1. CRYOGENIC DEWAR MAINTENANCE

1.1 LIQUID HELIUM DEWAR VACUUM

Because there is some diffusion of helium through warm fiberglass, helium gas should not be allowed to remain in a warm dewar for extended periods. There is also a small amount of helium diffusion that occurs during normal operation through the warm, upper portion of the neck tube. Large quantities of air, water, and other gasses are also outgassed from the warm, interior surfaces of the dewar vacuum space. However, there is a molecular sieve getter in the vacuum space which absorbs large amounts of gas when the dewar is cold. Therefore, the vacuum space should not require any maintenance for over a year of normal operation.

Eventually, the vacuum space of the dewar will need to be re-evacuated. This will become obvious in one of two ways:

- The helium evaporation rate will increase during normal operation. If the evaporation rate has increased by more than 30%, you should consider re-pumping the vacuum space. *n.b.*, if you have an adjustable tail dewar, be sure that the excessive boil-off is not due to extremely close spacing of the dewar tail. See your manual for details.
- You will be unable to transfer liquid helium. All of the helium transferred into the dewar will immediately evaporate. If the vacuum is extremely poor, the outside of the dewar may get cold and even condense water ("sweat"), especially along any tail section with especially close spacing between the cryogenic region and the exterior of the dewar.

If you suspect a poor vacuum, use the following procedure to check and pump on the vacuum:

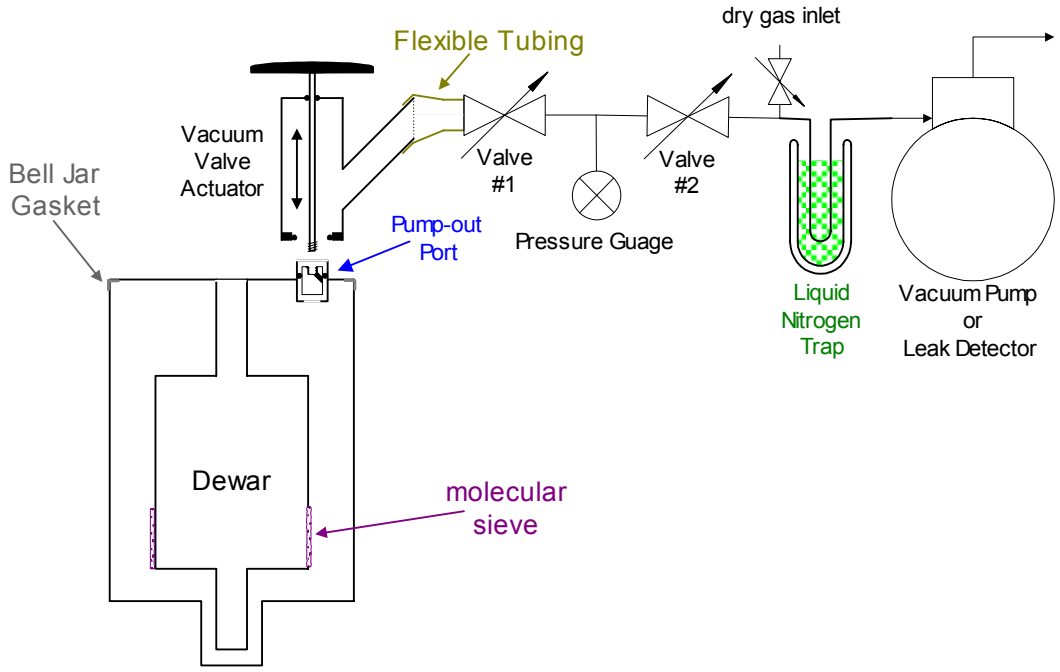

Figure 1: Schematic of dewar pumping components

You will need a Vacuum Valve Actuator (Tristan model VVA or equivalent), a vacuum pump (or helium leak detector), a thermocouple pressure gauge with millitorr sensitivity (or equivalent), two valves and connecting hoses or tubing. Connect the components as shown in Figure 1.

If the vacuum space of the dewar is at atmospheric pressure *(or if you suspect it is)*, and the dewar uses bell jar gasket(s) or o-rings to keep the outer case together,

- Be sure that you don't lift the dewar by the top piece. If there is no vacuum or partial vacuum in the vacuum space, the bottom section of the dewar will fall off.
- Inspect the bell jar gasket(s) or o-ring(s) to be sure they are clean and properly located. If they need to be replaced, be sure that the replacement(s) are coated with silicon vacuum grease of an equivalent.
- In situations where the top piece is just sitting on the dewar body, gravity alone may not be sufficient to form a good vacuum seal between the bell jar gasket or o-ring and the dewar pieces. Be sure that the dewar top piece is securely attached to the dewar body. Only then should you start the pump-out process.

The dewar is equipped with a vacuum space evacuation valve mounted on the dewar top. Before opening this valve, a leak-tight connection should be made to it and the pumping line to the valve should be evacuated using a leak detector or a pumping station equipped with a diffusion pump and cold trap (or other pumping system with equivalent capability such as a turbomolecular or oil-less diaphragm pump). The pump should be capable of achieving an ultimate vacuum (total pressure) below 5 millitorr (a helium leak detector may be suitable) and have a pumping speed of ½ CFM (cubic feet/minute) or larger. This should be sufficient to pump down most dewars.

WARNING:

***EXTREME* caution must be used when examining the vacuum. There are many fine layers of superinsulation in the vacuum space. Rapid changes in pressure may cause rupturing of the superinsulation. Therefore, NEVER abruptly open the dewar vacuum space to atmospheric pressure; the dewar vacuum should be slowly vented over a period of about 15 minutes. The helium reservoir must always be at room temperature when gas is admitted to the vacuum space or when it is being pumped.**

If the pump is not oil free, then a liquid nitrogen trap is required. The cold trap is necessary to prevent back-streaming of diffusion pump oil into the vacuum space after it has reached a low, static pressure.

