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Magnet Group
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4K Cold Head Gas Cleanup

Charge, Run, and Vent

Doc. No.: 51076
Rev: E

Purpose

This document provides a procedure to perform a "charge, run, and vent procedure" to a 4K cold head installed in a magnet.

This procedure may help restore a loss of magnet margin due to loss of cold head capacity resulting from potential contamination of the 4K cold head helium-gas charge.

This procedure is intended to be used by personnel specifically trained to perform maintenance of 4K Cold Heads.

Special Note: With the magnet on field, special non-magnetic tools are required. Use the non-magnetic tools delivered with the 4K service tool kit.

Supporting Documentation

"Cold Head Service Manual for 4K MRI Magnet Systems" Document Number: 49011.

Required Resources

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

- The Refrigerator 4K main tool kit code number 4522 150 42711, as referenced in the instruction Manual, Doc. No. 49011, or equivalent selected tools.

- Bottled helium gas with certified helium purity of 99.999% and a pressure regulator that can supply gas at up to 300-psig.

Preliminary Set-Up

This document assumes that the compressor and the cold-head power cable are available, so that the cold head can be energized to move the internal displacer piston up and down.

Only Personnel Trained in 4K procedures may Perform the "Charge-Run-Vent" Procedure.
The Procedure may be performed when the Magnet is Energized

1. Turn the compressor main switch on compressor to the "O" (OFF) position.
2. Turn-off mains-power to the RMMU OR disconnect DC power from connector MJ-X1 on the MEU.
3. Remove the supply and return gas lines from the cold head (to isolate the contamination in the 4K cold head).
4. Partially vent the pressure from the cold head as described below.

NOTE: It is REQUIRED to first vent the charge pressure of the cold head to less than 25 psig before proceeding to lift or warm the cold head. Follow steps 4. through 6, below (next page), then proceed to section 1.0, below (next page). Failure to relieve cold head pressure before heating will result in sudden release of pressure through the installed pressure relief valve. This release will be loud and sharp, sounding like a gun shot.

4. Verify that both gas lines have been removed from the cold head.

CAUTION - ***The charge/vent adapters each contain a steel spring, and are slightly ferromagnetic. Be careful to keep control of the adapters when installing and removing them.***

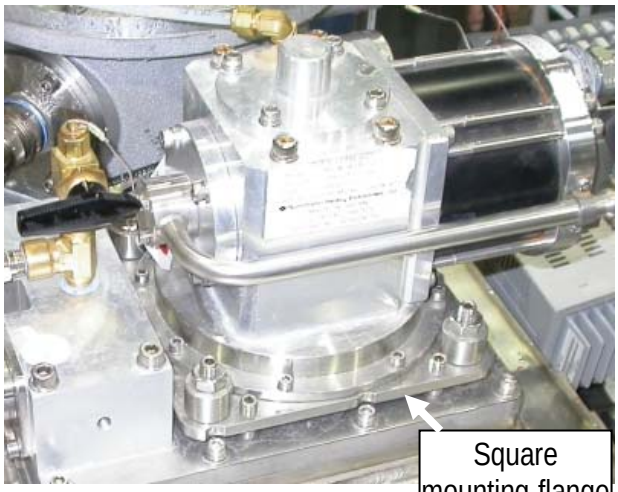
5. Using 2 wrenches, install the two charge/vent adapters (Item #10 from the 4K cold head service tool kit) to the supply and return gas fittings on the cold head.

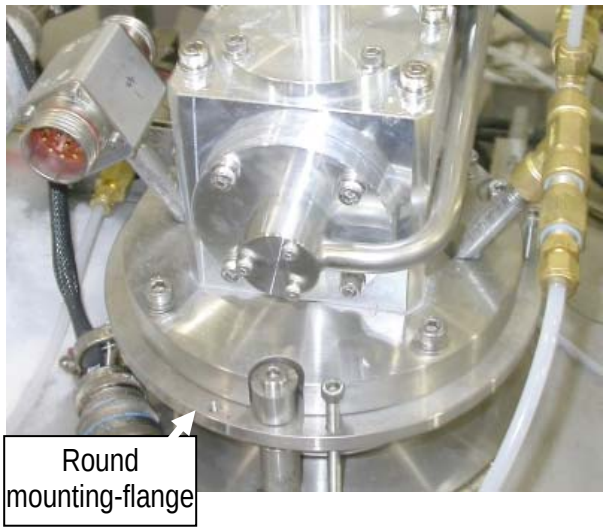
6. De-pressurize the cold head by opening both the return and supply valves and letting gas escape until the flow almost stops (audible). Close the valves.

