

Philips Healthcare, MRI
Best, The Netherlands

DE-ICING INSTRUCTIONS

4K-Coldhead Magnets

DMR120791
Rev: 1

The Philips logo, consisting of the word "PHILIPS" in a bold, blue, sans-serif font.

Philips Healthcare, MRI

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DE-ICING

1 - TRAINING AND SAFETY



 **DO NOT ATTEMPT THIS PROCEDURE WITHOUT FIRST THOROUGHLY READING AND UNDERSTANDING THE CONTENTS. FAILURE TO COMPLY MAY RESULT IN EQUIPMENT DAMAGE, SERIOUS INJURY OR DEATH.**

Do not perform any of the procedures described in this manual without proper training on safety methods and required personal protective equipment, including de-icing training course MR3473. The two primary hazards associated with this procedure are cryogenic burns and asphyxiation. Minimum personal protective equipment includes: an oxygen concentration monitor, a full-face shield and safety glasses with side shields; cryogenic rated gloves with gauntlets; and a cryogenic rated vest.



Magnetic fields pose another significant hazard while working on an operating magnet. All work done inside the magnet should be performed while the magnet is de-energized.

 **DANGER** 

A QUENCH EVENT ALLOWS THE RAPID ESCAPE OF HELIUM GAS FROM THE MAGNET. THE GAS ESCAPES THROUGH THE NECK AT VERY HIGH VELOCITY AND PRESSURE. IN CONFINED SPACES, THE GAS DISPLACES OXYGEN. AN OXYGEN CONCENTRATION MONITOR SHOULD BE USED TO ALERT INDIVIDUALS OF OXYGEN CONCENTRATIONS BELOW 19.5%. THE ESCAPING HELIUM MAY ALSO CAUSE CRYOGENIC BURNS TO EXPOSED SKIN. CRYOGENIC GLOVES WITH GAUNTLETS, A CRYOGENIC VEST AND A FULL FACE SHIELD WITH SAFETY GLASSES SHOULD BE WORN.

 **DANGER** 

METALLIC OBJECTS CONTAINING FERROUS METAL MAY BECOME MAGNETIZED WHEN THE MAGNET IS AT FIELD AND WILL CREATE A HAZARD TO INDIVIDUALS IN THE VICINITY OF THE MAGNET. REMOVE METAL OBJECTS WITH FERROUS CONTENT FROM THE MAGNET AREA BEFORE ENERGIZING. NOTE ALSO THAT SURGICAL IMPLANTS, JEWELRY AND ARTICLES OF CLOTHING MAY ALSO BECOME MAGNETIZED. TAKE APPROPRIATE PRECAUTIONS IN SUCH CASES.

 <b style="font-size: 1.2em;">DANGER 
<p>CRYOGENIC GASES ARE PRESENT DURING THIS PROCEDURE. CRYOGENIC GASES CAN INFLICT FROSTBITE OR CAUSE DEATH DUE TO ASPHYXIATION. ONLY A QUALIFIED TECHNICIAN SHOULD PERFORM THIS PROCEDURE.</p>

2 - REQUIRED TOOLS AND MATERIALS

The following required tools and materials are required to perform de-icing:

A. Items not supplied with Kit(s); must be obtained separately:

1	Oxygen Monitor
2	Cryogenic-Rated Gloves with Gauntlets
3	Safety Glasses with side shields
4	Full-Face Shield
5	Safety Vest
6	Gas Regulator (0 to 50 psig) with adapter fitting for gas hose
7	Leak Seeker 182 [®] or Snoop [®]
8	Aluminum Wrench for lead ports
9	Spare Rupture disk and Gaskets
10	Propane Torch or Electric Heat Gun
11	9/16 in, 10 mm, 13 mm wrenches
12	5mm & 6mm ball-headed wrenches
13	Liquid Helium
14	Bottled Helium Gas, 12 bottles minimum (99.99% pure)
15	0.5 mm Shim material or feeler gauge (for re-seating cold head)

B. Kits required for complete de-icing.

16	De-icing Tool Kit, P/N 4535 010 00181
17	Cold Head Service Tool Kit, P/N 44747-53 or higher or P/N 4522-150-42713

C. Documents from the Magnet's Documentation CD

18	Seek applicable "Installation, Operation and Maintenance Manual."
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De-icing Tool Kit

DE-ICING KIT PMSMR Part No. 4535 010 00181

	Item Name	P/N	Qty
1	Copper De-icing Rod	44501-01	1
2	Extension Tube	23005	1
3	Extension Tube with Straight End	23006	1
4	Extension Tube with 90 degree End	23007	1
5	Extension Tool	23011	1
6	Gas Hose with In Line Valve (Yellow Jacket #25)	22658	1
7	Flashlight	23022	1
8	1/4-inch Flare Union 45-deg	22659	2
9	Hex Wrench, 5mm	22660	2
10	De-icing Assembly Case	50891-53	1
11	De-icing Procedure (F2000)	44171	1
12	De-icing Procedure (Titan)	46054	1
13	Rupture-disk spacer	44375-51	1
14	AA Batteries	22868	1 Pkg
15	1/4-inch Flare to Male NPT Fitting	22912	2
16	Rubber Stopper	22909	3
17	1/4-inch Flare to NPT Female Fitting	22914	2
18	Clear Access plate	46799-01	2
19	De-icing Plate Assembly	54934-51	1
20	Hold Down Plate Assembly	44512-51	1
21	Thermal Insulating Access plate	44511-51	1
22	Rupture-disk spacer (Titan)	46810-51	1
23	Lead Organizer	23004	1
24	Modified Locking Pliers	44502-01	1
25	Inspection Mirror	44505-01	1
26	Inspection Light	44506-01	1
27	Spare Light Bulbs	44507-01	1 Pkg
28	Plate, Clear Blank	44126-01	1
29	Extension Tube	23053	1
30	De-icing cover plate	52263-01	1
31	De-icing cover plate - common	54269-01	1
32	De-icing Instructions – 4K Magnets	53021	1
33	Top Cover	470391-01	1
34	Mounting Plate	470389-01	1
35	Rubber Gasket	470392-01	1



Figure 2-1



Figure 2-2

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PROCEDURES IN THIS INSTRUCTION.

- **ALL INDIVIDUALS WORKING WITHIN THE MAGNET AREA MUST WEAR APPROPRIATE PROTECTIVE CLOTHING INCLUDING: SAFETY GLASSES WITH SIDE SHIELDS; FACE SHIELD; A CRYOGENIC VEST; AND CRYOGENIC GLOVES WITH GAUNTLETS.**

3 - OVERVIEW OF DE-ICING

Magnets with 4K cold heads have two paths that can potentially form ice when air enters the magnet. The “neck” of the magnet is the path for filling and ramping the magnet, and for providing the vent path in case of a quench. Icing issues associated with the neck are similar to icing issues experienced on older magnets using a 10K cold head.

The design of the 4K magnet creates another possible icing path. This path, which contains the cold head is known as the “Wet Sock”, and will also need to be de-iced.

This procedure will define how to de-ice both areas.

In general, when de-icing one path, you will need to also de-ice the second path, and then re-clear the first path. If necessary, the magnet can then be refilled.

CAUTION

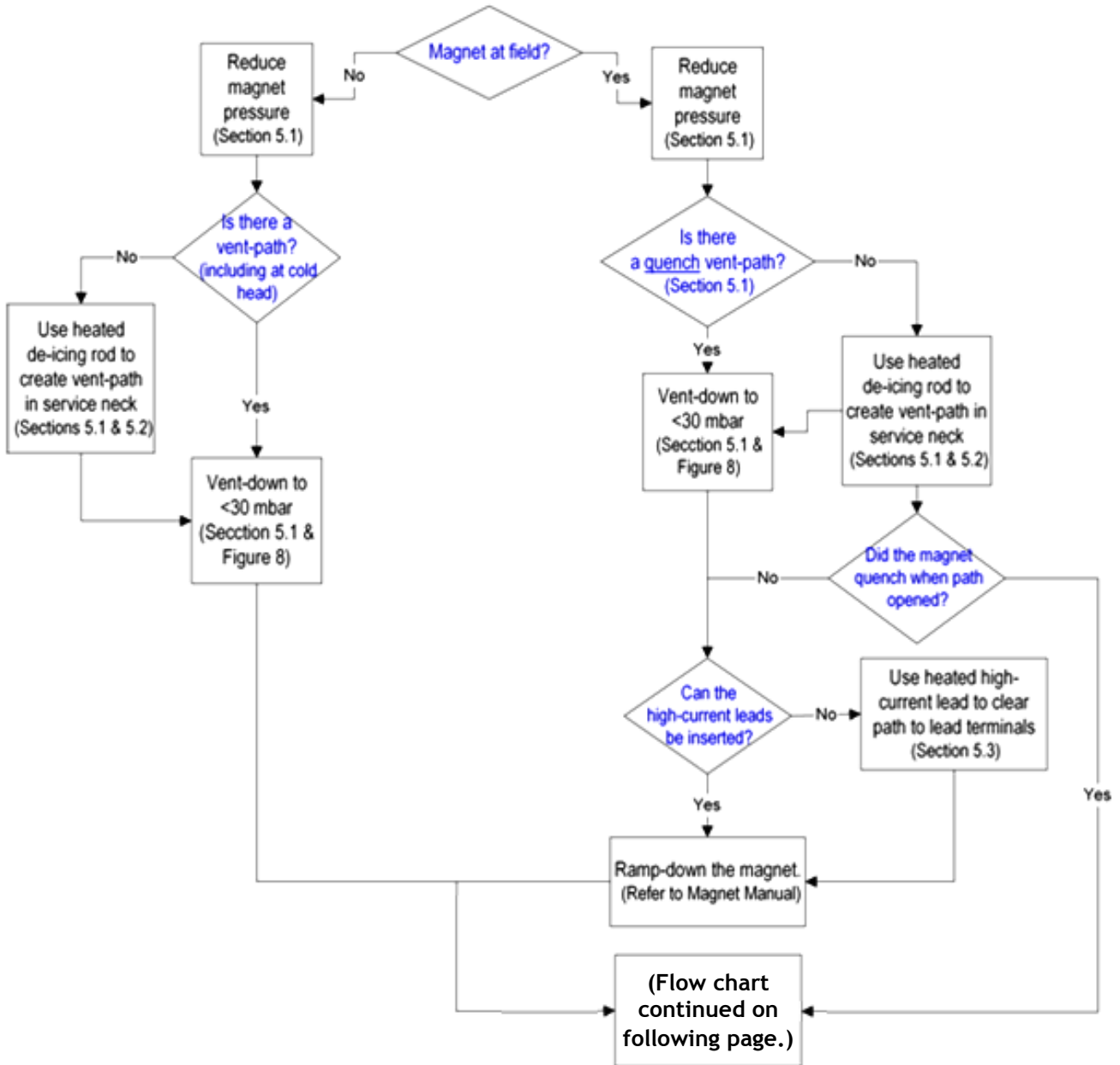
BE EXTRA CAREFUL WHEN HANDLING LOOSE TOOLS, HARDWARE AND MATERIALS AROUND THE OPEN NECK OF THE MAGNET. RECOVERING LOST ITEMS FROM THE INTERIOR IS COSTLY AND TIME CONSUMING. IF LEFT INSIDE THE UNIT, SUCH ITEMS CAN CAUSE IRREPARABLE DAMAGE.

DANGER

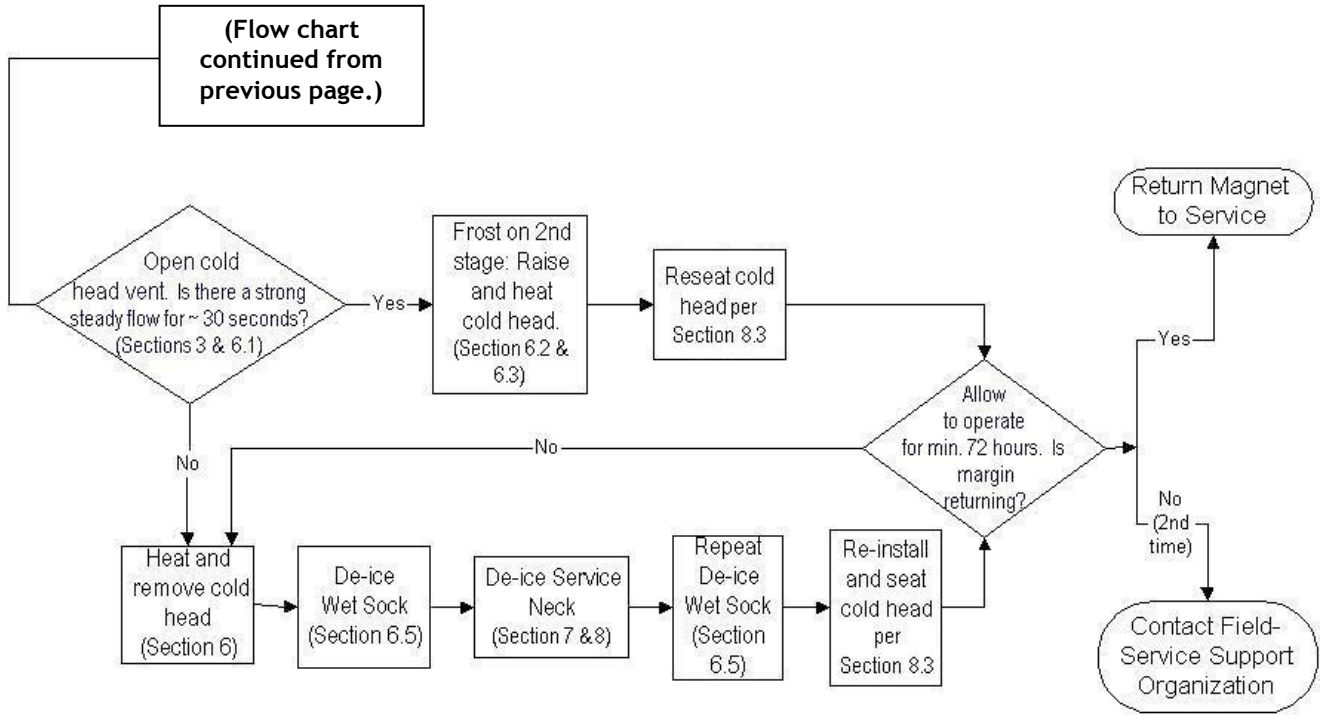
DO NOT ATTEMPT TO DE-ICE THE NECK OR THE WET SOCK WHILE THE MAGNET IS AT FIELD.