- Make sure all the components in Figure 1 are connected and leak tight. Valves #1 and #2 should be closed. If a LN_2 trap is being used, fill the trap.
- Connect the vacuum valve actuator onto the pump-out port on the dewar. Be sure that the o-ring that will surround the pump-out port has seated.
- Lower the actuator piston until it touches the pump-out port plug (which has a threaded insert in it).
- Screw in the actuator piston into the pump-out port plug. Only screw it in a couple of turns. If you screw in the piston all the way, it may get stuck and it will be nearly impossible to disengage the pump-out port plug and remove the vacuum valve actuator assembly after you have completed pumping out the dewar. DO NOT RAISE THE PISTON YET

CAUTION:

Care must be taken in the use of the dewar vacuum valve actuator. It is very difficult to tell if the valve is disengaged or not. It is best to pull the body upper off while keeping the piston extended (*i.e.*, CLOSED) before removing the pump-out port plug.

- Turn on the vacuum pump and open valve #2. Monitor the pressure gauge.
- When the pressure has reached a minimum, note the value.
- Close valve #2 and open Valve #1. Now raise the vacuum valve actuator.

WARNING:

Raise the actuator very slowly until it reaches its highest position and observe the pressure in the dewar. Do NOT begin pumping until you observe the pressure.

- If you observe a high pressure (more than a few torr), you should pump the vacuum space very slowly by opening valve #2 as little as possible.

WARNING:

The pressure in the vacuum space must NEVER be allowed to change quickly. Ideally, there should never be more than a torr pressure reading at the vacuum gauge. Rapid pressure changes will cause permanent damage to the thermal shield and superinsulation.

- The actuator piston may begin to lower by itself (due to the vacuum pressure differential on the valve). Putting a toothpick to prop up the top of the actuator piston handle can keep it from lowering.
- A satisfactory vacuum is about 50-100 millitorr *when the whole dewar is at room temperature* (small dewars will typically pump down below 100 millitorr whereas a large MEG whole head dewar may only achieve 200 millitorr). Depending on the pressure, it may take up to 24 hours pumping to obtain a satisfactory vacuum.

WARNING:

Do not leave the dewar pumping unattended.

You can check for outgassing by closing valve #2 and seeing if the pressure rises. Usually, it will only take one or two minutes to determine the static pressure. If the static pressure is greater than desired, resume pumping.

WARNING:

Never use helium gas to flush the vacuum space. While small quantities of nitrogen or air left in the dewar vacuum space will eventually freeze out, helium left in the vacuum space will never freeze out. The result will be either extremely high boil-off or the inability to collect liquid helium.

WARNING:

Never flush a cold dewar. Admitting *any* gas into the vacuum space of a dewar that still has a liquid cryogen in it will result in catastrophic event with the potential for injury, loss of life and significant damage to the dewar and surroundings. If you have *any* concerns about flushing a cold dewar, contact the manufacturer before proceeding.

To help remove any helium gas, flush the dewar with dry nitrogen gas and pump the dewar three times. It is not necessary to pull a hard vacuum when flushing the dewar. It need only be pumped down to a few torr if you are going to immediately flush it with nitrogen. If after repeated pumping, the static pressure seems to stay at a few torr, it is possible that there is water in the vacuum space (pumping on liquid water will cause it to freeze with a vapor pressure of ~4.6 torr after it has warmed up). Flushing the dewar with dry nitrogen gas will help to purge the water vapor.

If you are using a leak detector for your pump and if your leak detector indicates any helium gas, it may be advantageous to flush the vacuum space once with nitrogen gas. Slowly fill the vacuum space with 10 torr of nitrogen gas (this should not be done at a rate faster than 1 torr per minute). It should then be re-evacuated as described above. This procedure may be repeated several times until the helium level is low.

Once you have achieved a good vacuum in the dewar, close the valve by the following procedure:

- Test the static pressure as described above and write down its value. This may be useful in diagnosing potential problems in the future.
- Lower the vacuum valve actuator until the vacuum plug is seated in the pump-out port
- Unscrew the actuator piston (be sure it is completely unscrewed) and raise the vacuum valve actuator.
- Close off the vacuum valves (#1 & #2) and turn off the pump.
- Remove the vacuum valve assembly.

If the dewar does not perform well after pumping the vacuum, or if it requires pumping at intervals more frequent than once a year, there may be a leak in the dewar. If you suspect this problem, contact your Tristan representative for assistance.

1.2 LIQUID NITROGEN DEWARS

Just as in liquid helium dewars, there is some diffusion of gas through warm fiberglass. While there is a getter in the vacuum space which absorbs large amounts of gas when the dewar is cold, it is nowhere as efficient as a getter cooled to liquid helium temperatures. It is not uncommon for a liquid nitrogen dewar to need pumping out on an annual basis. Eventually, like liquid helium dewars, the vacuum space of the dewar will need to be re-evacuated. This will become obvious in one of two ways:

- The nitrogen evaporation rate will increase during normal operation. If the evaporation rate has increased by more than 30%, you should consider re-pumping the vacuum space.
- While you may be able to transfer liquid nitrogen, the outside of the dewar may get cold and even condense water, especially along the tail (if any).

If you suspect a poor vacuum, use the same procedure (§1.1) as is used on liquid helium dewars to check and pump on the vacuum.

If you are still having problems, contact the manufacturer for advice.