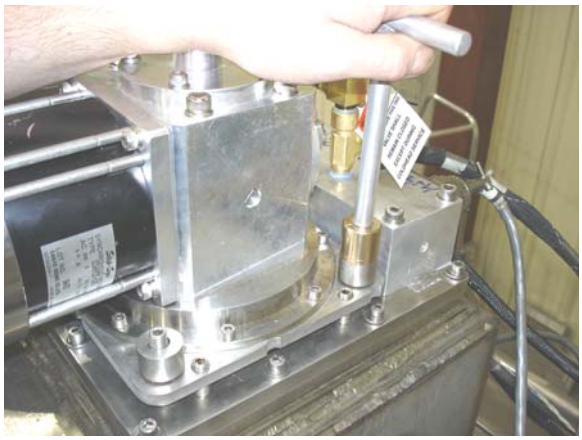
1.0 LIFT THE COLD HEAD

1. Identify whether the mounting flange of the coldhead is square or round.

- If square (below left), go to Step 2;
- If round (below right), go to Step 6 on page 5.







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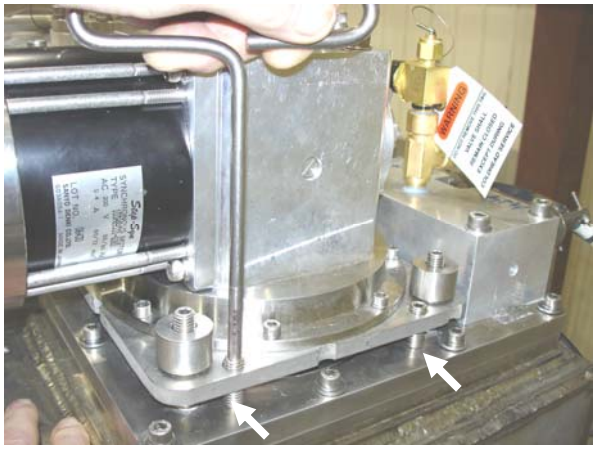
2. Open the (yellow-handled) ¼-turn vent ball valve to relieve magnet pressure.

3. Loosen and remove the four 17mm nuts at the corners of the flange (left).

Use the 17-mm socket tee handle wrench (item #32) provided in the service-tool kit.

Save these nuts for re-use.



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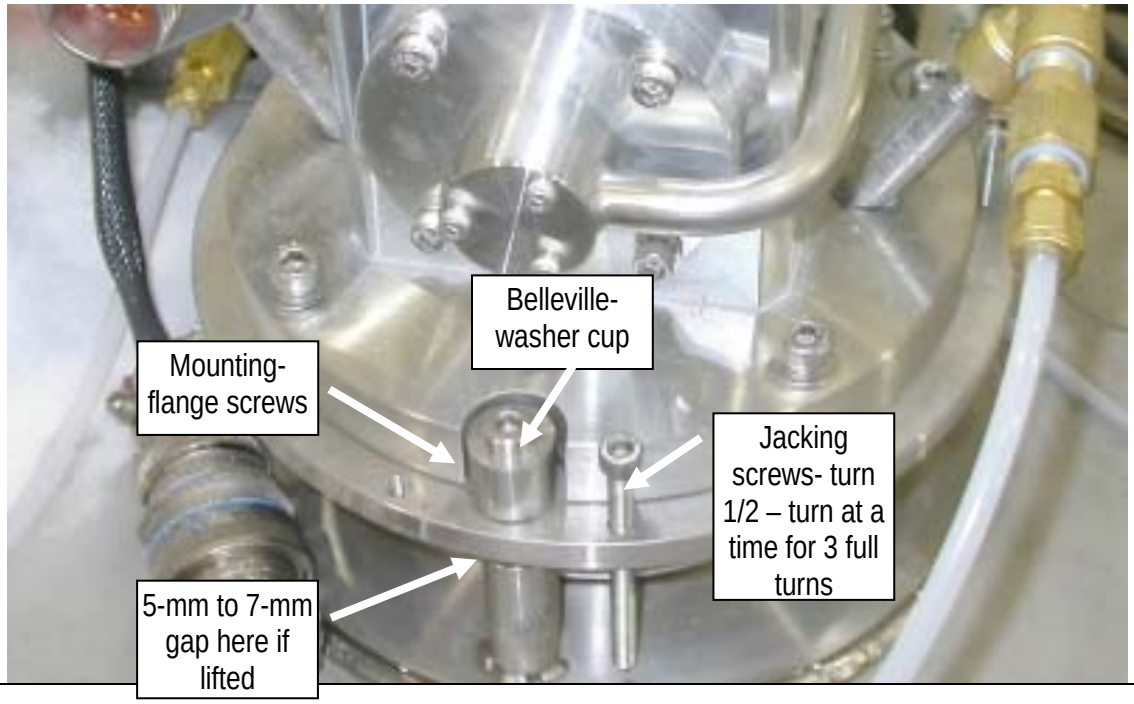
4. Install (4) jacking set screws (item #30) in the threaded holes shown.

