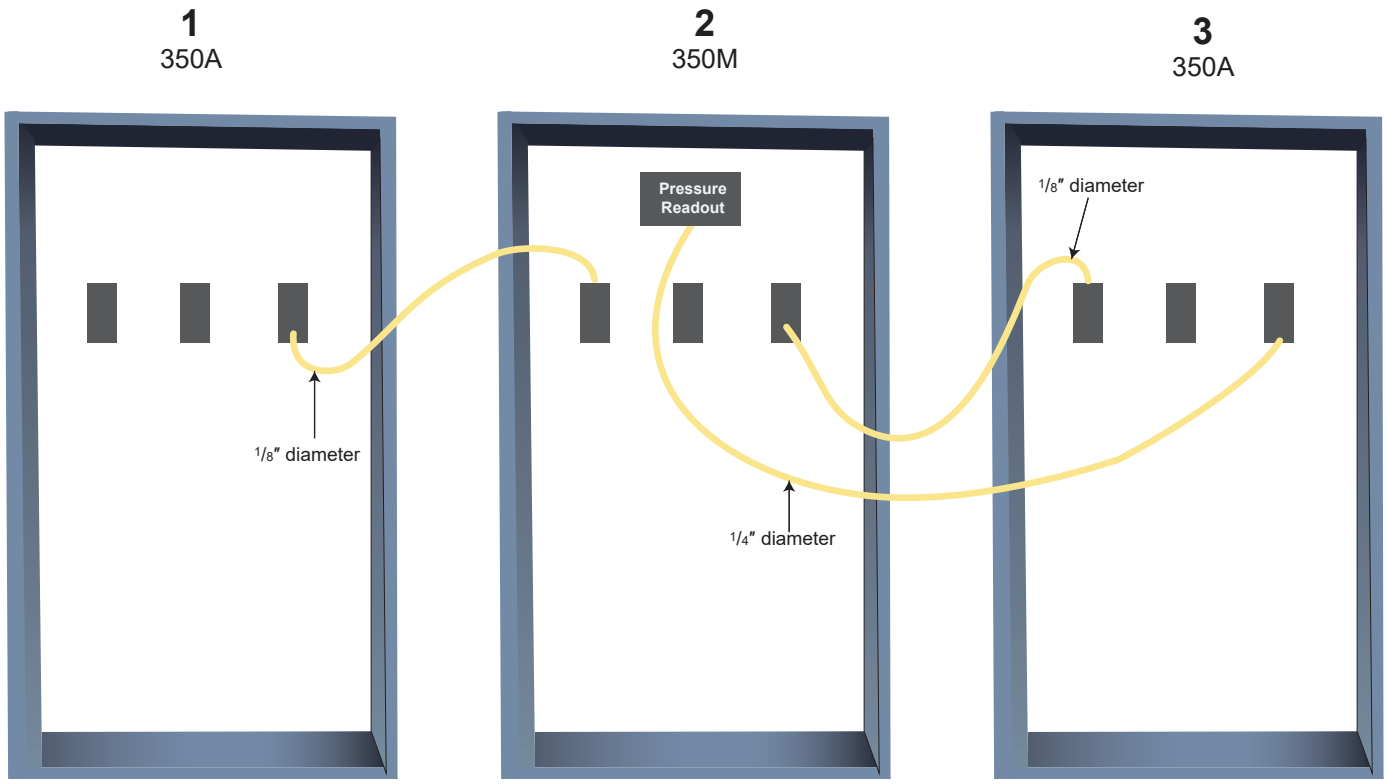



***Figure 2***