

SRI Model H2-40 Hydrogen Generator

Operation and Maintenance

Nov 2006

Place the H2-40 on a benchtop surface which will not be damaged by water in the event of a leak.

Fill a bottle with clean water. Tapwater is OK in most large cities, but bottled drinking water should be used in areas with dirty or highly mineralized water. It is not necessary to use de-ionized or distilled water, but it doesn't hurt either.

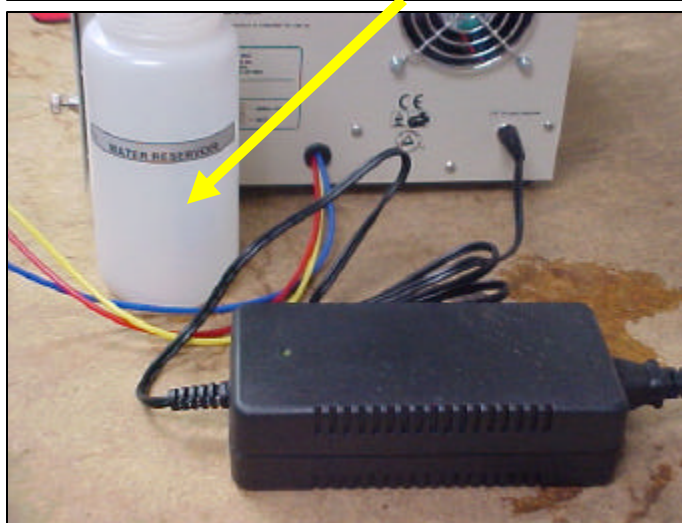
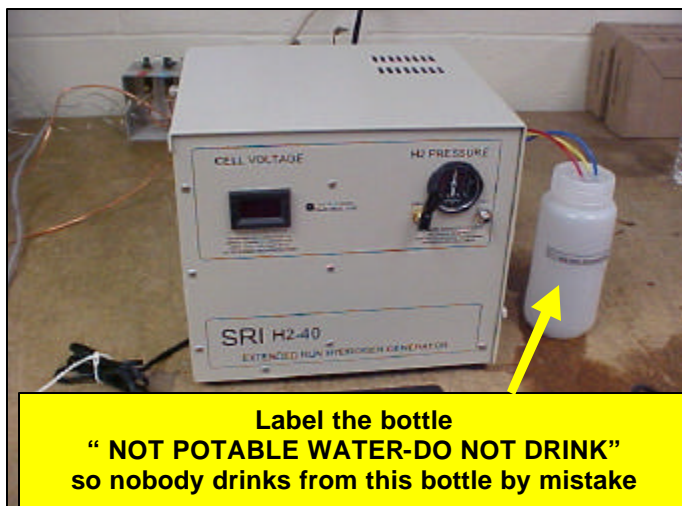
Insert the three colored (blue, yellow and clear) plastic tubes into the water bottle. The H2-40 will consume about 1 liter of water per week at maximum H2 production.

Plug the 12 volt power supply into the power jack on the rear of the H2-40. The H2-40 will immediately begin producing hydrogen. There is no power switch. Any 12 volt power source may be used including car cigarette lighter outlets so long as it is capable of delivering 7 amps of current.

With the toggle valve closed allow the hydrogen pressure to build up to 30psi. This will happen slowly at first but then faster as the cell warms up and cell voltage drops below 8 volts.

The H2-40 is supplied with a flow restrictor which will limit the flow to 20 ml/min for testing the proper function of the unit. With this restrictor connected and the toggle valve open (sticking straight out) the H2-40 should maintain 30-35 psi of pressure and cycle on and off about equal amounts of time (2-5 minutes on, 2-5 minutes off).

Attach a copper or stainless steel tube to the outlet fitting using a 1/8" swagelok type nut and ferrule. Avoid teflon or other plastic tubing if possible since hydrogen will permeate outthrough many plastics and air may permeate in.