Lift the cold head by turning the four jacking screws three full turns clockwise. Use the 5-mm T-Handle wrench (item #15). *Turn all screws until they just touch the lower plate. Then tighten each screw in ½ turn increments* and in a diagonally opposed pattern, until each has been turned 3 full turns.

GO TO SECTION 2.0, "WARM THE COLD HEAD" ON PAGE 5 STEP 9.

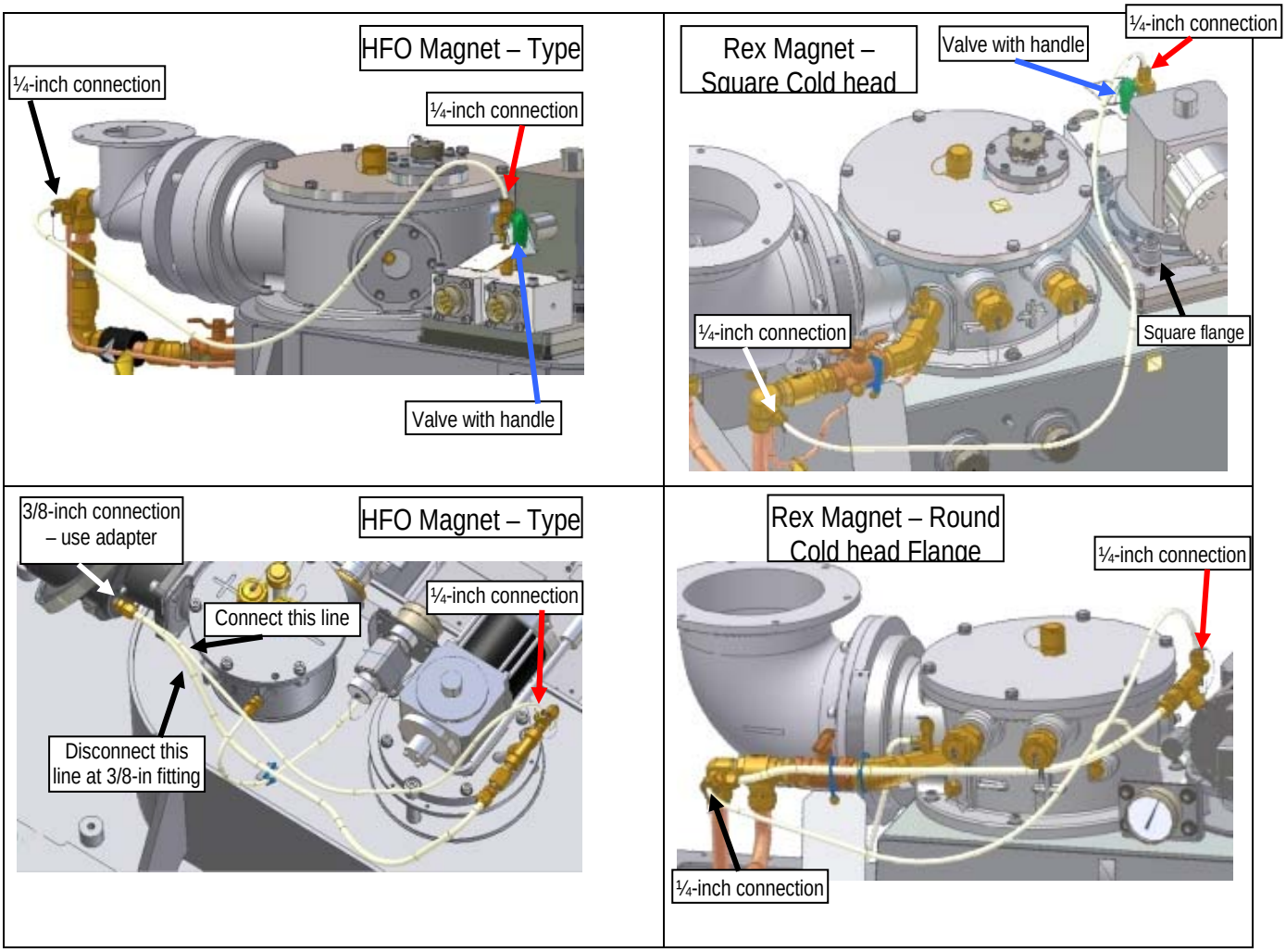


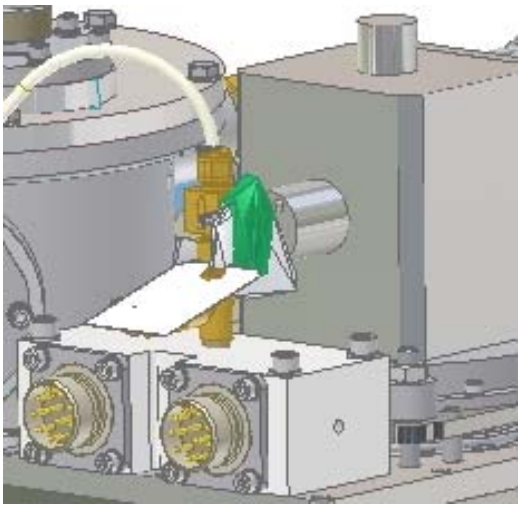
6. Open the (yellow-handled) ¼-turn vent ball valve to relieve magnet pressure.

7. Use the 5-mm T-Handle wrench (item #15) to loosen the three mounting-flange screws. Loosen until the Belleville cup can be lifted above the flange by 5mm to 7mm.

8. Lift the cold head by turning the three jacking screws three full turns clockwise.(If the screws are not already present, install the three screws provided in the kit (item #37). Use the 5-mm non-magnetic T-Handle wrench (item #15). *Turn