- **ONLY THE SECTION “DE-ICING A PLUGGED NECK” MAY BE PERFORMED AT FIELD. ALL OTHER SECTIONS OF THIS PROCEDURE SHALL BE PERFORMED ONLY WHEN THE MAGNET IS DISCHARGED.**
- **TO PREVENT *DEATH BY OXYGEN STARVATION*, DO NOT ATTEMPT THIS PROCEDURE WITHOUT ADEQUATE VENTILATION AND A WELL-PLANNED ESCAPE ROUTE TO FRESH AIR!**
- **WHEN WORKING IN CONFINED SPACES, ALL INDIVIDUALS MUST WEAR AN OXYGEN MONITOR CALIBRATED TO ALARM AT 19.5% LOW OXYGEN CONCENTRATION. IF THE ALARM SOUNDS, EVACUATE IMMEDIATELY TO FRESH AIR.**
- **ONLY QUALIFIED TECHNICIANS SHALL PERFORM THE**

4K-Coldhead Magnet De-Icing Process



4K-Coldhead Magnet De-Icing Process (Continued)



4 – Magnet Top-Assembly Layouts

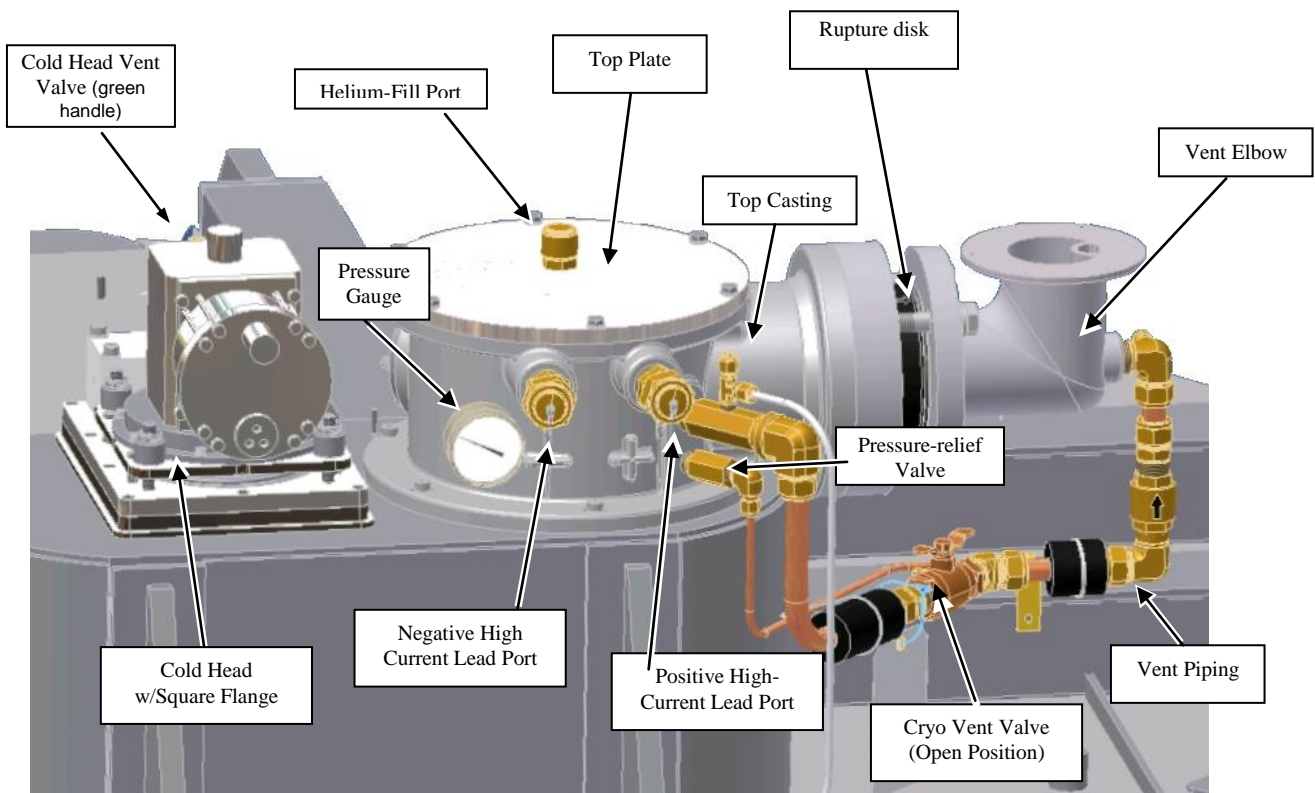


Figure 4-1 - HFO X-Type Magnet Top Assembly

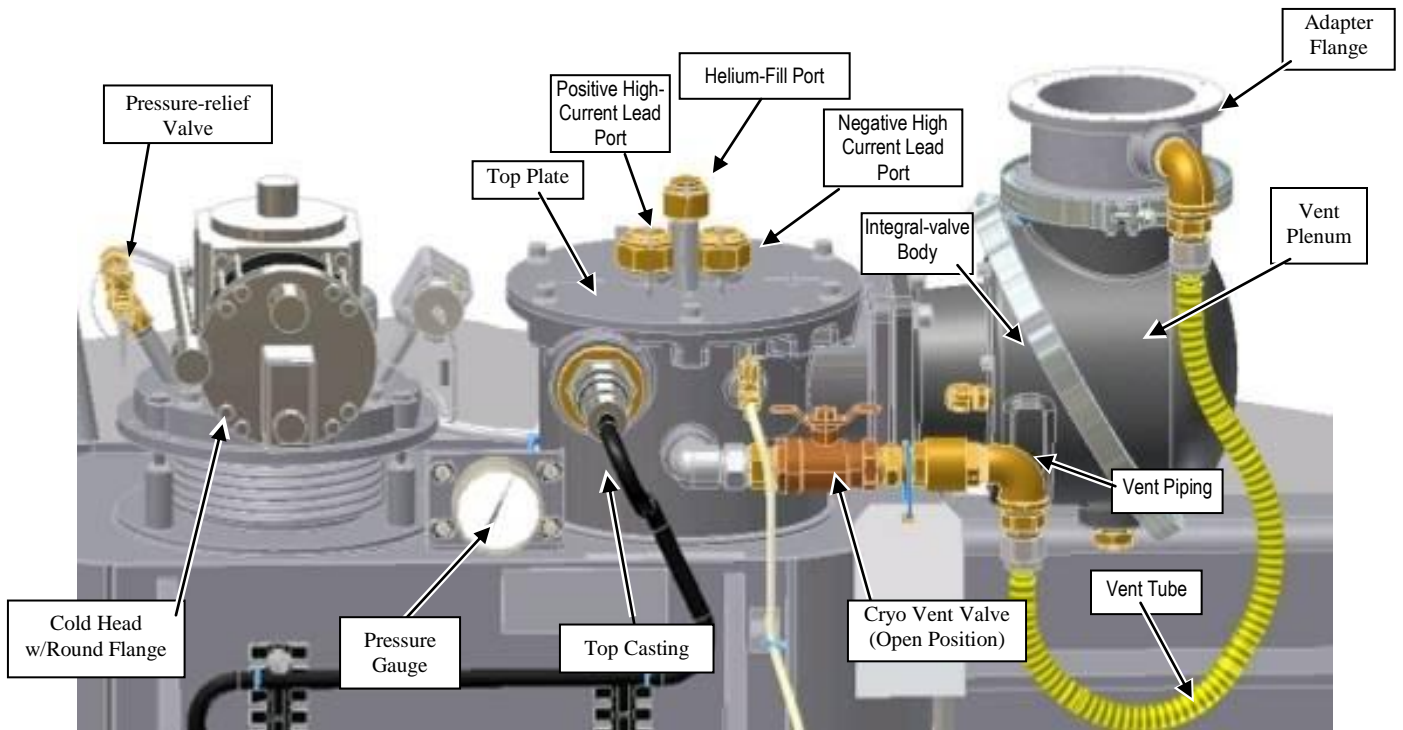


Figure 4-2 - HFO-Y Magnet Top Assembly (with Integral Valve)

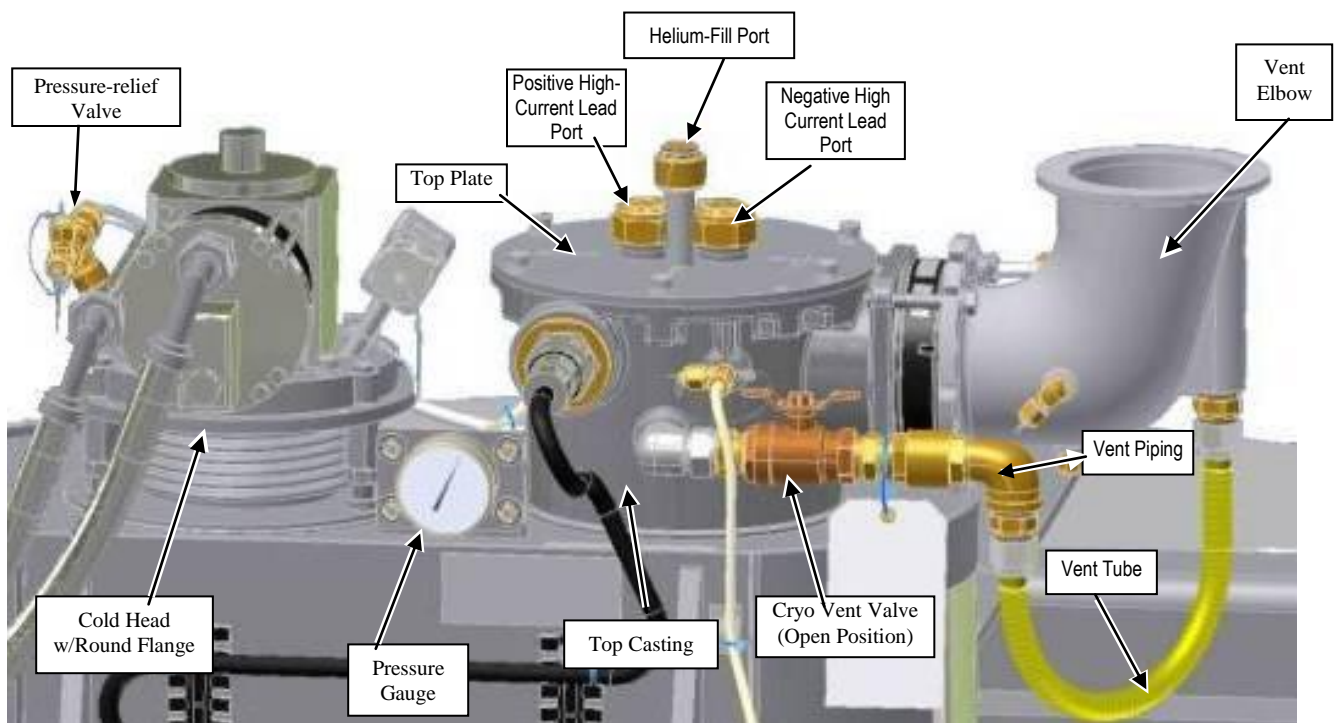


Figure 4-3 - HFO-Y Magnet Top Assembly (without integral valve, with Rupture Disk)