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Once the hydrogen pressure builds up to 35 psi (2 bar) the internal pressure switch will shut off gas production. The cell voltage will drop to around 0.00 volts (anything between -.5 and +1.00 volts is normal. This voltage will slowly drift down and results from residual oxygen and hydrogen generating a voltage much like a fuel cell. So long as the toggle valve remains closed the pressure should not drop (for a t least 30 minutes). This is a good way to test for internal gas leaks which can develop over time.

If the hydrogen is to be use for FID fuel gas then a filter is not normally necessary, but if the hydrogen will be used as GC carrier gas then an outlet filter is recommended to remove any residual water. There is a few hundred ppm of O₂, N₂ and CO₂ in the hydrogen produced by the H2-40. Use an oxygen filter to avoid damage to columns at high temperatures. Polar capillary columns are especially easy to damage if there is oxygen in the carrier gas at temperatures above 160C.

This is not normally a problem, but there will be more O₂ and N₂ in the first few hours of operation or after servicing the unit where the hydrogen pressure is complexly vented and air allowed to enter the cell, dessicant bottle and tubing.

Open the toggle valve allowing hydrogen to flow to your GC. The hydrogen flow should be limited to 40ml/min or less. The H2-40 can actually make 50ml/min, but works better if it can cycle on and off rather than be making gas 100% of the time. If the flow is more than 50ml/min the pressure will drop.



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In normal operation the pressure will build up to 35 psi at which point gas production will stop until pressure drops to 28 psi at which point gas production will start again. You can hear more noise during gas production (mostly the peristaltic pump).

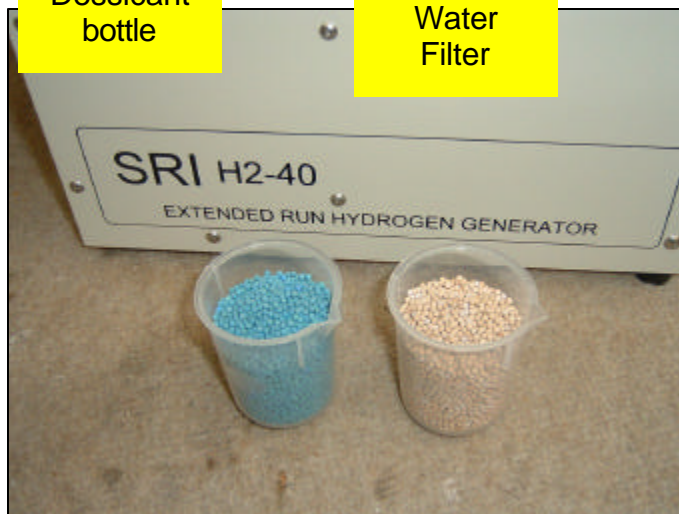
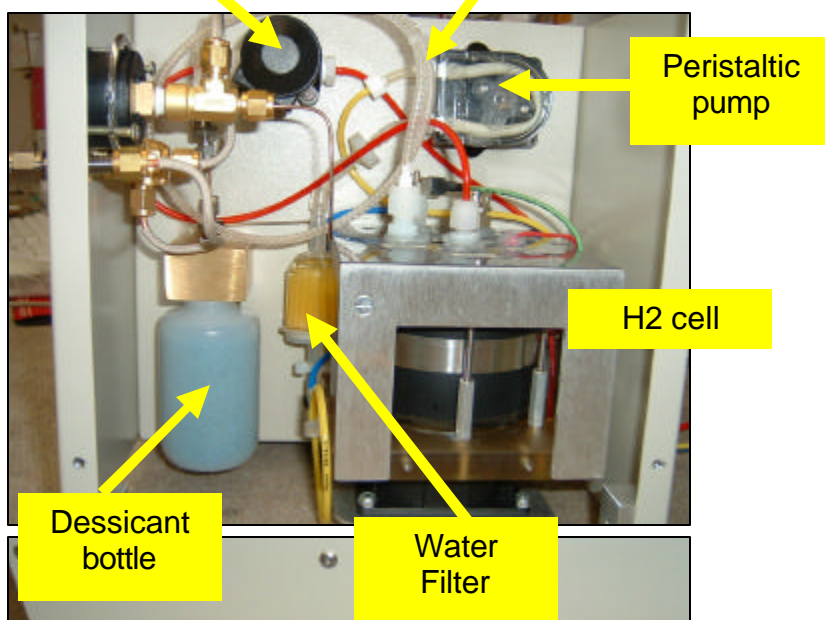
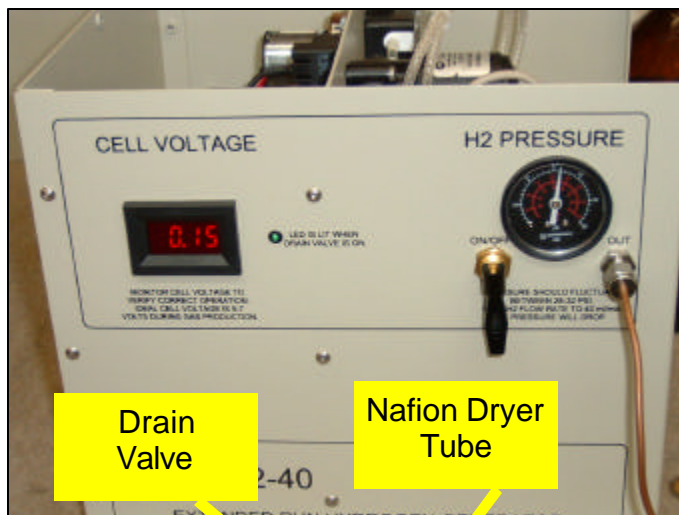
During gas production the cell voltage will increase to somewhere between 5 and 9 volts. The voltage depends on the temperature of the cell, the supply of water to the membrane and the condition of the membrane itself. Anything below 8 volts allows for maximum gas production (50ml/min). If the voltage is above 8 volts then gas production drops.