all screws until they just touch the lower plate. Then tighten each screw in ½ turn increments* and in a circular pattern, six times, until each screw has been turned for 3 full turns..

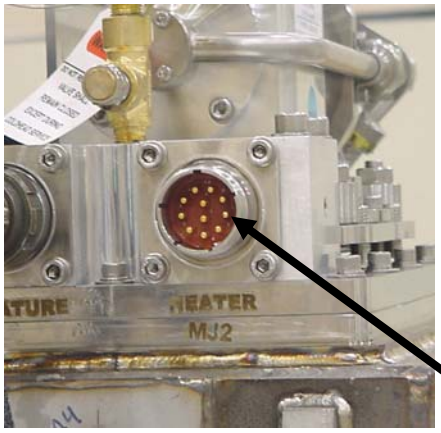
9. Connect the Magnet Vent-down Tubing (Item # 29) as shown below, using adapters as required.





If your magnet has a valve with a handle, (see figures above) open it (give it a ¼ turn, so that the handle points up and down.

2.0 WARM THE COLD HEAD



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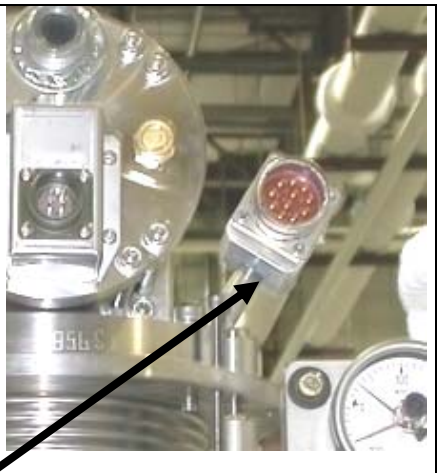
1. Connect the thermo-couple/heater power cable, CM3 (item #4 or #38), *first* to the 11-pin connector MJ2 on the Magnet, and *then* to the CHHC.

Identify your magnet's 11-pin connector type:

Install cable, Item #4, on this type connector.

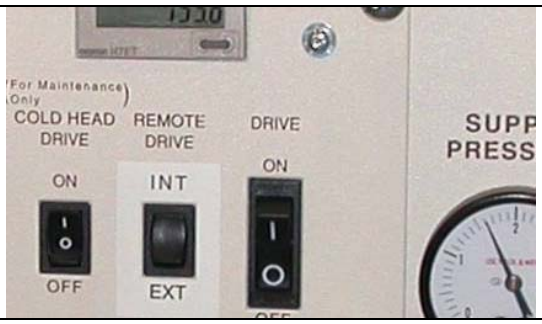
Install cable, Item #4 *or* #38 (whichever fits) on this type connector.