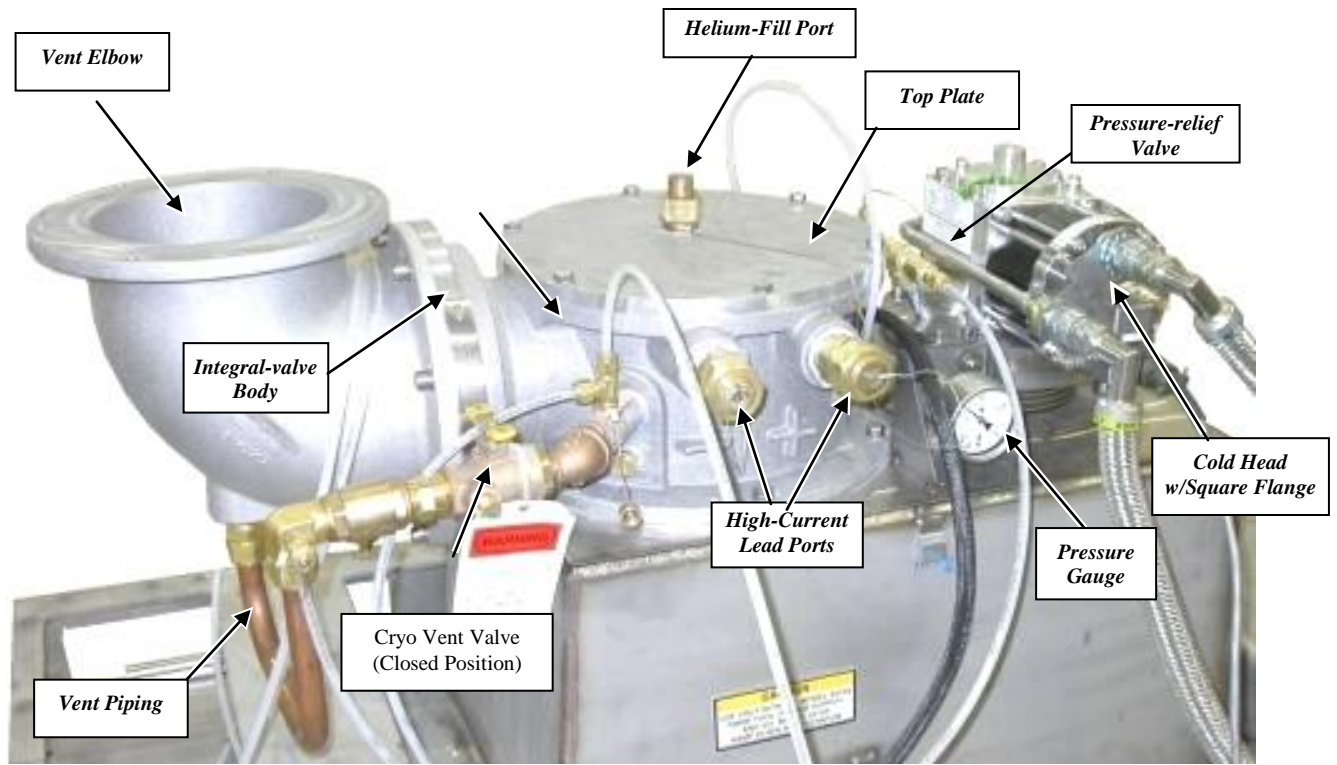


Figure 4-4 - Rex Magnet Top Assembly – w/ Older-Model Integral Valve

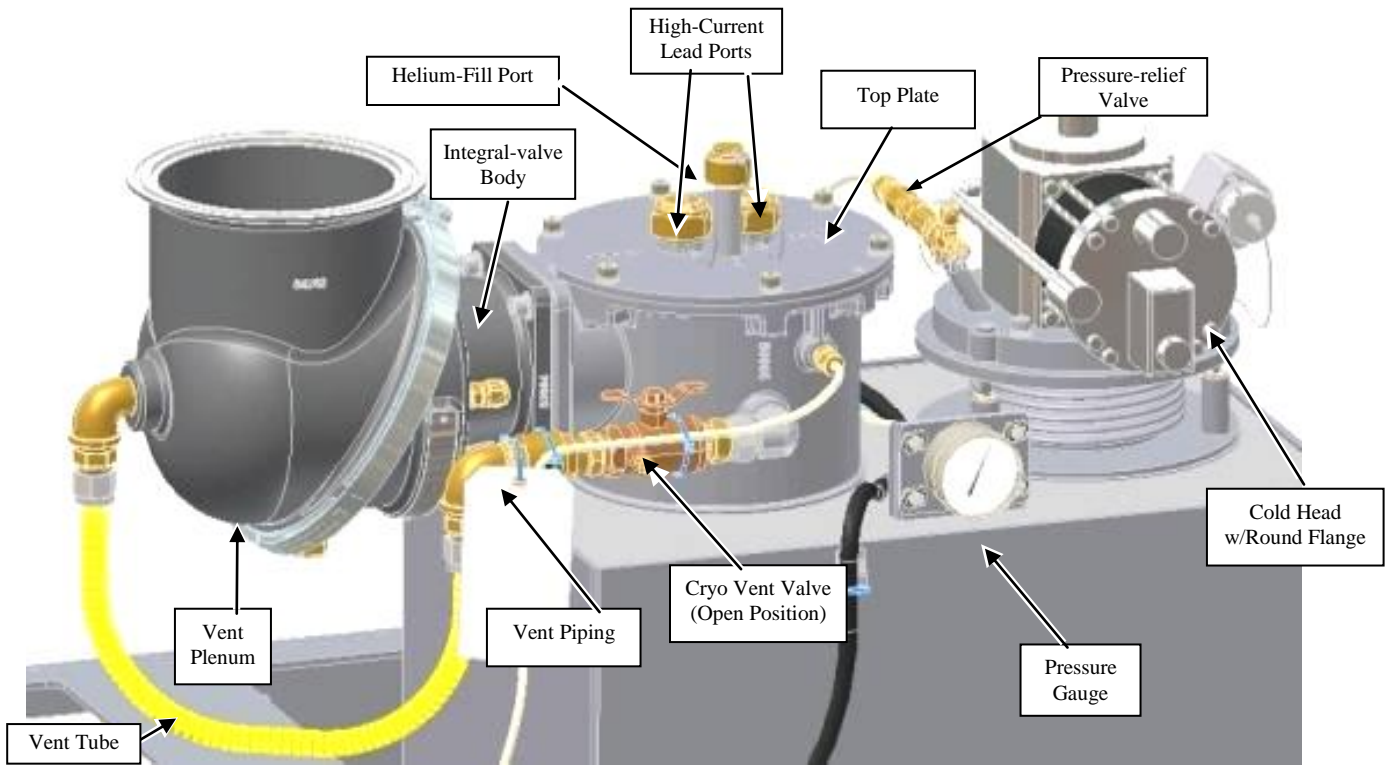


Figure 4-5 - Rex Magnet Top Assembly w/Newer-Model (dynamic) Integral Valve

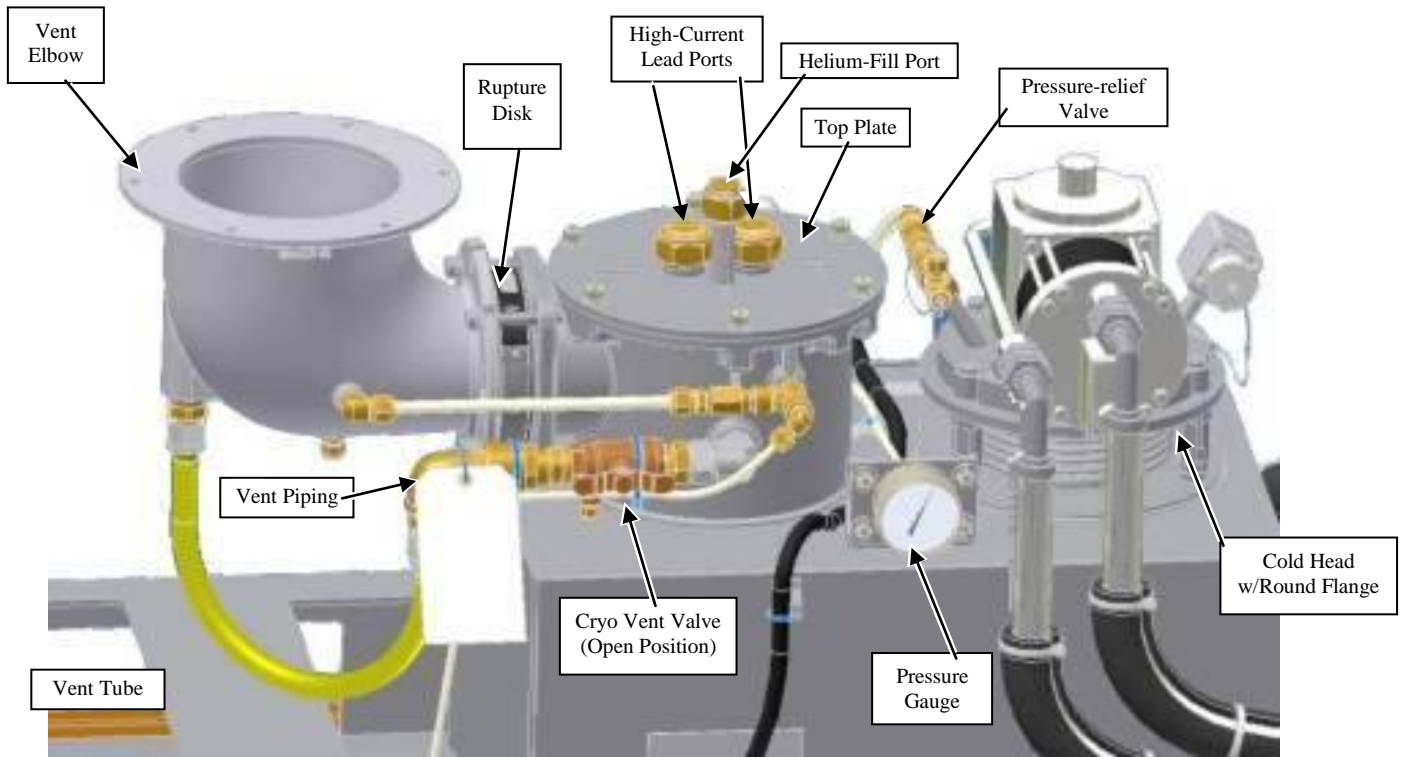


Figure 4-6 - Rex Magnet Top Assembly without Integral Valve, with Rupture Disk

5 – CLEARING THE QUENCH VENT-PATH AND LEAD PORTS

 CAUTION 
<ul style="list-style-type: none"> • DO NOT TURN-OFF THE COLDHEAD WHILE THE MAGNET IS AT FIELD. • DO NOT PUSH THE ERDU BUTTON!

5.1 - Verify Ice Blockage

The most difficult de-icing circumstance is when the magnet is at field, and the neck is plugged with ice. Successful de-icing is dependent on accurately determining the extent of the blockage and noting ice deposit locations.

A plugged neck will have one or more of the following indicators:

- No exhaust out of the vent pipe (frosting on vent pipe) after opening the Cryo Vent Valve.
- After opening the helium-fill port or a high-current lead port, either no venting or only a “puff” sound of venting gas is heard. Normally there will be a strong “whoosh” sound and vapors are visible.
- An ice plug blocks the insertion of a transfer line or high-current leads.
- Helium-transfer efficiency is reduced to less than 50%.

Note: The following procedure is to determine if ice is blocking the vent path through the neck.

1. Open the Cryo Vent Valve. If the inside portion is not blocked, escaping gases will vent through the vent pipe, and frost will form on its outside. The pressure gauge reading should drop to approximately 10 to 25 mbar, and hold. If gas does not vent,
2. Slowly remove the cap to the negative high-current port. Be careful. If the ports are not blocked, gases will vent from this port. Stand away from the port (to one side).
3. If no vapor escapes, ice is blocking the port or the service neck itself, and must be cleared.
4. Reinstall the lead port cap.
5. Go to section 5.2 “Clear a Vent-Path”.

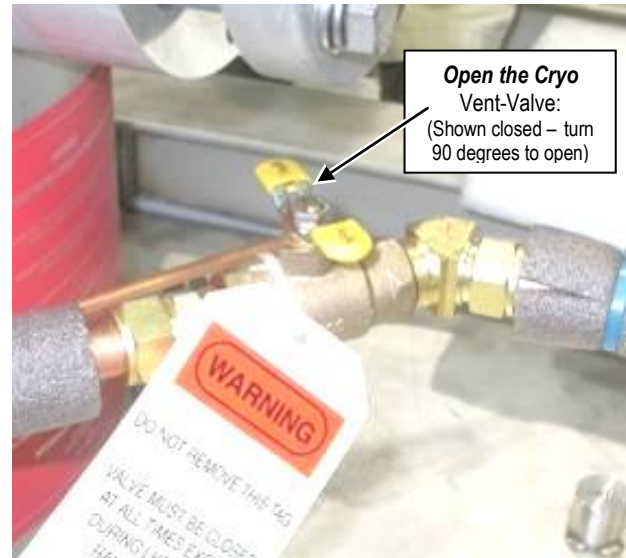




Figure 5-1 Open Cryo Vent-valve

 WARNING 
<p>DO NOT ALLOW VENTING VAPORS TO CONTACT YOU DIRECTLY. FREEZING VAPORS CAN FREEZE UNPROTECTED SKIN.</p>

 DANGER 
<p>HIGH PROBABILITY OF A QUENCH EVENT AFTER VENT-PATH IS CLEARED.</p> <ul style="list-style-type: none"> • DO NOT ATTEMPT TO STOP A QUENCH FLOW! LEAVE THE AREA IMMEDIATELY! • PLAN AND PRACTICE AN ESCAPE ROUTE AWAY FROM THE QUENCH AREA INTO A WELL-VENTILATED AREA OR OUTDOORS. • ESCAPING VAPOR AND GASES CAN CAUSE SEVERE FROSTBITE AND POSSIBLY DEATH BY ASPHYXIATION. • ONLY QUALIFIED TECHNICIANS SHOULD PERFORM THIS PROCEDURE. • WEAR APPROPRIATE PROTECTIVE CLOTHING AND GEAR. • KEEP AWAY FROM THE VACUUM PUMPOUT COVER HOUSING.

5.2 - Clear a Vent Path

Clearing a vent path is very important for providing an exhaust path in case the magnet quenches.

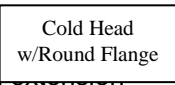
1. Remove the cap to the helium-fill port. 
2. Assemble the ½-inch de-icing wand, copper tubes and the copper de-icing rod to create a de-icing rod.



Figure 5-2 - Heating the 1/2" copper de-icing rod to create a vent.

Heat the end of the 1/2-inch copper de-icing rod. This can be done with a propane torch (for no more than 30 seconds) or an electric heat gun (for a minute or more).



Figure 5-3 - Melt through the ice with a heated de-icing rod.

Insert the heated de-icing rod into the helium fill port and allow it to melt the ice. Keep your face away from fill port. Gases will vent as the de-icing rod bores through the ice blockage.

3. Each time boring gets progressively slower, remove the de-icing rod, reheat it, and then reinsert it into the fill port.
4. Vapors will escape through the fill port as the de-icing rod bores through the ice block. This indicates that a vent path has been created.
5. Continue heating and boring through the ice block until the de-icing rod bottoms-out in the fill funnel.

6. Remove the de-icing rod and allow the gases to vent until they subside. You may have to reinsert the de-icing rod periodically if the vent ices over.

WARNING	
<p>THE MAGNET MAY (WILL PROBABLY) QUENCH WHEN THE PRESSURE IS SUDDENLY RELEASED. THIS CAN HAPPEN EITHER WHEN THE VENT-PATH IS OPENED THROUGH THE HELIUM-FILL TUBE OR WHEN THE HIGH CURRENT LEAD GUIDE TUBE IS CLEARED. AVOID THE GAS PLUME EMERGING FROM THE HELIUM-FILL PORT, OR COLD-CONTACT INJURIES WILL RESULT.</p>	

7. Replace and tighten the helium-fill port cap, to restrict vent gasses to the vent path, if possible.
8. If the magnet did not quench, proceed to "Clear the High-Current Lead Ports."

5.3 - Clear the High-Current Lead Ports

(This process is for use with Flex-Leads ONLY.)

Use this procedure to open ice blockage in the high-current lead ports. This will enable you to connect the high current leads with the terminal connectors. If you can connect the leads to the terminals, skip to Step 9 in this section.

1. Remove the negative high-current port plug.
2. Connect the ground cable on the negative high current lead to the grounding post.
3. Warm the tip of the negative high current lead, using a heat-gun. DO NOT USE A TORCH.

CAUTION: NEVER USE AN OPEN FLAME TO WARM LEAD TIPS. – An open flame can cause damage to the lead connections.

CAUTION: HEAT ONLY THE TIP OF THE LEAD. - The nylon insulation can be damaged if the connector gets too hot.