Remove the cover by loosening the three captive screws. The right side of the H2-40 has no bottom so any water leaks will drip onto the countertop rather than accumulate inside the unit. Familiarize yourself with the various parts.

The hydrogen produced by the H2-40 is water saturated as it leaves the cell. A Nafion dryer tube lowers the water content to that of ambient air.

Nafion is very permeable to water but impermeable to hydrogen. The hydrogen is further dried by a dessicant bottle containing indicating molecular sieve beads. As the mole sieve absorbs water it changes color from blue to brown.

When the dessicant turns brown, unscrew the bottle from the brass holder and pour the dessicant into a glass (not plastic). Microwave the dessicant for 5-10 minutes or until the blue color returns. Cover the glass with another glass or plate until the dessicant cools then pour it back into the plastic dessicant bottle and re-attach. Remember the air content of the hydrogen will be higher until the air gets purged out of the dessicant bottle.



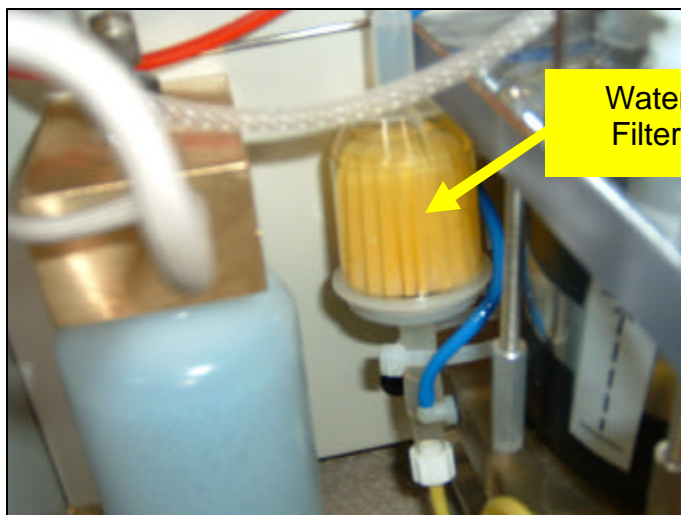
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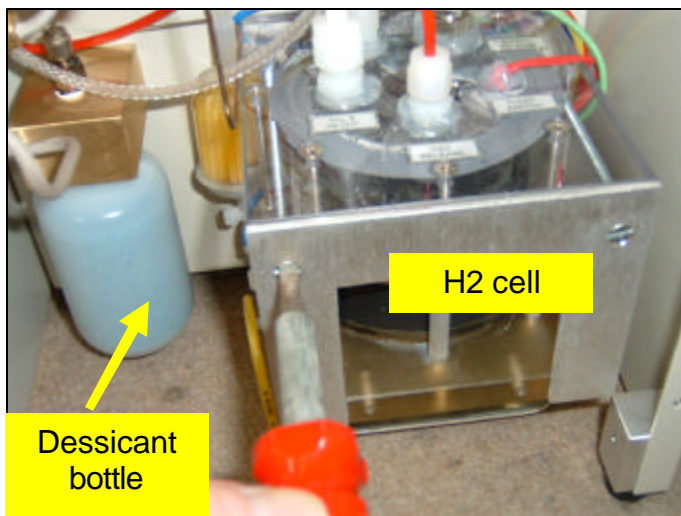
The water filter should be replaced if it starts to look dirty. The filter prevents dirt and fibers in the water bottle from clogging the internal water passages in the bottom of the H2 cell.

This filter is readily available in most countries of the world. Be sure to use a filter which is all plastic (no metal) to avoid poisoning the membrane.

If the H2 cell needs to be removed, loosen the two screws securing it to the chassis.



Water Filter



Dessicant bottle

H2 cell

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Remove the aluminum plate which clamps the cell to the chassis.

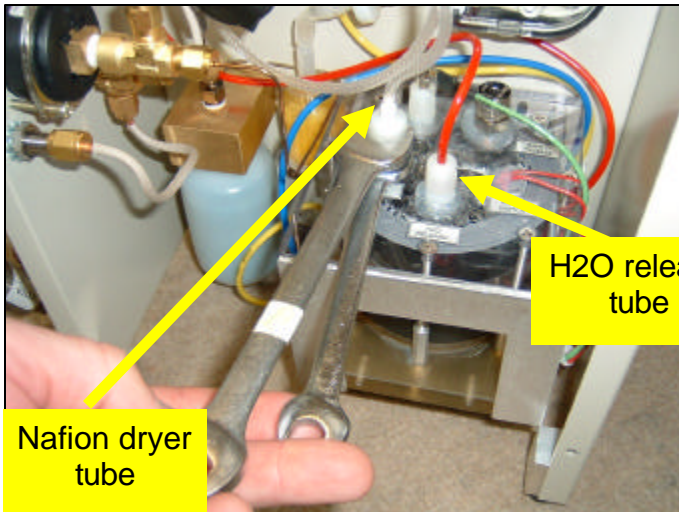
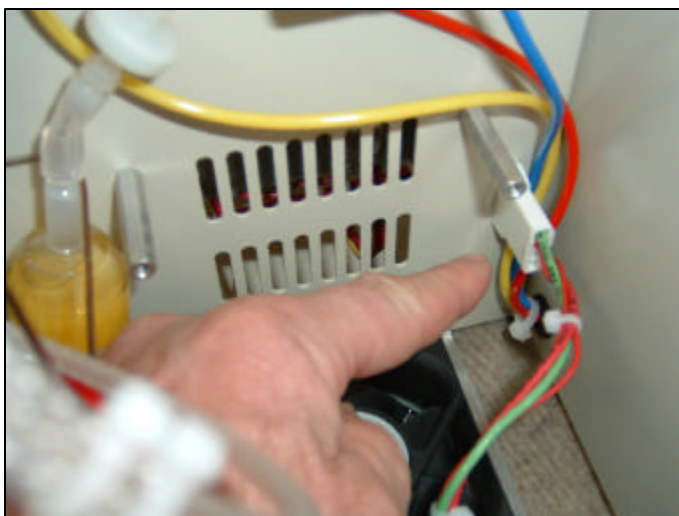
Remove the water in and out tubes from the barb connectors by pulling gently on the tubes.