2. Connect the power cable to the cold head if disconnected previously.

2. Access the rear panel of the compressor. Move Cold Head Drive switch to "ON" position. (This will cause the cold head displacer to cycle during the warm-up period.)

Note: The Remote Drive switch remains in the "EXT" position.



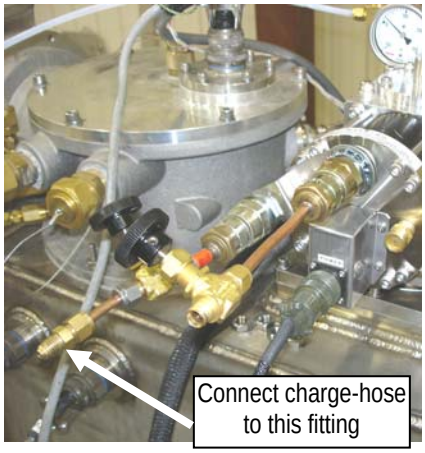
3. Turn the **mains switch** and the **heater power switch** on the CHHC to the "O" (OFF) position.
4. Connect the CHHC mains power cable assembly, item #3 in the 4K cold head service tool kit, to the CHHC and to a 220Vac power source within the instrument room.
5. Turn the **mains switch** of the CHHC to "|" (ON). *VERIFY* that the displayed temperatures, shown in °C, are **approximately** -260°C and -220°C.
6. Turn the **heater-power switch** on the CHHC to "|" (ON). The heat station warm-up time is approximately **45** minutes.
7. Do not proceed until both cold head heat stations have reached 15°C temperature setpoint 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 displacer piston including the internal heat exchangers).

3.0 CHARGE, RUN, AND VENT

CAUTION

VERIFY that only helium gas of 99.999% purity is used. Charging the system with gas of lesser-purity will cause the cold-head to malfunction.

3.1 CHARGE, RUN AND VENT THE COLD HEAD



1. Set the helium-supply pressure regulator to 100 psi (6.9 bar/689.7 kPa). Purge the high-pressure hose (kit item #8) of air with helium gas, then connect the high pressure hose to the charge/vent adapter on the cold head supply fitting, and tighten the connection with an adjustable wrench (kit item #16).
2. Open the valve on the supply fitting to pressurize the cold head to 100 ± 5 psi (6.9 ± 0.34 bar/689.7 ± 34.5 kPa) with 99.999% pure helium gas. Close the supply fitting after the cold head is pressurized.
3. Open the valve on the "Return" fitting, to purge gas through the cold head to approximately 0 psi (0 MPa) (audible). Close the return valve.
4. Repeat steps 2 and 3 twenty (**20**) more times.
5. ***Verify*** that the return valve is closed.
6. Open the valve on the supply fitting to pressurize the cold head to 235 ± 5psi (16.2 ± 0.34 bar/1620.3 ± 34.5 kPa).
7. Close the valve on the supply fitting.

8. Turn off the cold head. Access the switch panel of the compressor. Move cold head drive switch to "OFF" position.

Note: The Remote Drive switch remains in the "EXT" position.