Cover the lead immediately adjacent to the gold-plated tip of the charging lead with your hand, with your thumb on the tip. (see Figures 5-4, below) Heat the gold-plated tip with a heat gun. (For Flex Leads: Do not allow heated air to blow on the black nylon braid.)

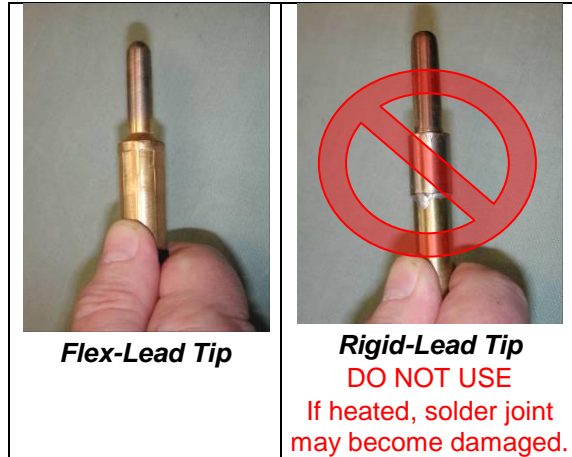




Figure 5-4 – Thumb position when heating lead-tip

Continue heating until the tip is warm enough to be uncomfortable.

4. Insert the warmed high-current lead into the negative high-current port and allow it to melt a path to the terminals. Do not force the lead. Allow it to melt through the ice without too much pressure. Periodically remove the lead, reheat the tip, and then reinsert it.

 WARNING 	
<p>THE MAGNET MAY (WILL PROBABLY) QUENCH WHEN THE PRESSURE IS SUDDENLY RELEASED. THIS CAN HAPPEN EITHER WHEN THE VENT-PATH IS OPENED THROUGH THE HELIUM-FILL TUBE OR WHEN THE HIGH CURRENT LEAD GUIDE TUBE IS CLEARED. AVOID THE GAS PLUME EMERGING FROM THE HELIUM-FILL PORT, OR COLD-CONTACT INJURIES WILL RESULT.</p>	

5. Vapor will vent when the lead melts through the ice blockage. Stand away from the vapors and allow the gases to vent completely.
6. After the gases vent, continue de-icing the port until you reach the high-current terminal. As the lead reaches the end of its length, you will feel it contact the metal of the high-current terminal.
7. Heat and reinsert the lead one more time until it seats securely into the terminal. Then tighten the nut (on the lead) to lead port.
8. Repeat Steps 1 through 7 to clear the positive lead port. Check the helium-fill port for adequate venting. Deice a fresh path with the copper tube if ice blocks the vent
9. After successfully seating the high current leads into their terminals, check for lead voltage drop. If lead-voltage drop is 100 mV or less, ramp-down the magnet. If higher than 100 mV, further de-frost the lead terminals (see Section 4.9.1 in the magnet's "Installation, Operation and Maintenance" Manual).
10. Discharge the magnet.

6 - DE-ICING THE WET SOCK

To be able to perform this procedure, the technician must have access to:

- The 4K Service Tool Kit defined by PN 44747-53 or higher version or PN 4522-150-42713 referenced in the “Cold Head Service Manual for 4K Magnet Systems.”

Special Note:



With the magnet NOT at field, special non-magnetic tools are not required. Standard magnetic tools may be substituted for tools normally referenced in the 4K service kit.

- 17mm socket wrench is required
- 5mm hex wrench is required (long tee handle is best). On HFO-Y, a 6mm wrench is required.
- jacking screws are required (short for square mounting flange, long for round mounting flange)
- 0.5 mm shim material is needed to re-seat cold head and set hold down force.
- Bottled helium gas with certified helium purity of 99.99% and a pressure regulator that can provide up to 75 psig gas.

6.1 - Preliminary Set-Up

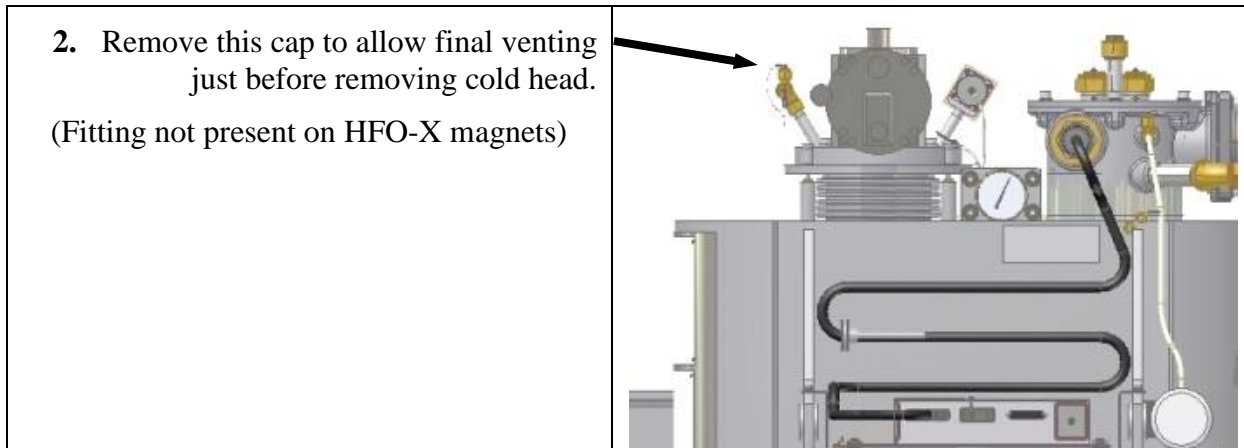
This document assumes the compressor, gas lines and cabling are in place and properly wired so that the cold head can be energized to move the internal displacer piston up and down.

MAKE SURE THE MAGNET IS NOT AT FIELD.

 DANGER 
DEATH BY OXYGEN STARVATION
<p>HELIUM GAS DISPLACES OXYGEN NECESSARY FOR BREATHING IN CONFINED OR POORLY-VENTILATED AREAS. HELIUM IS ODORLESS, COLORLESS, AND TASTELESS AND CANNOT BE DETECTED BY HUMAN SENSES. IN SUFFICIENT QUANTITIES, HELIUM WILL CAUSE UNCONSCIOUSNESS AND POSSIBLY DEATH DUE TO LACK OF OXYGEN.</p>

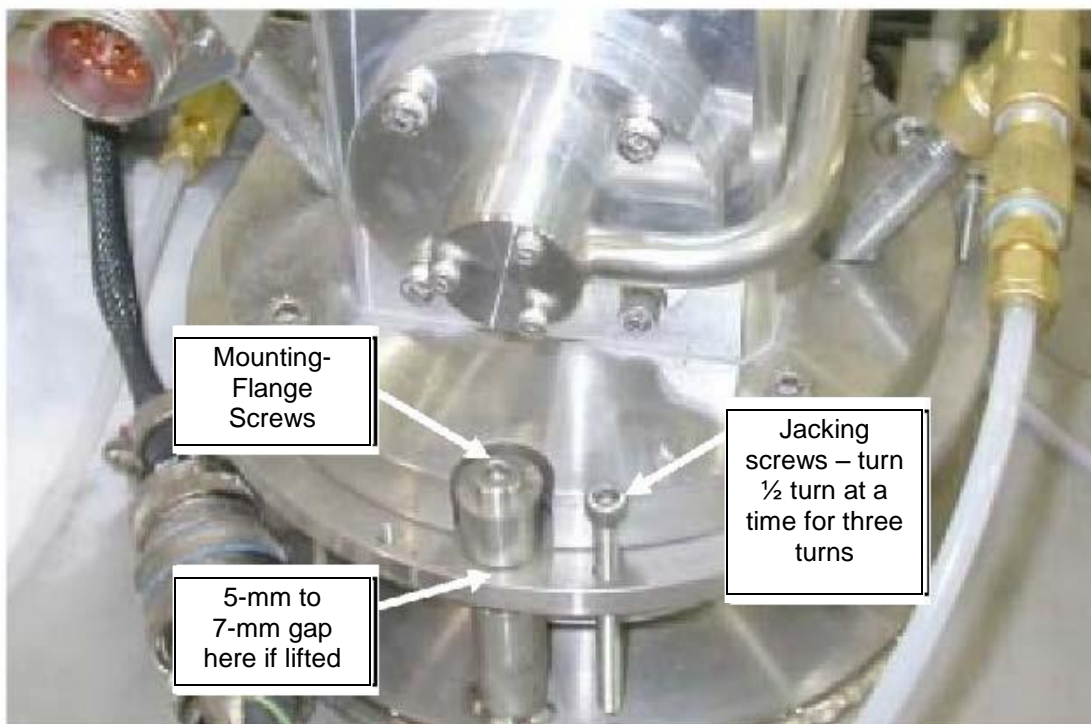


1. Depressurize the magnet. Open the 1/4 turn yellow handle valve and relieve magnet pressure by allowing cold gas to escape out of the neck of the magnet.



6.2 LIFT THE COLD HEAD

Lift the cold head as follows:



3. Use the 5-mm T-Handle wrench to loosen the three mounting-flange screws (four screws on square-flange coldheads). Loosen until the Belleville cup can be lifted above the flange by 5mm to 7mm.

4. Lift the cold head by turning the three jacking screws (*four screws on square-flange coldheads*) three full turns clockwise. (If the screws are not already present, install the screws provided in the kit (item #37). Use the 5-mm T-Handle wrench. *Turn all screws until they just touch the lower plate, then tighten each screw in 1/2 turn increments and in a circular pattern until each has been turned full turns.*

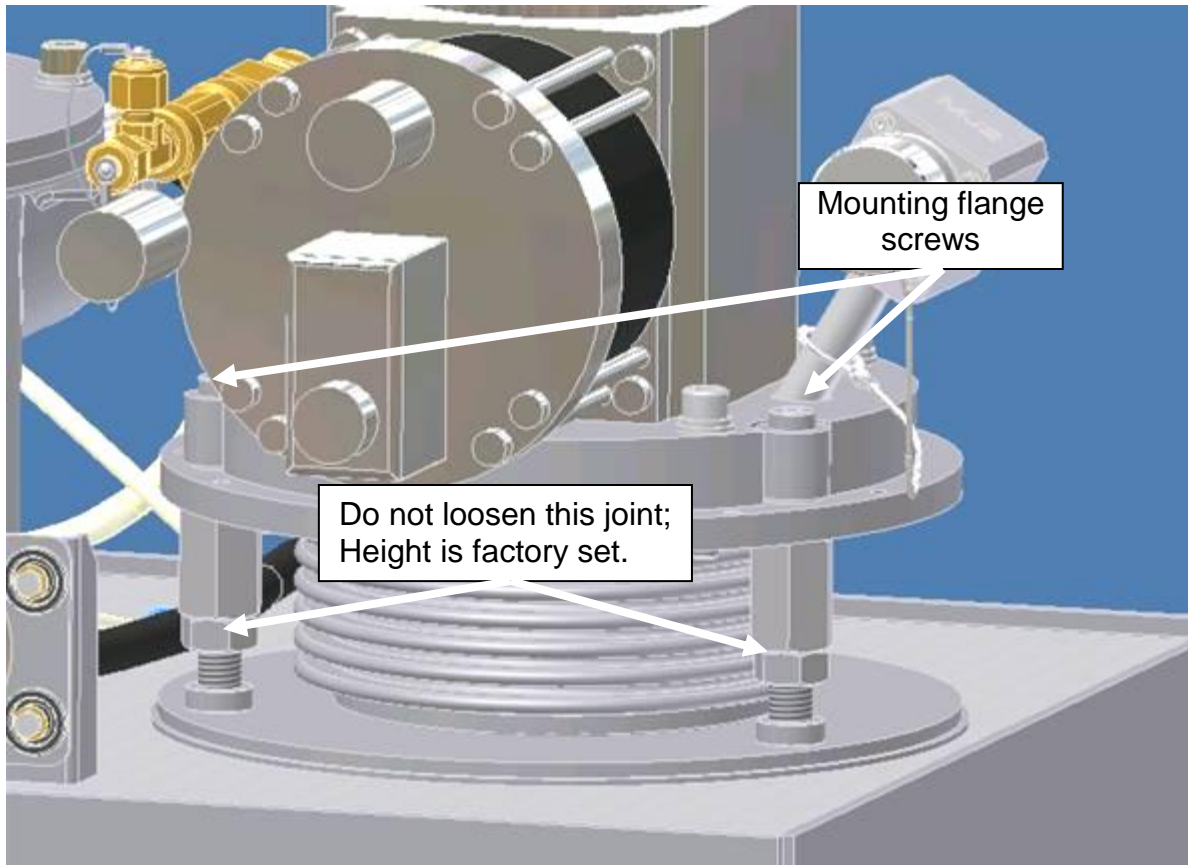
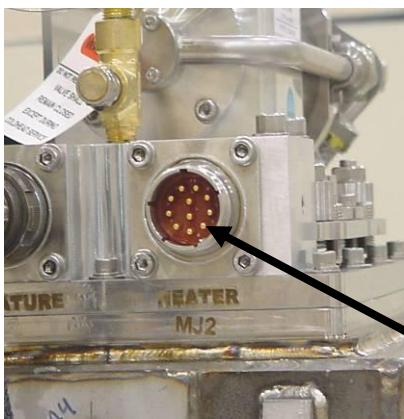
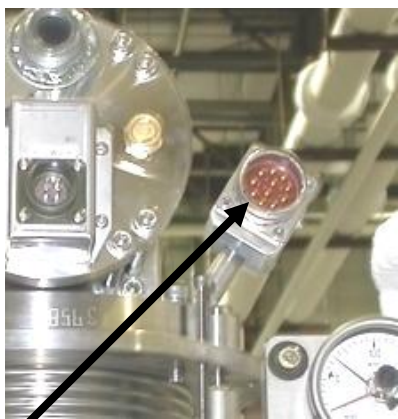


Figure 6-1 - Alternate design for cold head hold-down screws

6.3 REMOVE GAS LINES

	<p>Connect the thermo-couple/heater power cable, CM3 (from the Coldhead Service Tool Kit), first to the 11-pin connector MJ2 on the Magnet, and then to the CHHC.</p> <p>Identify your magnet's 11-pin connector type:</p> <p>Install cable here on this type connector.</p> <p>Install cable here on this type connector.</p>	
---	--	---

Note: The next step is performed with the main power switch on the compressor front panel in the "OFF" position.

