Standard Operating Procedure

Filling the 800 and 900 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

See schematic attached to the end of the process.

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.

Step 1. Prepare the dewar.

Locate the He transfer line. Both the 800 and 900 have their own transfer lines, which are located on their respective platforms. Note that each transfer line is in two parts. The short part is inserted into the magnet. The longer part is inserted into the dewar.

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 two pieces of the Goddard fitting – ie make sure the He transfer line can be inserted into the fitting with a tight seal. The diameter of the transfer lines for the 800 and 900 are larger than for the 500/600. Thus, you only need the two biggest rings of the Goddard fitting.

Attach the helium gas line and brass fitting 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 black fill plug at the top of the He fill port of the magnet. To loosen the plug, partially unscrew the fitting just below the plug.

Insert the longer end of the transfer line (A) into the port and tighten the seal by turning the fitting just below the port.

Open the short end of the transfer line for a few seconds to purge the line of air, then close it back up.

On the 900, remove the stainless steel cap at the end of the (gold) 20 psi pressure release valve. Do not remove the gold release valve.

On the 800 there are two gold release valves. Remove the first one but not the second one.

Step 3. Cool down the transfer line.

The long part of the transfer line should extend from the platform down to the dewar.

At the magnet end of the long part of the helium transfer line, make sure that the valve (twist type) is closed. Note that it operates opposite to normal convention. Turn it right to close, and left to open.
The vent valve and pressure release valve on the dewar should be closed

Insert the long end of the transfer line into the He dewar. Go down about one-half of the way, and check that the pressure in the dewar is increasing. Note that no He gas should escape from the dewar during this procedure.

Step 4. Cool down the long part of the transfer line and begin the fill.
Purge the magnet end of the long part of the transfer line by removing the protective cover. Open the valve slowly. Allow He gas to escape from the line. Continue until a large plume emerges from the line – essentially meaning that liquid He is emerging and evaporating.

Close the valve on the transfer line and open the port on the short transfer line, insert line the tip of the long transfer line into the short transfer line and tighten the locking bolt.

Reduce the pressure in the He dewar (to about 3 psi) by temporarily opening the relief valve. Then open the valve on the transfer line, and begin the transfer. Note that opening and closing works opposite to convention. Gas should escape from the 20 psi relief valve.

After a few minutes push the long end of the transfer line to the bottom of the dewar, and then up one-half inch.

Monitor the pressure in the liquid He dewar. Once the pressure goes down to 2 psi, begin pressurizing the dewar with the He gas from the cylinder. To do this, open the gas vent valve on the He dewar, and then adjust the He regulator to get the right amount of gas flow. It often requires many adjustments during the fill. Keep the pressure in the dewar low – at about 3 psi. If the pressure rises to 4 psi or more, open the relief valve for a moment.

Another thing to monitor is the percentage of liquid He in the magnet. Do this at the workstation. On the BSMS (shim panel) hit the (second) and He level buttons one after the other. After a few seconds, it will report back on the He level in percent.

Step 5. Stop the fill.
The fill is complete when the meter reads 95% to 100%, or you hear a swoosh, meaning that the dewar is empty.

Close the main valve on the He gas cylinder, which stops pressurization of the dewar. Also close the He regulator to stop the gas flow.

Depressurize the He dewar by opening the pressure release valve. He gas should escape from the dewar.

At the magnet, close the valve on the He transfer line to stop the flow of liquid He.

Uncouple the two transfer lines, and plug and close transfer line A.

Quickly loosen the fitting below the insert point to the transfer line A and pull the transfer line – quickly out of the magnet. Insert the black plug and retighten the fitting. If not pulled out quickly enough, the short transfer line can get stuck – ie. Freeze part way up. If this happens, simply tighten the fitting, and let the transfer line and fitting warm up for 30 minutes. Then try to remove it again.

For the 900, replace the stainless steel cap on the 20 psi relief valve.

For the 800, replace the gold one-way valve. Make sure the flow arrow is pointed away from the magnet.

At the He dewar, pull the long end of the transfer line out and place it on the platform and close the top port/valve on the dewar. Be sure that the pressure release valve is open – to keep the pressure in the dewar low. Remove the He gas fitting and hose and close the vent port of the dewar.

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.