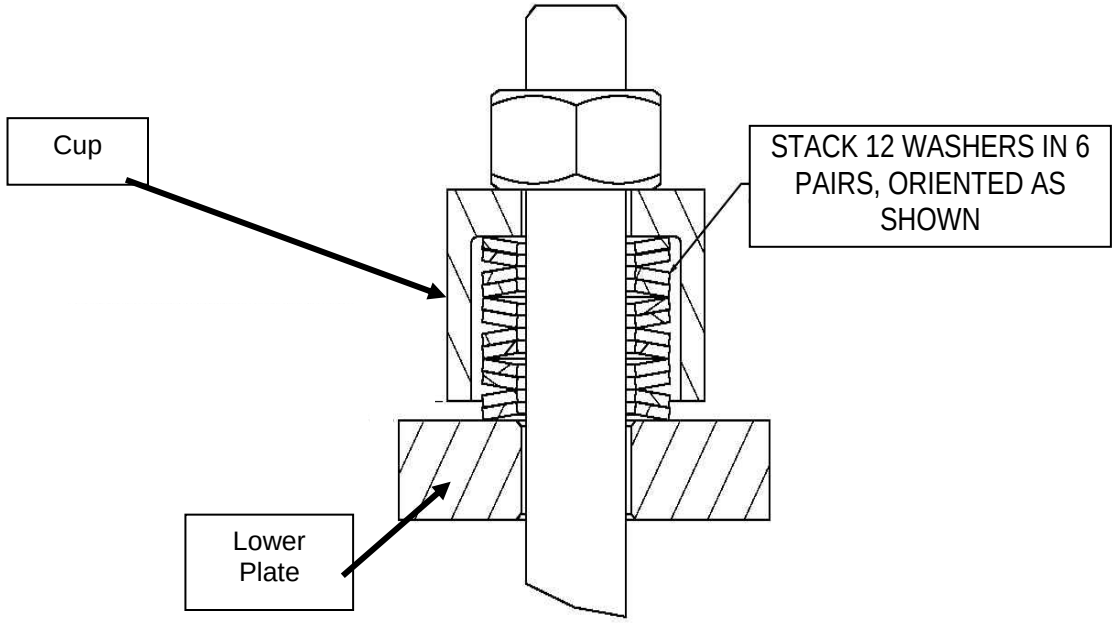
4.0 RESEAT COLD HEAD

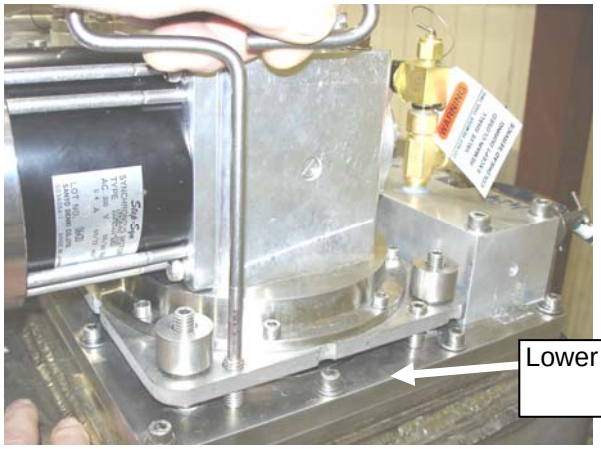
For coldheads with *Square* mounting flange, go to Section 4.1, Step 1, below.

For *Round* flanges, go to Section 4.2, Step5.

4.1 Square flange:

1. If the Belleville washers were removed, re-install them into the cups as shown below.
2. Re-install the 17mm nuts. Hand tight!
3. Turn CHHC heater control switch to the "O" (OFF) position.





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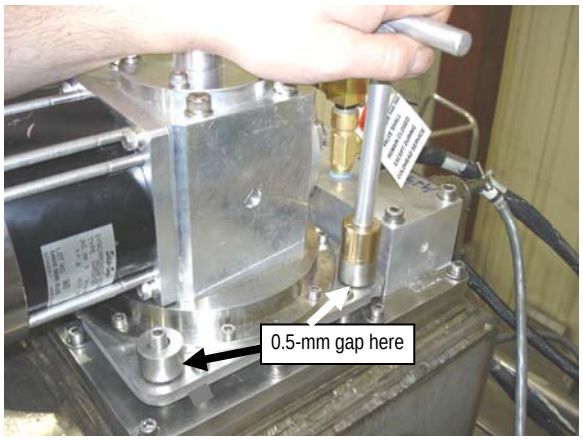
3. Lower cold head by unscrewing the jacking screws.
   - In a diagonal pattern, loosen the jacking screws in ½ turn increments until the screw-ends are clear of the top surface of the lower plate.
   - Remove jacking screws completely from the top plate and return to the tool kit.



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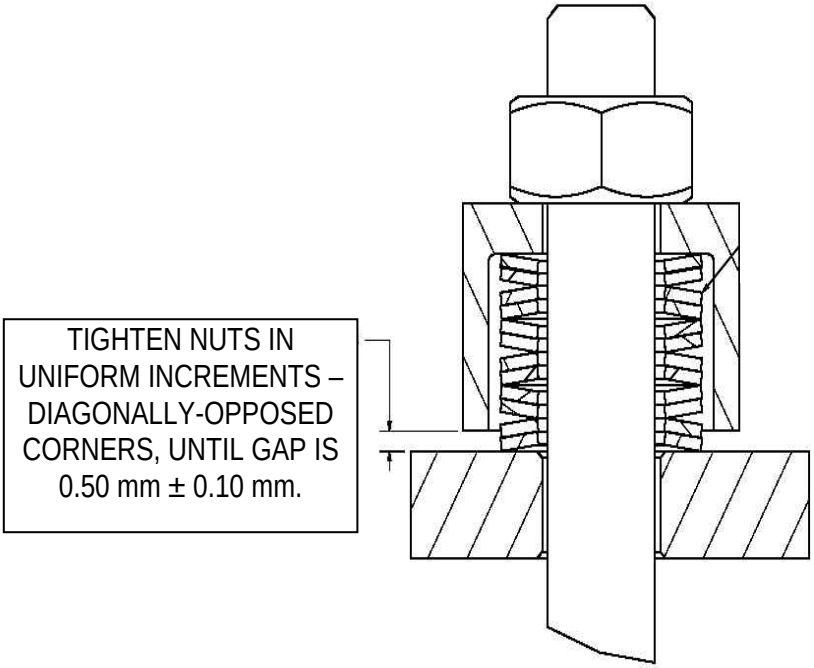
4. Re-seat the cold head.