5. Turn the mains switch and the heater power switch on the CHHC to the “O” (OFF) position.
- IMPORTANT: Before continuing**, turn-off mains-power to the RMMU OR disconnect DC power from connector MJ-X1 on the MEU.
6. Connect the CHHC mains power cable assembly to the CHHC and to a 220VAC power source within the instrument room.
 7. Turn the mains switch of the CHHC to “|” (ON). *VERIFY* that the displayed temperatures, shown in °C, are approximately -260°C and -220°C. This temperature range will vary based upon how long the CHHC has been turned off.
 8. Turn the heater-power switch on the CHHC to “|” (ON). The heat station warm-up time is approximately 45 minutes.
 9. Do not proceed until both cold head heat stations have reached 15°C temperature set-point as indicated on the CHHC. It is best to allow the CHHC to maintain the 15°C set point for approximately 30 minutes before proceeding (this allows complete warm up of the heat stations to reduce frost accumulation upon removal.).
 10. *Loosen* the gas-line coupling from the coldhead fitting by holding the fitting on the cold head with one wrench, while loosening the gas-line nut on the coupling *one turn* with the other. **Use two wrenches.** See *Figure 6-2*. Note the “HOLD” location illustrated.

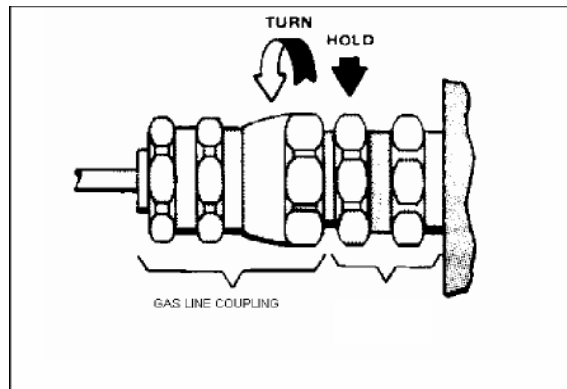


Figure 6-2

11. *Disconnect* the gas line from the fitting. **Use 2 wrenches.** Hold the body of the gas-line coupling with one wrench, while unscrewing the gas-line coupling nut from the fitting. See *Figure 6-3*. Note the **new** “HOLD” location illustrated.

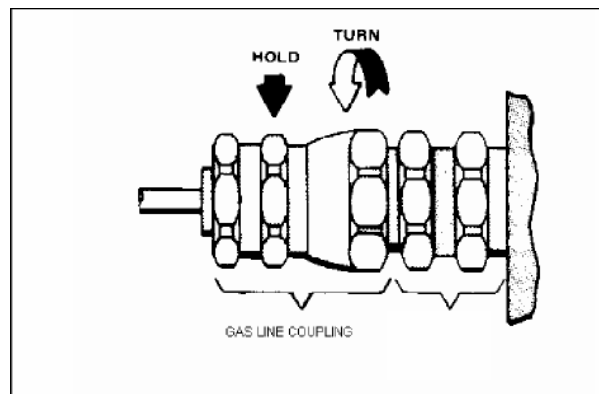


Figure 6-3

6.4 REMOVE THE COLD HEAD

12. **For Round-flange coldheads,:** (See **Figure 6-4**) Remove (with a 6mm hex-key wrench) the four M8 hold-down screws that attach the cold head to the mounting flange. See *Figure 6-4*. Secure the screws so they will not fall into the magnet when the cold head is removed.



Figure 6-4 – Round-flange coldhead hold-down screws



Figure 6-5 – Rectangular-flange with ten M6 (5mm socket head) hold-down screws (six are not shown)

- For Rectangular-flange coldheads,:** (See **Figure 6-5**) Remove (with a 5mm hex-key wrench) the ten M6 hold-down screws that attach the rectangular cold head mounting flange to the wet sock base plate. See *Figure 3A*. Secure the screws and washers so they will not fall into the magnet when the cold head is removed. *These screws and washers will be used in step 15 to secure the de-icing mounting plate to the wet-sock base plate.*

13. Turn off CHHC heater output to prevent damage to heating elements.
14. Lift the cold head from the magnet (*on rectangular-flange magnets the mounting flange is removed with the cold head*) and place on protective surface, taking care to prevent damage to wiring or connectors.
15. Cover the wet-sock opening:

For ROUND-FLANGE coldheads: (See **Figure 6-6, next page**) Place the de-icing top cover (33) over the wet-sock opening to prevent entry of air into the magnet. Insert a rubber stopper (16) into the hole in the cover. Screw-down the four captive M8 socket-head cap screws on the top cover (6-mm hex key wrench).

CAUTION

DO NOT OVER—TIGHTEN SCREWS – The four M8 screws may only be tightened until they are snug, slightly more than finger-tight. If you over-tighten the screws, you may crack the Lexan® de-icing top cover.

For RECTANGULAR-FLANGE coldheads: (See **Figure 6-7, next page**) Place the de-icing mounting plate (34) over the protruding top of the wet-sock bellows. Center the gasket (35) on top of the bellows, then place the clear access plate (18) on top of the gasket, and insert a rubber stopper (16) into the hole in the access plate. Place the triangular hold-down plate assembly (20) on top of the clear access plate.

CAUTION

DO NOT TIGHTEN the three screws on the triangular hold-down plate assembly at this time.

Insert the ten M6 screws and washers removed with the coldhead flange through the holes in the mounting plate into the wet-sock base plate. Screw-down the ten M6 socket-head cap screws (5-mm hex key wrench) until snug.

Now tighten the three screws on the hold-down plate assembly to seal the clear access cover to the gasket and bellows-top.

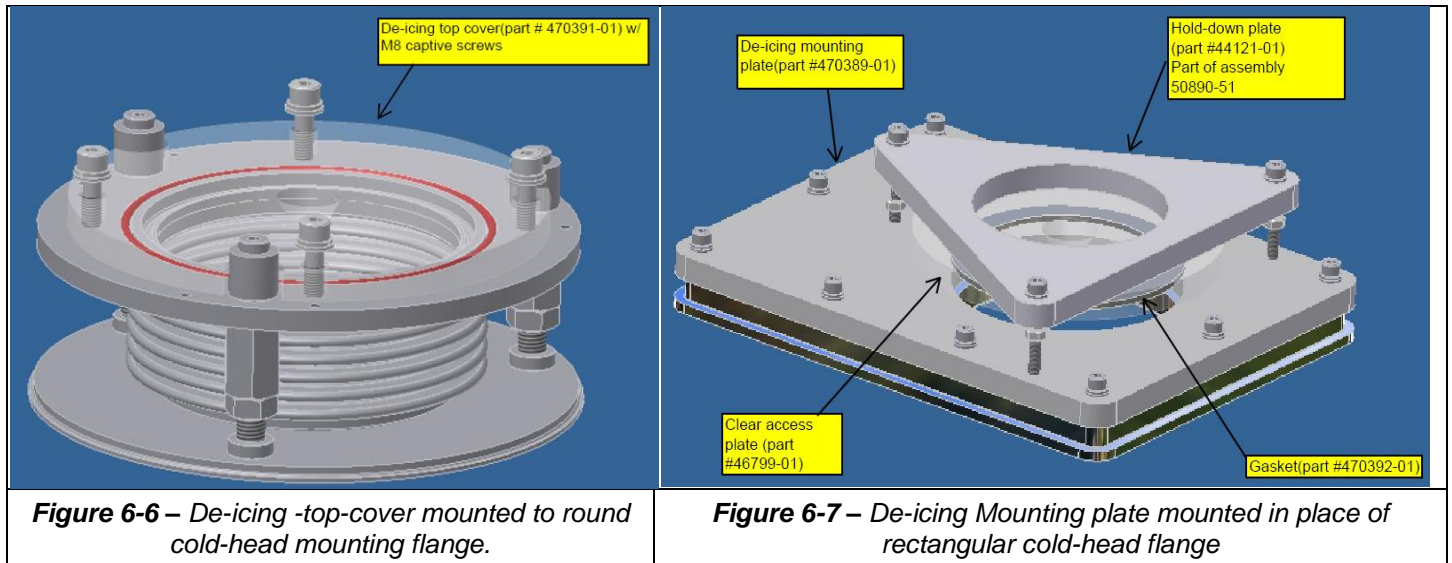


Figure 6-6 – De-icing -top-cover mounted to round cold-head mounting flange.

Figure 6-7 – De-icing Mounting plate mounted in place of rectangular cold-head flange

6.5 De-ice the Wet Sock

16. Inspect wet sock for ice accumulation, especially in the small bellows located at the bottom. See *Figure 6-8*.



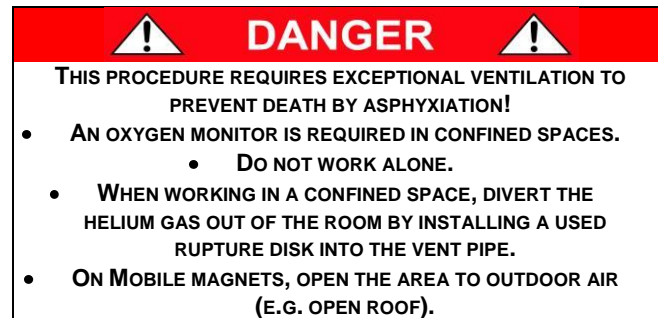
Figure 6-8

17. Using He-gas and standard de-icing procedures, de-ice the wet sock with the de-icing wand from the de-ice kit. Make sure that a vent path is open through the main turret to vent gasses. To ensure the vent path, remove a lead-port cap. Never insert the de-icing wand, or anything else, into the small bellows. Loss of vacuum may occur as a result.
18. Replace the clear access plate with a clear blank plate (Item 28 in the de-icing kit), cover the wet-sock opening when deicing has been completed for wet sock. Make sure that gas cannot escape through wet sock opening while performing next step.
19. Deice main turret service neck area using standard deicing procedures per Section 7. Leave the

deicing plate in place.

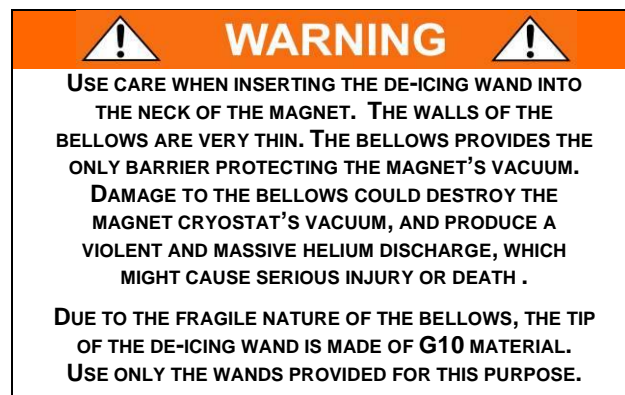
20. Repeat steps 16 thru 17 to make sure all ice has been removed. Wet sock should be completely clean. Cover wet sock opening again to prevent entry of air. The Main Neck must be completely clean also. Before proceeding, see section 7, “De-icing the Service Neck.”

7 – De-icing the Service Neck



7.1 - BEFORE DE-ICING:

- Open the magnet-room door (for ventilation).
- Turn-ON the installation’s normal systems for air circulation.



7.2 - Prepare the De-icing Assembly

1. Remove the helium fill port cap to vent gases before removing the top plate. If the port is not venting, go to “Clear Vent Path”, on page 11, and then return to this procedure.
2. Make certain that the coldhead is turned off.
3. Make sure that the de-icing plate assembly is ready for installation.

- For HFO OPEN-X and for Rex with PMS No. beginning with UA, use kit components described in Figure 7.1 A.

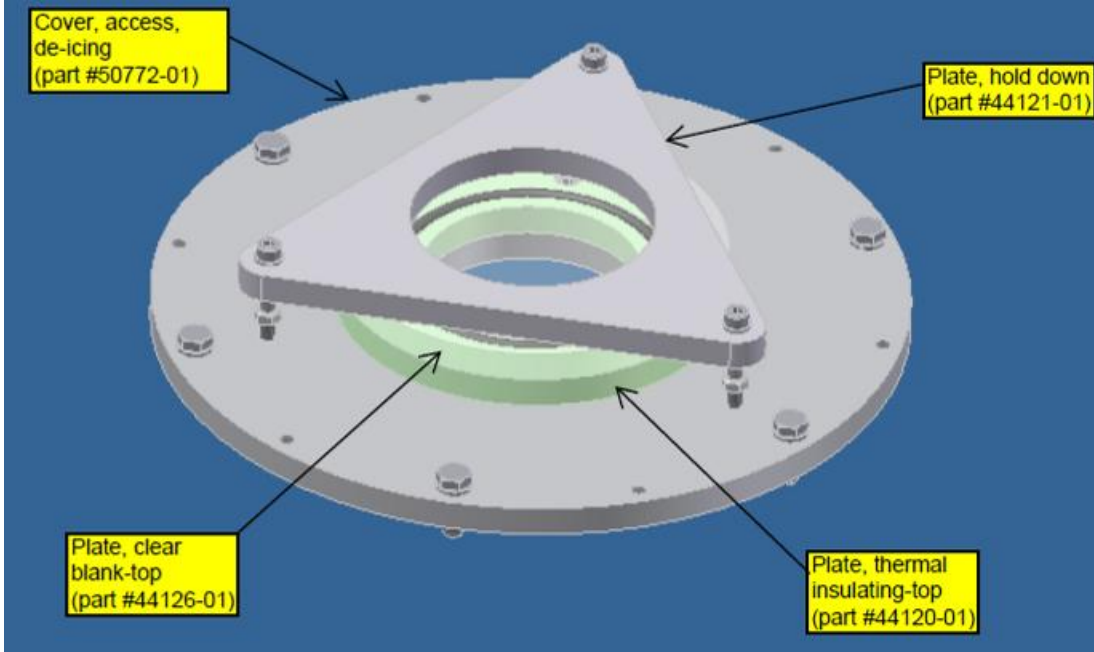


Figure 7-1A.

- For HFO OPEN-Y, with PMS No. beginning with JA through JE, use kit components described in Figure 7.1B.