Water in and out
barb fittings

Unplug the cell from the white connector.

These fitting should be finger-tight ONLY, but if they have been over-tightened:

Be sure to use **TWO WRENCHES** To remove the Nafion dryer tube and the H2O release tube. If you twist the nylon fittings the silicone seal may be disturbed causing a subsequent gas leak.



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If the membrane needs
to be replaced

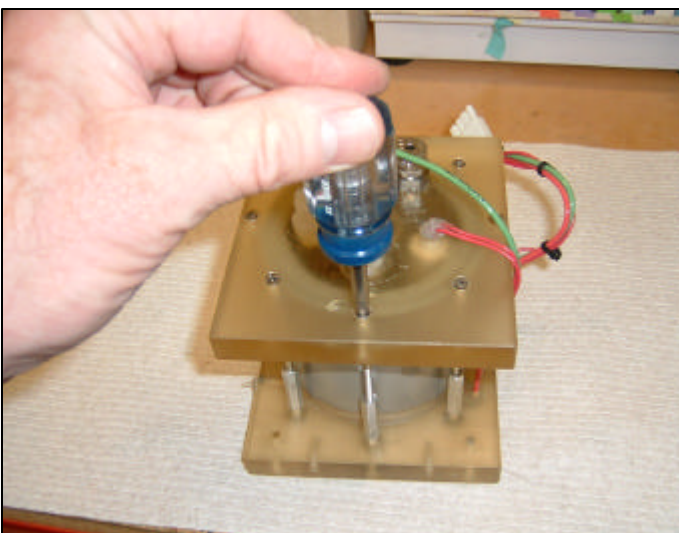
Drain the water from the cell.
Examine the cell for cracks or leaks.

**Start by loosening
each screw just 1/10th
of a turn**

Loosen the eight (8) screws clamp-
ing the cell and membrane together.
Be careful to loosen the screws
equally and gently. Do not loosen
one screw more than the others.

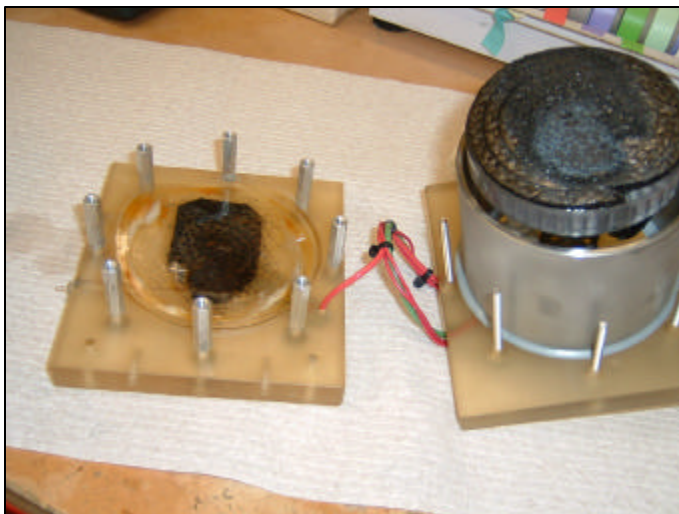
When the screws are completely
loose, the spring inside will push the
cell up and away from the mem-
brane.

The cell shown here is stainless
steel, but the cell may be made of
glass or stainless.



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Place the cell off to one side exposing the membrane.



The graphite disk is actually made of a long graphite rope which can unravel with too much handling. Try not to disturb it.