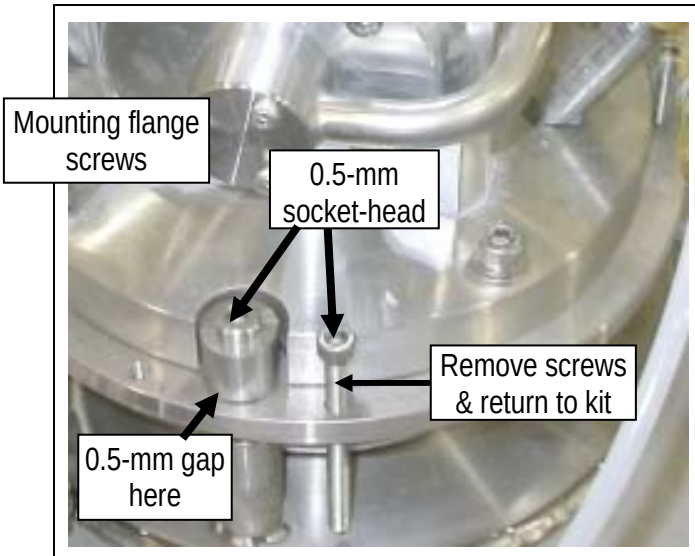
- In a diagonal pattern, evenly tighten the four (4) 17mm nuts in ¼ turn increments. Use the 17-mm socket Tee-Handle wrench (item #32).
- Use a .5-mm (.020 inch) feeler gage (item #31) to measure and set the gap between the bottom of the cup and the top of the lower plate as shown.

IMPORTANT: Note temperature of first stage on controller. Temperature should drop abruptly (to less than -100 C) when proper seating contact is made.

IMPORTANT: Verify and reset the 0.5 mm gaps, after a One-Hour Waiting period.



4.2 Round flange:



IMPORTANT: Note temperature of first stage on controller. Temperature should drop abruptly (to less than -100 C) when proper seating contact is made.

Turn CHHC heater control switch to the "O" (OFF) position.

1. Lower cold head by unscrewing the jacking screws.

- In a circular pattern, loosen the jacking screws (5-mm key wrench #15 or #12) in ½ turn increments until the screw-ends are clear of the top surface of the lower plate.
- Remove jacking screws completely from the top plate and return to the tool kit.