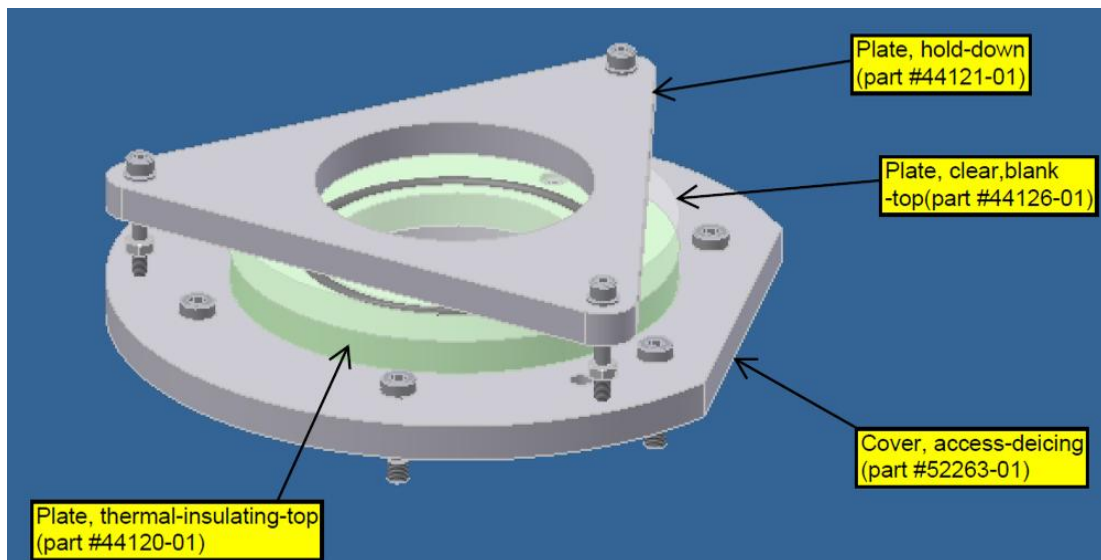


Figure 7-1B.

For magnets with “Uniserve” top covers:

- HFO-Y with PMS No. beginning with JF or higher, and
- Rex PMS No beginning with UB or higher, use the kit components shown in Figure 7.1C

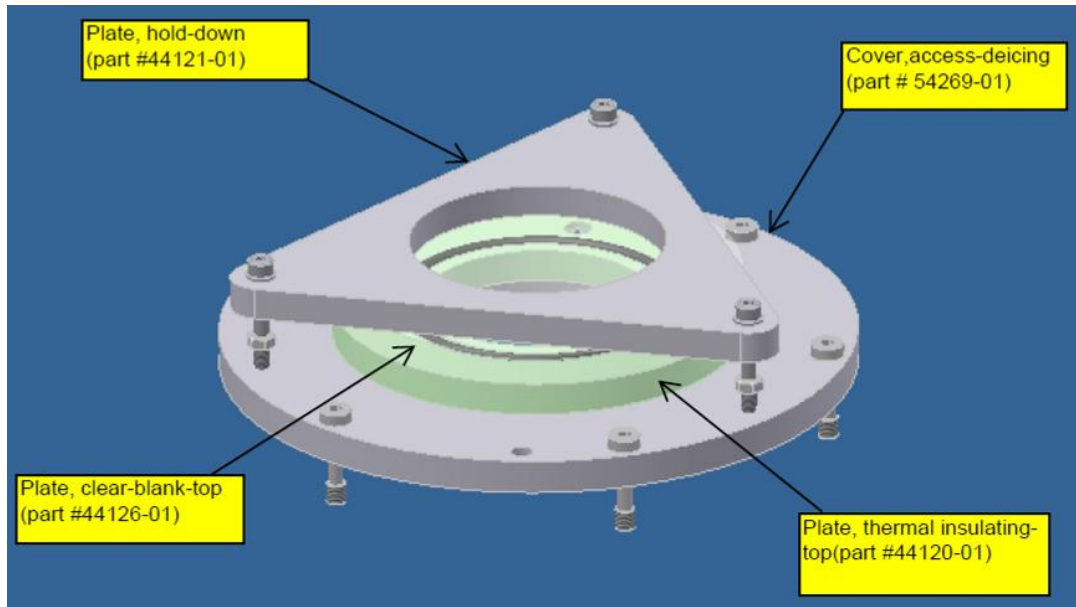


Figure 7-1C

7.2.1 Remove the top-plate and install the de-icing plate:

NOTE: It is important to keep as much air out of the unit as possible. Air will freeze and cause further ice deposits.

NOTE: Before installing the de-icing plate assembly, make sure that the instrumentation-cable bundle does not obstruct the interior view or the de-icing wand path. It may be necessary to gently move the bundle out of the way.

1. Loosen the six M8 captive screws that secure the top plate to the top casting until finger-tight (Figure 7-2).

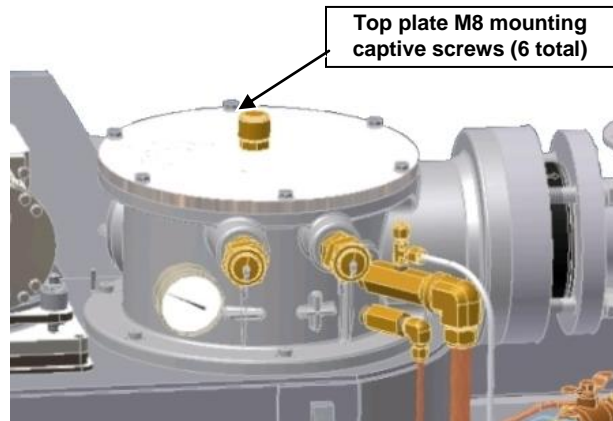


Figure 7-2 (OPEN-X shown).

2. Replace the top plate with the appropriate de-icing plate assembly either Figure 7-1A or 7-1B or 7-1C.

Try not to let outside air into the unit. Tighten the six M6 captive screws with a wrench.

CAUTION DO NOT OVER—TIGHTEN SCREWS – The four M8 screws may only be tightened until they are snug, slightly more than finger-tight. If you over-tighten the screws, you may crack the Lexan® de-icing top cover.

- Use a flashlight to look into the top-casting area. Look down the LHe-fill tube to check for ice at the bottom-fill funnel (see Figure 7-3). Also look for ice in the neck region.



Figure 7-3 - Example of visible ice at the bottom-fill funnel

- Noting ice buildup will enable you to aim the de-icing wand directly into icy areas for more efficient de-icing. If you cannot see the bottom-fill funnel, icing is significant.
- Assemble the stainless steel de-icing wand (Figure 7-4).



Figure 7-4 De-icing wand.

7.3.A - Install the Rupture-disk Spacer

(Magnets with Vent-Elbows and Rupture Disks. See Figure 7-5)

Install a rupture-disk spacer to allow gases used or produced during de-icing to vent through the facility vent-pipe.

- Remove the two top screws (Figure 7-5) and loosen the two bottom screws that secure the vent pipe to the top hat assembly.

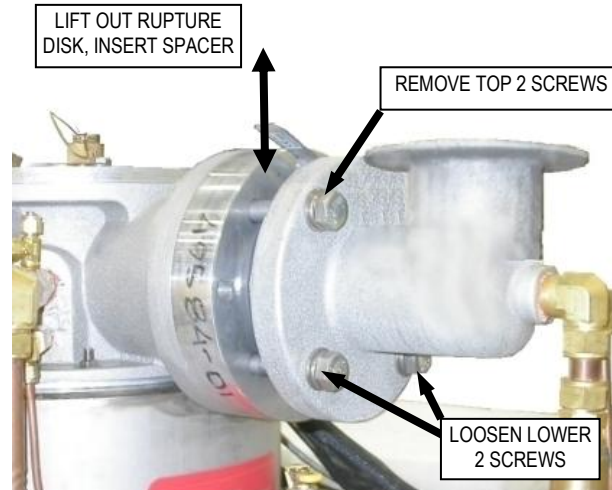


Figure 7-5 - Remove the top two mounting screws to remove the rupture disk. HFO shown.

2. Remove the rupture disk and install the rupture-disk spacer. Replace top screws and tighten all four screws finger-tight.
3. Go on to “Deice the Service Neck Region”.

7.3.B – Remove the Rupture Disk:

(Magnets with Integral valves and flexible vent lines. See Figure 7-6)

Remove the rupture disk from the integral valve to allow gases used or produced during de-icing to vent through the facility vent-pipe.

1. Loosen (if necessary) the M6 nut on the V-band clamp holding the exhaust plenum to the valve body. Open the V-band clamp and swing the exhaust plenum out of the way, to expose the integral valve and rupture disk.

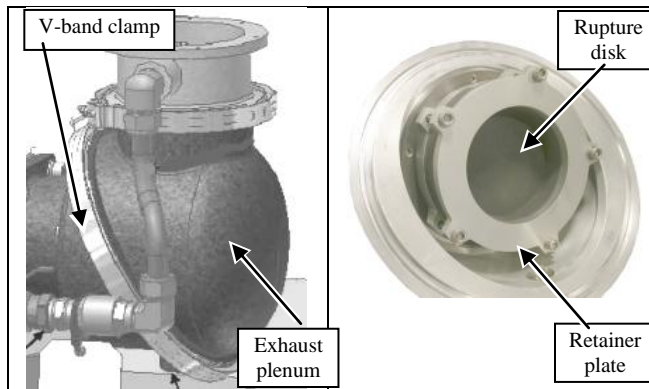


Figure 7-6 - Remove the Rupture Disk (Open-Y and some Rex models)

2. Loosen and remove the disk-retainer plate with its captive screws, with a 5-mm hex-key. Remove the rupture disk. Secure the disk and the retainer plate for later re-installation.
3. Move the exhaust plenum back into position and close the v-band clamp.
4. Go on to “Deice the Service Neck Region”.

7.3.C. – Remove the Rupture Disk:

(Rex Magnets with Copper vent lines. See Figure 7-7)

Remove the rupture disk from the integral valve to allow gases used or produced during de-icing to vent through the facility vent-pipe.

1. Using an adjustable wrench, disconnect the helium vent tube at the two Swagelok fittings.
2. Use a 6-mm hex-key wrench to loosen the 8 captive socket head screws that secure the quench vent elbow to the magnet. (Refer to Figure 7-7) Remove the quench vent elbow and O-ring.

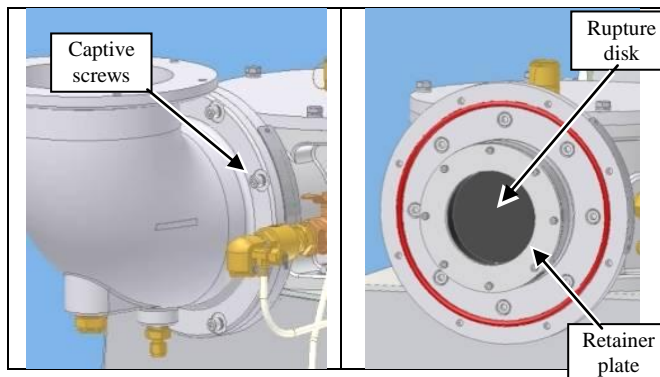


Figure 7-7 - Remove the Rupture Disk (Rex)

3. Use a 3-mm hex key wrench to loosen the 8 socket-head screws securing the rupture disk in place. Remove the disk retaining plate, rupture disk and O-ring.
4. Re-install the vent elbow.
5. Go on to “Deice the Service Neck Region”.

7.4 – De-ice the Service Neck Region

1. Replace the solid clear plate in the De-icing Plate assembly with one of the clear access plates. Insert a stopper in the hole in the access plate.
2. Connect an inline regulator valve adapter between the de-icing wand and the helium tank hose. (Figure 7-8). Be sure to turn the valve OFF.
3. Set the regulator valve on the gas bottle to 50 psi. The pressure can now be regulated from 0 psi-to-50 psi with the inline regulator valve. The pressure will not exceed the maximum recommended pressure of 50 psi.
4. Localize the gas flow to the areas where ice is seen. Direct the de-icing wand in-between and all around the lead guides. You may need to increase the pressure to deice some areas.

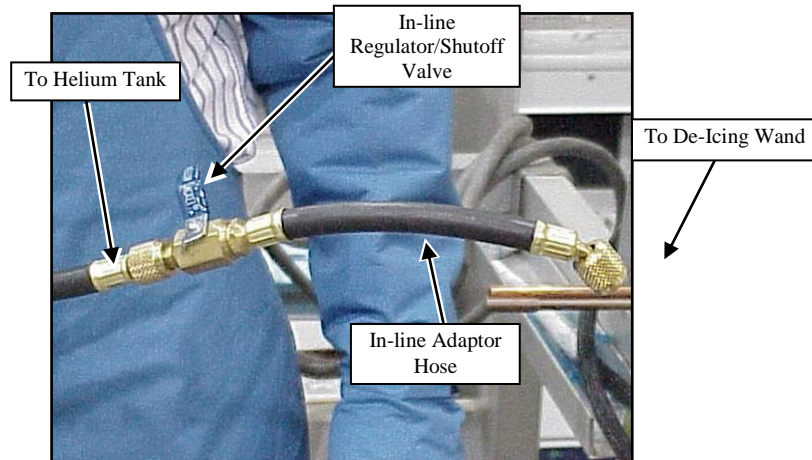


Figure 7-8 - Attaching inline regulator valve to de-icing wand.

5. When you believe that all of the ice is cleared from the neck region, install a solid view plate and inspect the neck region for ice. If there is no ice and it is possible to clearly see the bottom-fill funnel through the helium-fill tube remove the lead guides.
6. Proceed to section 8, “De-Icing with Lead Guides Removed”.

8 - DE-ICING WITH LEAD GUIDES REMOVED

8.1 - Removing the Lead Guides Assembly

Use the following procedure to remove the lead guides and deice the neck region.

NOTE: This procedure for removal of the high current lead guides is meant for magnet rooms with a ceiling height that is adequate to allow removal of the guide tube assembly. If the distance from the bottom of the top casting to the ceiling is less than 600 mm (Figure 8-1), contact the Service Support Organization for assistance.

