Standard Operating Procedure

Filling the 500 and 600 MHz magnets with liquid helium

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Process

Filling 500 and 600 MHz systems with liquid helium. Needed approximately every 6 weeks.

Hazardous chemicals

Liquid helium and compressed helium gas

Potential hazards

- ***Liquid cryogens pose a potential asphyxiation hazard. Nitrogen expands by a factor of 680 and helium expands by a factor of 740 when changing from the liquid to gas phase. The expanding gas displaces breathable oxygen. To limit the asphyxiation hazard, liquid nitrogen and liquid helium should only be handled in well ventilated areas. Immediately evacuate the room if oxygen senor audible alarm sounds.***
- ***The extreme cold of liquid nitrogen and helium can cause oxygen to condense from the air, resulting in fire danger. Keep cryogen use areas free of combustible materials (paper, cardboard, machine oil, etc) and eliminate any other sources of ignition.***
- ***Only use non-magnetic wrenches when working with the magnets. Steel or other ferro-magnetic tools may be sucked into or against the magnet causing equipment damage and/or bodily injury.***

Approvals required

Wemmer group members must be trained by Jeff Pelton and sign the SOP. They must also take the

UC Berkeley on-line Cryogens Safety course

Designated area

Fills are to occur in Rm B304

Personal protective equipment

The main hazards associated with handling liquid nitrogen and liquid helium are: A) burns when skin comes into contact with cold pipes or liquid, and b) asphyxiation if nitrogen or helium has expanded from its liquid form and the gas has displaced oxygen. To reduce the potential for injury, follow these guidelines:

- ***Avoid contact with cold unprotected pipes and vessels when working with liquid nitrogen or liquid helium.***

- ***Wear proper protective equipment:***

    - ***Dry leather or cryogenic gloves must be worn to avoid cold burns. The gloves must be loose fitting so that they can be removed easily.***

    - ***Safety glasses and face shield must be worn to protect the eyes and face.***

    - ***Wear close-toed shoes and long pants while handling cryogens to protect feet and legs from accidental spills.***

    - ***Wear a lab coat or a heavy, loose-fitting jacket or fleece to protect your arms.***

- ***Metallic objects (e.g. jewelry) should be removed from those parts of the body that may come into contact with the liquid.***

- ***Never accompany cryogens in the elevator. If the elevator were to malfunction, the expanding gas could fill the elevator and pose a serious risk of asphyxiation.***

  Load dewar on elevator, post "No Passengers" sign on the dewar, and retrieve it after using separate route (stairs or another elevator).

- ***When transferring cryogenic liquids, always direct the flow away from others.***

Engineering and ventilation controls

None

Process steps

Routine fills.

250 L will fill the 500 (from 30%), 600 (from 65%), and 800 (from 35%). The 500 is usually filled first, followed by the 600 and 800.

250 L will fill the 900 from 45%.

Note the fill volumes and minimum helium levels for each system on the plastic enclosed sheet near the SOPs.

Two people are recommended, if they are new to the procedure.

Step 1. Prepare the dewar.

Locate the He transfer line, which is kept on the cement cylinder block in the center of Rm B304.

Locate and attach the brass Goddard fitting to the top of the dewar. These are usually kept on top of the console to the 700. If not, check if they are on the Pines' group transfer line near the 700. If you can't find it, ask someone from the Wemmer or Pines labs for help. Make sure you have all three pieces of the Goddard fitting – ie make sure the He transfer line can be inserted into the fitting with a tight seal. If not, you are probably missing the top most Goddard fitting.

Attach the helium gas line to the vent port of the dewar. The fitting and plastic hose are kept on the floor in a green plastic bin to the right of the nitrogen fill room. Attach the gas regulator to the He gas cylinder within the nitrogen fill room. Attach the hose to the regulator. Do not start the flow of gas at this time.