The old membrane will be discolored. This is normal.



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The new membrane is clear. Look carefully in the plastic bag it comes in, the membrane is sometimes hard to see.

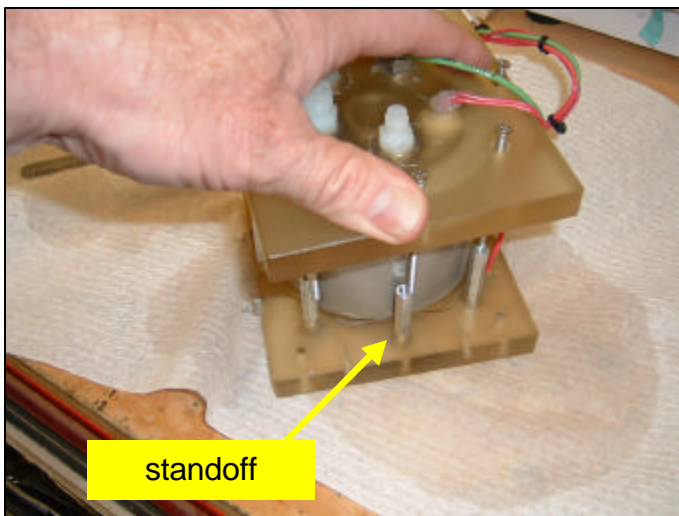
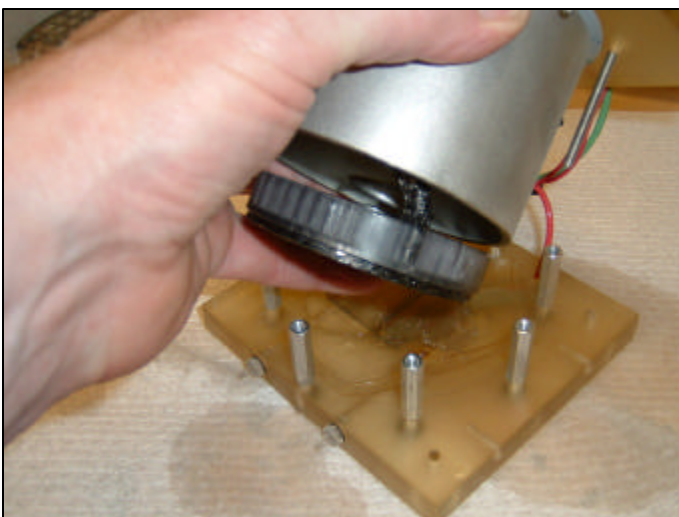
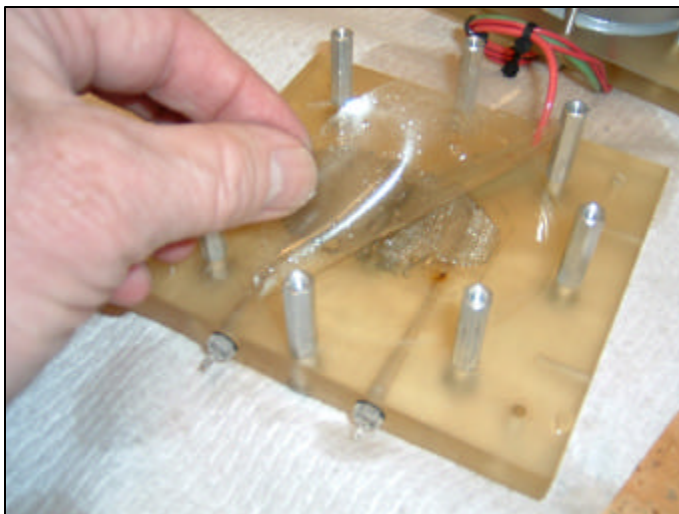
Soak the membrane in water before installing. The membrane swells in size when it is wet.

Do not install it dry.