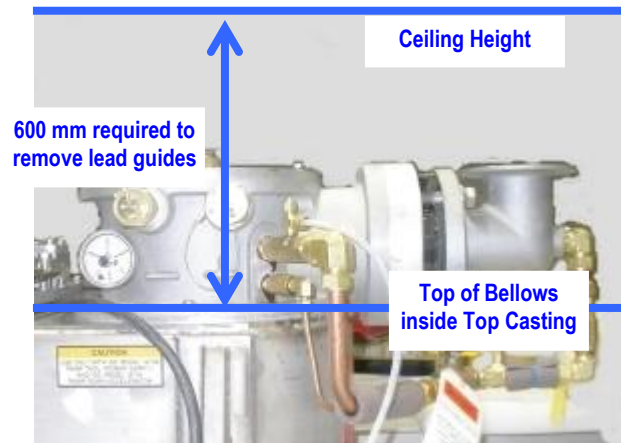


Figure 8-1 - Clearance Requirement (Open-X shown)

1. Unscrew the six M8 captive screws that secure the de-icing plate assembly to the magnet.

NOTE: Do not drop fasteners or tools into the magnet. Recovering them can be time consuming and costly.

2. Remove the deicing plate assembly and set aside. Use the de-icing wand and/or regulator gas-line to maintain a positive flow of helium into the magnet through the neck through the following steps.



3. Loosen the two lead-guide captive mounting-screws.

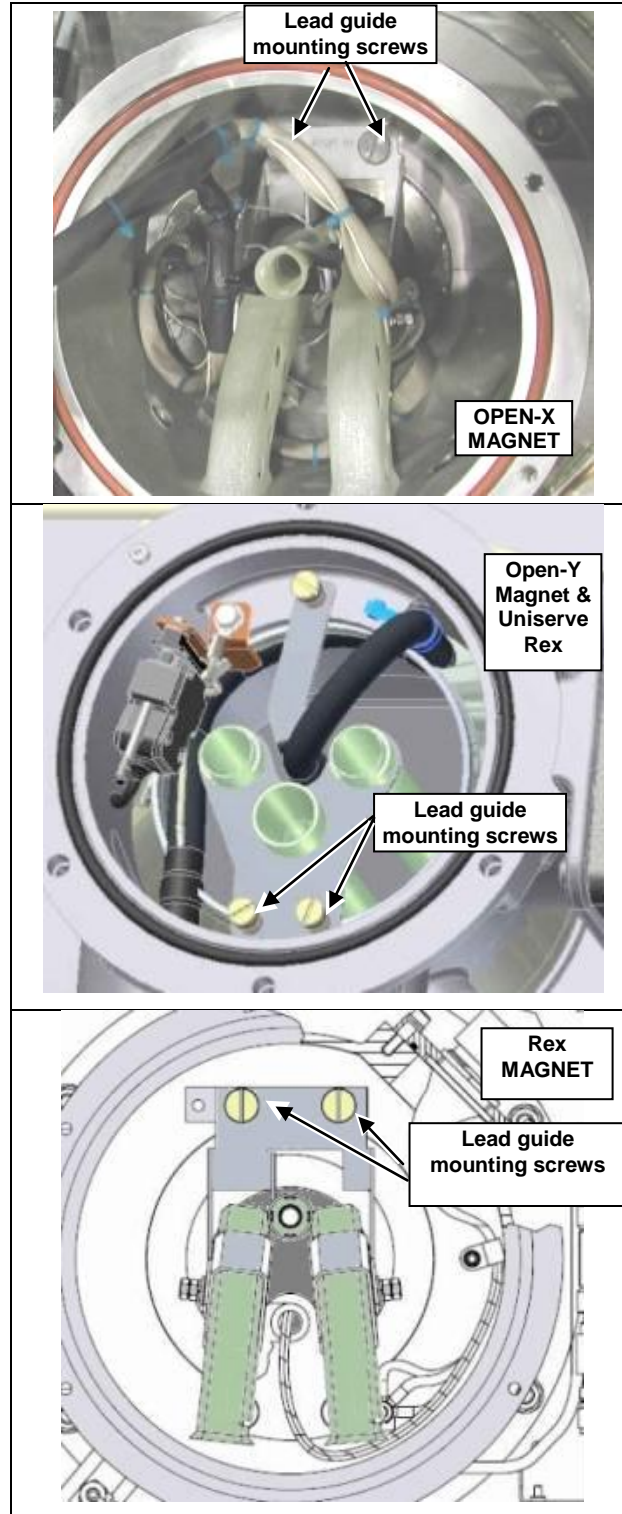


Figure 8-2 - Loosen lead guide mounting screws.

 **CAUTION** 

USE CARE WHEN REMOVING THE GUIDE TUBE ASSEMBLY. EXCESSIVE FORCE WILL RESULT IN A BROKEN GUIDE TUBE ASSEMBLY. THIS RENDERS THE MAGNET INOPERABLE.



4. Gently lift the high current lead guides assembly out but DO NOT FORCE THEM. If they won't come out, ice is holding them in place.
5. If the high current lead guides do not come out go to step 6. If they do come out go to step 10.
6. Set the regulator valve on the gas bottle to 50 psi. The pressure can now be regulated from 0 psi-to-50 psi with the inline regulator valve. The pressure will not exceed the maximum recommended pressure of 50 psi.
7. Localize the gas flow to those areas holding the guides in place. Direct the helium de-icing wand in between, and all around the lead guides. You may need to increase the pressure to de-ice hard-to-get-to areas. Continuously check for lead guide movement while de-icing.
8. Remove the lead guides from the magnet when they become free.

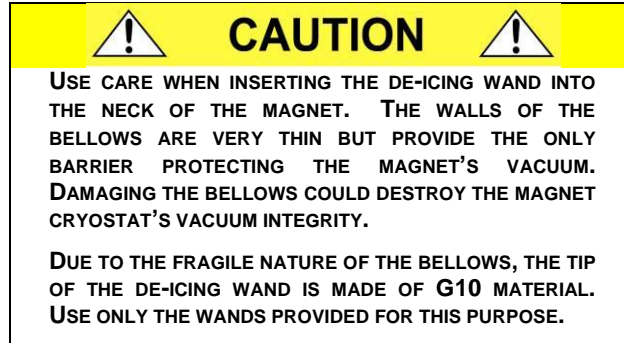
NOTE: Keep positive helium gas pressure while checking the lead guides for movement. Outside air can freeze and form further ice deposits.



Figure 8-3 - High-Current Lead Guides (OPEN-X or Rex shown)

9. Immediately re-install the de-icing plate assembly.

 DANGER 	
<p>THIS PROCEDURE REQUIRES EXCEPTIONAL VENTILATION TO PREVENT DEATH BY ASPHYXIATION!</p>	
<ul style="list-style-type: none"> • AN OXYGEN MONITOR IS REQUIRED IN CONFINED SPACES. • DO NOT WORK ALONE. • WHEN WORKING IN A CONFINED SPACE, DIVERT THE HELIUM GAS OUT OF THE ROOM BY INSTALLING A USED RUPTURE DISK INTO THE VENT PIPE. • ON MOBILE MAGNETS, OPEN THE AREA TO OUTDOOR AIR (E.G. OPEN ROOF). 	



8.2 - De-icing procedure:

Visually determine the location of the ice blockage. If the blockage is high in the neck direct the flow of helium gas onto the top of the ice accumulation. IA gurgling sound may be heard as the ice vaporizes. The de-icing helium cools quickly and loses its effectiveness. Maintain a constant flow of gas.

NOTE: The vapor produced when de-icing is caused by displaced air ice. This is a good indicator that the process is working.

1. Insert the de-icing wand through the access plate and down the neck with 30 to 50-psi of warm helium gas.

NOTE: Cold gas created while de-icing will vent out of the rupture-disk spacer/through the rupture-disk void.

2. Direct gas along the sides of the neck and at the terminal board at the base of the neck. The exhausting gas will lift the vaporized air up and out of the neck. Gurgling may be seen and heard while performing this step. Visibility is important when performing this step. The heat from the de-icing wand produces helium boil-off which helps clear the fog in the neck.

NOTE: You should (eventually) see a space between the base of the neck and the terminal - board. When you deice, make sure you direct the de-icing wand into this area. Use the 90-degree wand-tip.

3. Continue blowing the entire contents of the gas cylinder down the neck even if vapors and gurgling cease. Use as many gas cylinders as necessary to completely deice the area.



4. Remove the wand and immediately stopper the view plate.

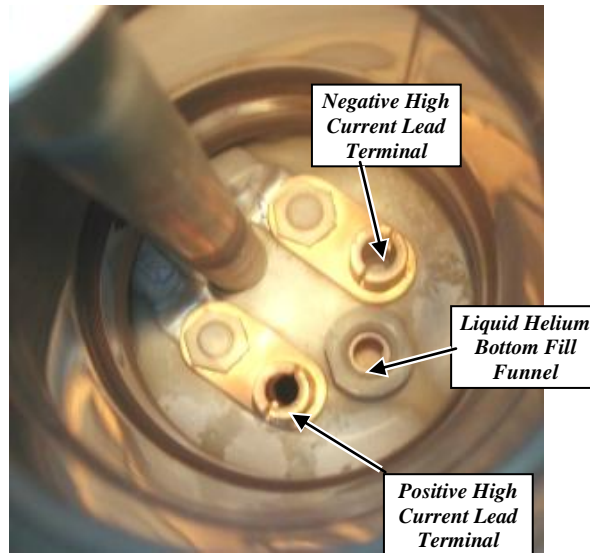



Figure 8-5 - Check lead terminals and liquid helium fill funnel for ice.

5. Use a flashlight to check for residual ice in the neck of the magnet. You should be able to clearly see both high current lead terminals and the liquid helium fill port. Also check the base of the bellows. You should see a gap between the bellows and the terminal board. If any of these areas are not visible, continue de-icing.
6. De-Icing Procedure with 90° Tip.
 - a. Use the extension tube with a 90 degree end. (See item No. 4 from the De-Icing Kit.)
 - b. Position the wand 0.5 to 1 cm above the terminal board.
 - c. Blow helium gas through the extension tube into the shields.
 - d. (Keeping the wand 0.5 to 1 cm above the terminal board) make circles of 360 degrees.

NOTE	
	<p><i>It is not possible to see the de-ice results. Ice which has to be removed is NOT visible from the service turret.</i></p>

- e. Repeat the procedure until 2 bottles (minimum) of helium gas have been fully discharged.

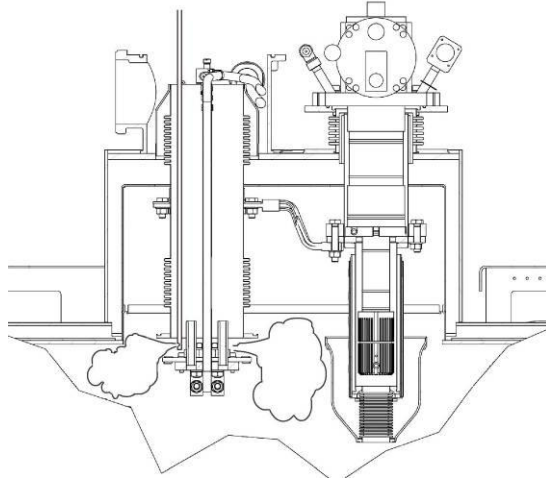


Figure 8-6 - 90/360 degree de-icing

7. When ice has been cleared, reinstall the rupture disk.

- For Magnets with vent-elbow and rupture disk: (Figures 4-1, 4-3, and 4-6): *Replace the rupture-disk spacer with a rupture disk.*
- For Magnets with Integral Valves (Figures 4-2, 4-4, and 4-5): *re-install the rupture-disk.*

8. Remove the Clear View Plate and inspect the terminal area for any ice accumulation. Remove any visible ice from the terminals by venting helium gas through the De-ice Plate.

9. Reinstall the Clear View Plate and allow a two hour wait period. Then re-inspect for returning ice. Remove any ice that reappears by repeating the above step 8. When the terminals remain free of ice, proceed to "Reinstall the Coldhead."

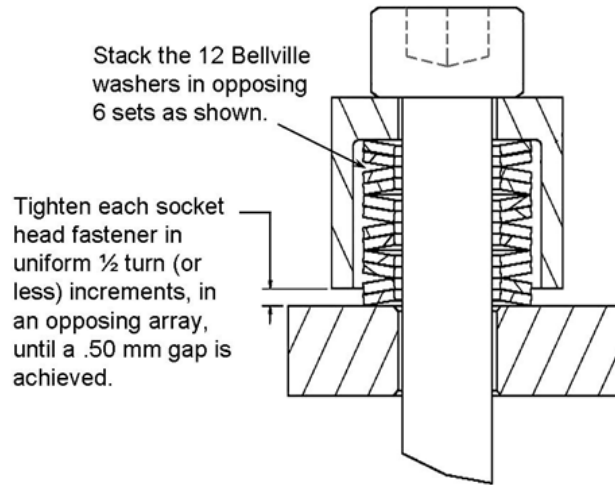
8.3 - Reinstall the Coldhead

1. Thoroughly dry cold head and pre-warm stages by turning ON the CHHC heater output control. It is very important that the cold head be completely dry. Use caution not to damage the wiring. Turn OFF the heater output upon completion of drying.

2. Just prior to reinstallation of cold head, remove the modified wet sock cover plate and purge the wet sock with helium gas to ensure first stage seat is completely clear of frost.

3. For **ROUND-FLANGE coldheads**: Carefully lower cold head into wet sock and secure to mounting flange using four M8 hold-down screws removed previously. Torque screws to 10-14 N•m.

For **RECTANGULAR-FLANGE coldheads**: Carefully lower cold head into wet sock and secure the mounting flange to the wet-sock base plate on the magnet, using the M6 screws and hardware. Torque screws to 5-6 N•m.



4. Re-seat cold head to magnet: Note temperature of first stage on controller; the first stage controller's temperature should drop abruptly (to under -100 C) when interface contact is made. Be sure that the jam-nuts (below flange) are clear when reseating the cold head to prevent false tensioning.
5. Turn off CHHC main power disconnect its power cable.
6. Reconnect compressor gas lines to cold head using the two-wrench method as outlined below.