An alternative to using the He gas cylinder to pressurize the dewar, is to use the built-in heater that comes with all of the 250 L He dewars. A yellow extension cord is located I the green bin along with the He gas hose, fitting, and regulator. The extension cord should be plugged into a 120 V outlet and the heater plug at the top of the magnet. The settings are for 4 and 8 psi. Even 4 psi is too much, but you can turn the heater on and off to maintain about 3 PSI pressure.

Step 2. Prepare the magnet.

Remove the brass one-way valve at the top of the magnet and insert a crumpled up paper towel so that air cannot enter the helium reservoir of the magnet.

Loosen the black He fill port at the top of the magnet. To loosen the plug, partially unscrew the fitting just below the plug.

Step 3. Cool the He transfer line and begin the fill

Close the vent valve on the dewar. Close the pressure release valve on the dewar.

One person should be on a step ladder close to the He fill port, and a second person should be close to the He dewar.

The person close to the He dewar should slowly insert the long end of the transfer line into the He dewar about one-half way. Helium gas should exit the short end of the transfer line. Allow the cooling process to continue unti a plume is apparent at the short end of the transfer line.

The person close to the dewar should open the pressure release valve while the person close to the magnet removes the black fill port plug and inserts the short end of the transfer line into the magnet. Note that the long end of the transfer line might need to be raised somewhat in order to create enough length to insert the short end into the magnet.
The paper towel usually pops out due to the increased pressure. If not, remove the paper towel to allow He gas to escape.

Slowly insert the transfer line until it hits the bottom of the dewar, and then raise it one-half inch.

Step 4. Pressurize the dewar and continue fill.

Helium gas is used to pressurize the He dewar and to "push" liquid helium from the dewar and into the magent.

Open the vent port on the dewar (with the hose attached). Open the He gas cylinder valve to start the flow of liquid helium. Use the secondary valve at the regulaor to keep the flow rate low. Pressure in the He dewar should not exceed 4 PSI. If it exceeds 4 PSI, close the He gas cylinder and continue the fill, until the pressure is reduced.

Alternatively, use the built-in heater that comes with 250 L dewars, as described above. Most 100 L dewars do not come with heaters.

Step 5. Monitor the fill.

After a few minutes, monitor the progress of the fill by checking the liquid helium level at the BSMS, which is located at the console (used for shimming). Note that the level on the 500 gets stuck at about 80 percent for a period of time. Once the magnet fills past 80%, the meter will read the correct value. Continue the fill until the level reaches 95% or until a plume is observed at the magnet vent port.

Also continue to monitor the pressure in the He dewar (less than 4 PSI) and monitor the

amount of He gas remaining the in the gas cylinder.

Step 6. Stop the transfer

Close the valve to the He gas cylinder, to stop the pressurization of the magnet.

Open the He dewar pressure release valve to reduce the pressure in the dewar.

The person at the magnet and the person at the dewar should both remove their end of the transfer line simultaneously.

Step 7. Close magnet and dewar

Close the top valve of the He dewar. Also be sure that the vent valve is closed and that the pressure release valve is OPEN. The pressure release valve must remain open while not being used to prevent overpressure of the He dewar, due to evaporating liquid helium.

Quickly re-attach the one-way valve and black He fill port plug on the magnet.

Remove the He gas line and gas line fitting from the He dewar.

Remove the Goddard fitting from the dewar.

Two hours after the fill, retighten the connection on the one-way vent valve and the plug on the He fill port.

Troubleshooting:

1. If the outside jacket of the transfer line is cold, stop the transfer. The vacuum in the line was probably lost. If the vacuum is completely lost it will not be possible to transfer liquid into the magnet. The result is blowing He gas over the liquid He in the magnet, which boils off the remaining liquid – meaning that the He level will actually decrease! Ask the Pines group to borrow their He transfer line for the 700. It will work in both the 500 and 600. The transfer lines for the 800 and 900 are interchangeable. Either line can be used to fill either magnet.

2. The He dewar won't pressurize using the gas cylinder. One possibility is a leak at a connection. The other possibility is that there is no more liquid He in the dewar. Stop the transfer and order more liquid He.