Carefully re-position the cell and graphite disk in the center of the membrane. The membrane may slide out of position, so try to hold it in place with a fingernail while positioning the cell.

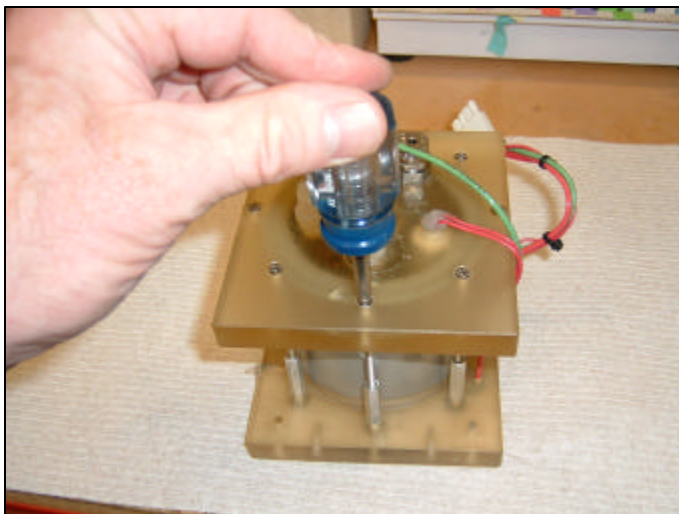
Push the cell down against the internal spring pressure and engage the screws one turn into the standoffs.

Verify that the membrane is still centered so that the cell when it is pushed down seals against the membrane all the way around.



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Tighten the eight screws gradually and evenly. Do not tighten one screw more than another. When the cell is all the way down evenly clamped against the membrane torque the screw to 5 ft/lbs or .5 Newton/meter. If you don't have a torque screwdriver then tighten the screws securely but not super tight.

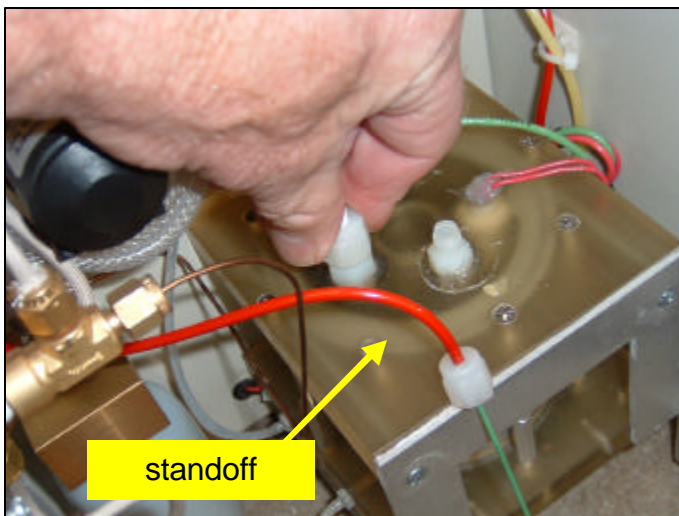


Re-install the cell into the H240 chassis.

Replace the Nafion dryer tube fitting and water relief tube. Tighten the Nylon nuts firmly finger tight. Don't use a wrench unless you have to, and then use TWO WRENCHES.



Replace the water inlet and outlet tubes. It does not matter which is the inlet and which is the outlet.



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Re-connect the H₂ cell, and with the toggle valve closed, and pressure in the system, check for leaks

around the fittings on the top of the cell using a solution of soap and water. If tiny bubbles appear around the base of a fitting, then tighten that fitting just a little. You may have to remove the bead of silicone sealant to get your wrench on the fitting. The plastic parts can crack if too much pressure is applied so tighten just enough to stop the leak.

You can tell if the system is leaking by watching the pressure gauge with the toggle valve off. If the pressure drops more than a few psi in a 30 minute period, then there is a leak.

The dessicant bottle is another possible place where leaks can develop. Make sure the bottle is securely tightened.



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