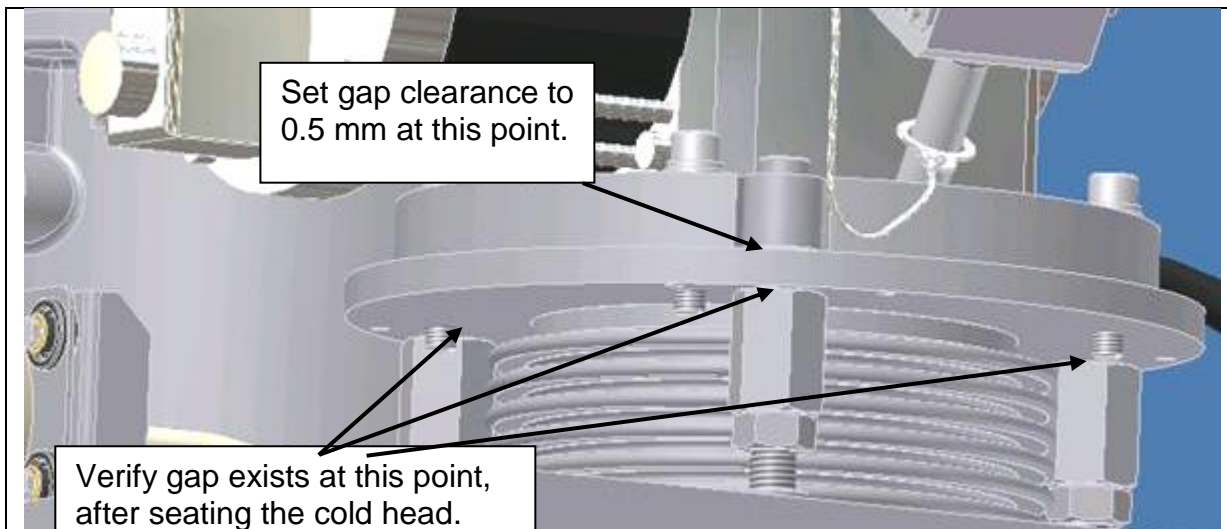
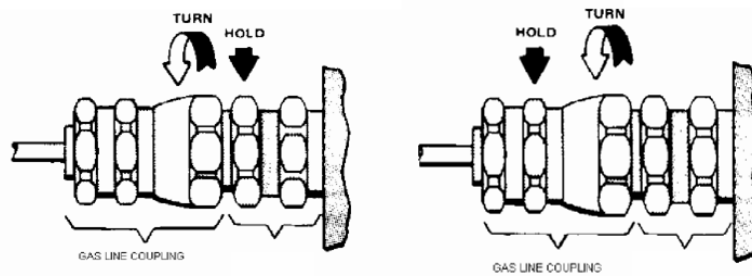
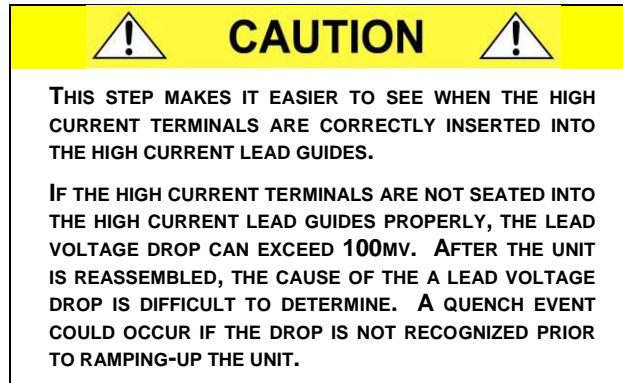


Figure 8-7 - cold head hold down screw set-point clearances

7. Wait a minimum of two (2) hours before starting compressor. No He refilling may occur during that time.
8. Proceed to “**Reinstall The Lead Guides.**”

8.4 - Reinstall the Lead Guides



An alignment rod is used to assist in reinstalling the lead guide assembly. If the alignment rod is not used, it can be difficult to align the assembly and seat it correctly over the terminals. The high current lead guides have a tendency to slide off to one side of the terminals. It is extremely important to correctly install and verify the installation of the lead guide assembly before reassembling the magnet.

NOTE: Keep a positive helium flow in the neck while performing this procedure.

1. Remove the de-icing plate assembly
2. Assemble the de-icing tubes and the copper de-icing rod to create an alignment rod.
3. Slide the helium fill guide tube (Figure 8-6) of the lead guide assembly over the alignment rod.



Figure 8-8 - Use an alignment rod to help direct the lead guides into place (OPEN-X / Rex style shown).

4. Insert the alignment rod and lead guide assembly into the magnet so that alignment rod is in the liquid helium bottom fill funnel. The liquid helium bottom fill funnel is located between the two high-current lead terminals (see Figure 8-5). It may take several tries to accomplish this. You will be able to tell that the alignment rod is in the liquid helium fill funnel from the resistance when the alignment rod is twisted slightly.
5. Tighten the two captive screws that secure the guide tube assembly.
6. Insert both high current leads to make sure that they seat properly into their terminals. The leads should seat snugly into the terminals.
7. Verify that the O-ring on the magnet top-casting is in place and not damaged and install the top plate to the magnet top-casting. Tighten the six M8 captive screws finger tight.
8. Torque the 6 M8 captive screws securing the top plate, to $6 \text{ n-M} \pm 1 \text{ n-M}$.
9. Re-install the helium vent line.

IMPORTANT: Before continuing, restore mains-power to the RMMU OR re-connect DC power to connector MJ-X1 on the MEU.

10. Close the $\frac{1}{4}$ -turn (yellow-handled) vent valve.
11. Insert the high current leads and perform a lead drop test.

NOTE: Remove the high current leads during the waiting periods. Reinstall the leads and perform another lead drop test prior to ramping

If the lead drop is greater than 40 millivolts perform the terminal de-icing procedure as outlined in the magnet operation manual. If the lead drop is less than 40 millivolts the magnet can be ramped to field after the wait.

12. Leak-check the magnet.
13. Wait two hours; then restart the coldhead.

14. Two hours after restarting the coldhead, the magnet may be refilled.
- A. *For Open-X and Open-Y Magnets:*
- First, perform a bottom fill to verify that the bottom-fill pipe is open. If the LHe level does not increase in the lower vessel, or if it increases only in the upper vessel,
 - vessel, go to Section 9, “De-icing the Bottom-fill Line”.
 - Do not fill beyond 50% of the bottom vessel using the bottom-fill.
 - Switch to a top-fill to verify if helium is flowing from the top to the bottom vessel. Overflowing occurs above an upper level in the range 35 to 40 %.
 - The final LHe-level must be more than 30% in the upper vessel and 35% in the lower.
- B. *For all Rex Magnets:* The final LHe-level must be more than 35%.
15. The magnet may be ramped either two hours after its refilling or four hours after restarting its coldhead.

9 - DE-ICING THE BOTTOM-FILL LINE (HFO ONLY)

Introduction:

This procedure describes successive steps to be taken to de-ice the LHe bottom-fill line on the HFO magnet in case of ice blockage.

Blockage of the helium bottom-fill tube has been reported in some cases of magnet quench, in which the rupture disk was not replaced in time to stop a ice from forming in the neck region. Blockage of the bottom-fill line is unlikely in cases of attended quenches where the rupture disk is promptly replaced.

Overview

This procedure prescribes successive steps for de-icing a blocked LHe bottom-fill line. The procedures are to be performed in the order given, 1 and 2. The fill-line should be tested after step 1 to check for existence or elimination of the blockage. If the blockage remains, proceed to step 2.

LHe Bottom-Fill Line Configuration (see Figures 9-1 and 9-2)

Understanding the fill line configuration is fundamental to understanding the sequence of defined steps to de-ice a blocked line.

Terminal Board TB1 : This is a common platform to all magnets. It carries the fill funnel, the +ve terminal, and the –ve terminal.

+ve Terminal : Hollow structure; will allow helium gas to pass through from neck to underside of TB1

-ve Terminal : Hollow structure, with a mini fill-line extending to the bottom of the upper vessel.

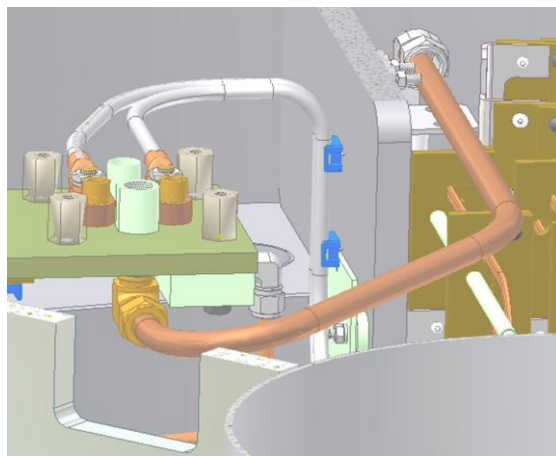


Figure 9-1 - Configuration of the bottom-fill line (upper-vessel portion shown).

Components of the fill line:

- Fill funnel
- Brass fitting which penetrates TB1 from the neck-side to the underside.
- Copper piping : Connects to the Brass fitting and carries the liquid helium, through several bends, to the start of the interconnecting piping between the two halves of the magnet
- Flexible fill line: Connects to the copper piping, and delivers the liquid helium to the bottom of the lower vessel.

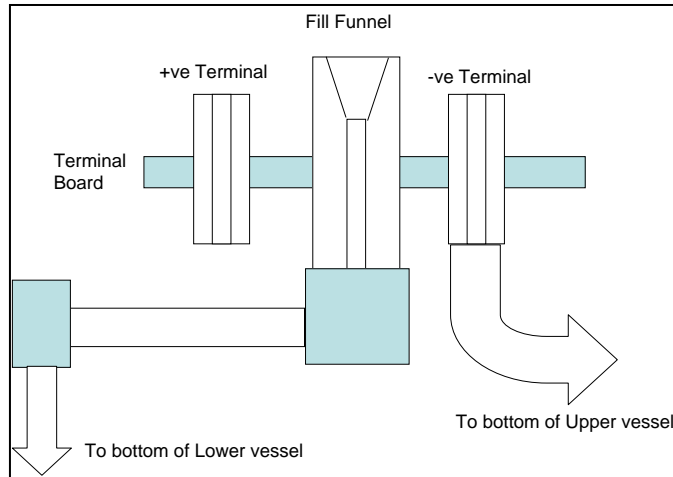


Figure 9-2 - Configuration of the TB1-connected plumbing in the upper chamber.

Blockage of the Helium Fill Line: The most likely locations for an ice blockage are :

- In the fill funnel
- In the Brass fitting
- In the copper piping which carries the liquid helium from the Brass fitting to the flexible fill line.

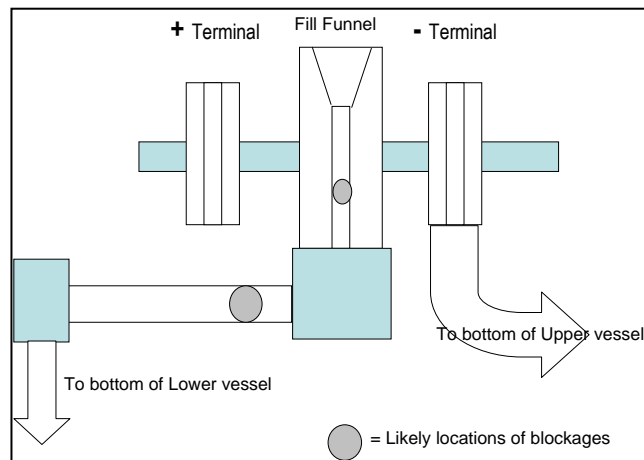


Figure 9-3 - Probable blockage locations in the bottom-fill line.

Steps in Procedure: (Refer to Figures 9-3 and 9-4)

Step #1 :

Helium gas is directed towards the fill funnel. This attacks blockages that have formed close to the entrance of the fill funnel.

Step #2 :

Helium gas is directed through the +ve lead; the result is a wider distribution of warm gas in the vicinity of the bottom surface of TB1. Pipes in this area would be expected to warm up. This attacks blockages that have formed lower in the fill funnel and those that have formed in the copper piping.

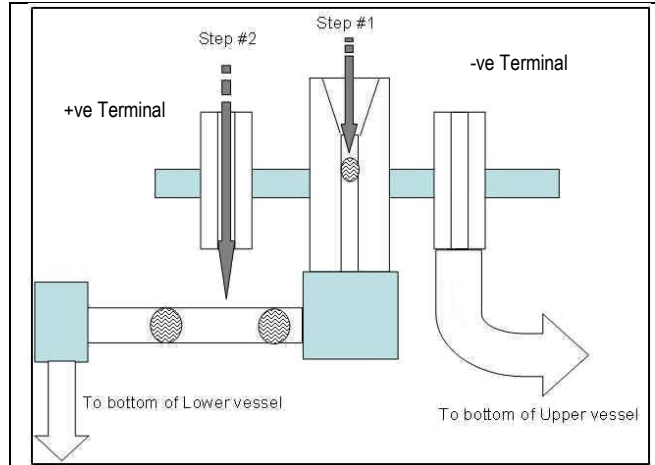


Figure 9-4 - Bottom-fill line de-icing Step #1 and Step #2.

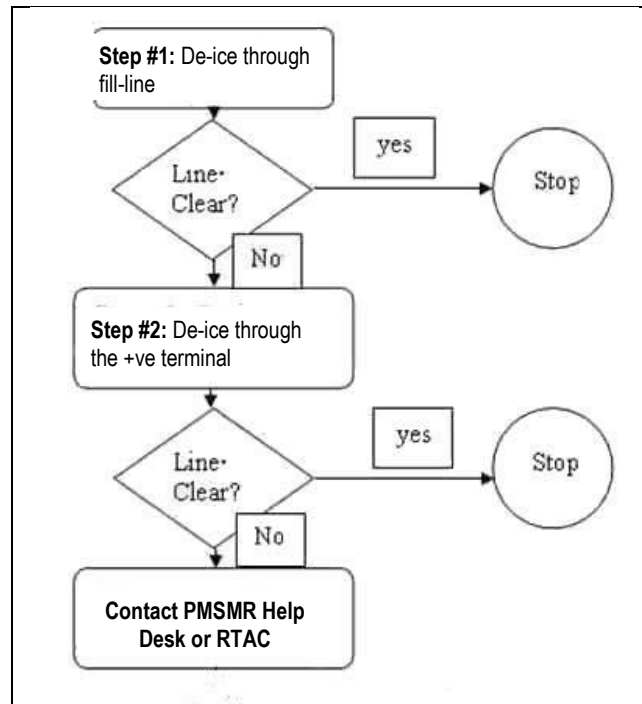


Figure 9-5 - Bottom-fill line decision-tree



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