2. Re-seat the cold head.

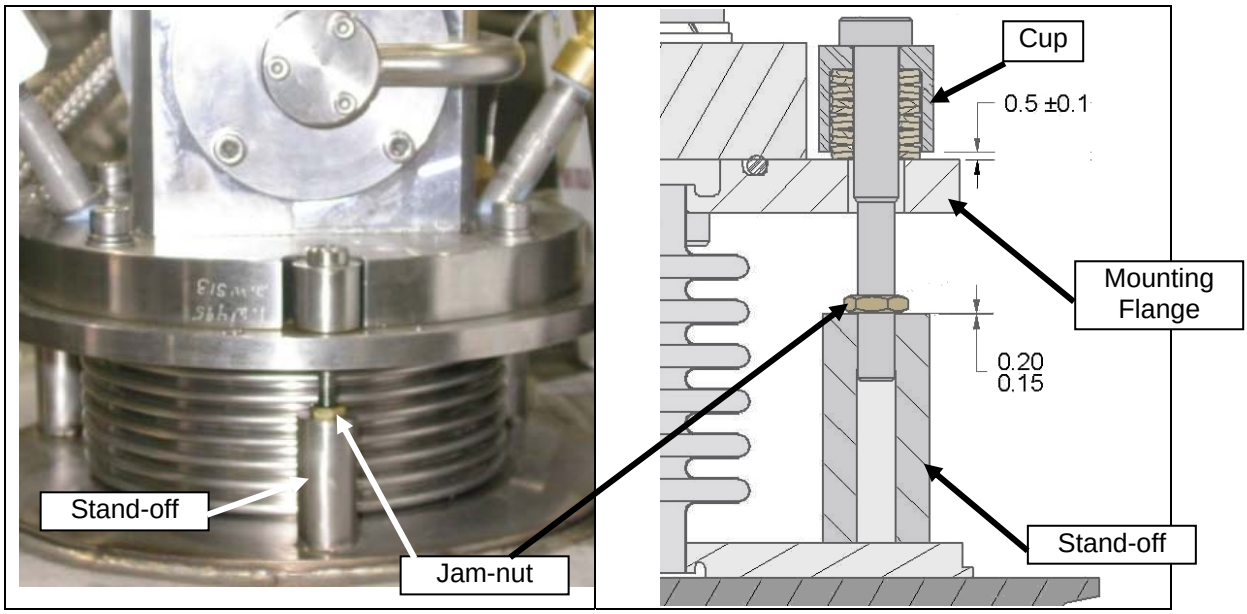
- In a diagonal pattern, evenly tighten the three mounting flange screws. Use the 5-mm T-handled wrench (item #15).
- Use a 0.5-mm (.020 inch) feeler gage (item #31) to measure and set the gap between the bottom of the cup and the top of the lower plate as shown.
- If the gap cannot be reduced to 0.5-mm, go to Section 4.3.

IMPORTANT: Verify and reset the 0.5 mm gaps, after a One-Hour Waiting period.

4.3 Configuration #1(with M6x1 Jam Nuts) - Re-positioning the Jam-Nut.

IMPORTANT: Verify and reset the 0.5 & 0.2-mm gaps, after a One Hour Waiting period.

If the screw cannot be tightened enough to make the 0.5-mm gap below the Belleville-washer cup, the jam-nut on the screw shaft may have been moved when the screw was loosened (Section 1.0, step 6, on page 4). This nut must be re-positioned.



1. Hold the screw in position with the 5-mm wrench. With an open or an adjustable wrench, turn the jam nut so that it moves up on the screw shaft.
2. Tighten the screw until the 0.5-mm gap below the cup is set, using the feeler gauge (Item #44 in the tool kit).
3. Hold the screw in position, and turn the jam-nut so that it moves down on the screw shaft until it reaches the top of the stand-off. Set the gap between the nut and the stand-off to 0.15 – 0.20 mm using the feeler gauge (6 – 8 mils) (Item #43 in the tool kit).
4. Re-check the 0.5-mm gap between the cup and the mounting flange.

IMPORTANT: Verify and reset the 0.5 mm gaps, after a One-Hour Waiting period.

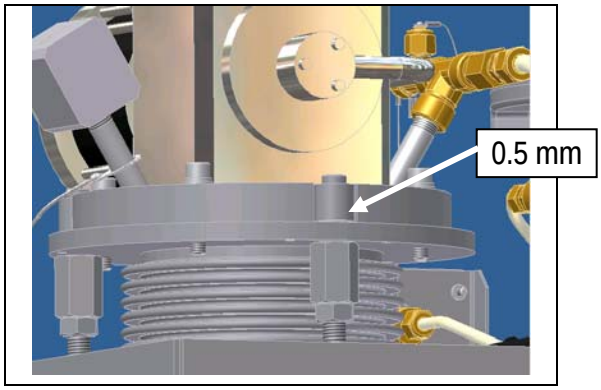
4.4 Configuration #2(with M12x1.75 Coupling Nuts) - Setting 0.5mm Gaps.

The figure to the right shows **Configuration #2** with the M12x 1.75 Coupling Nut and Jam Nut.

The coupling nut and jam nuts *will not need adjustment,* unless the coldhead is replaced.

If the coldhead is replaced, instructions for adjusting these nuts will be provided with the new coldhead.

IMPORTANT: Verify and reset the 0.5 mm gaps, after a One-Hour Waiting period.



5.0 REMOVE TOOLING & CHECK SYSTEM

The cold head will begin to cool as soon as it is re-seated, and the final charge pressure of 235 psig will drop.

1. After re-seating, wait 15 minutes, and then turn the cold head Drive Switch to "ON", and then re-charge the cold head to 235 psig.

2. Repeat the re-charge procedure until a stable pressure (after a one-hour wait) of 190 psig to 235 psig is achieved. Then do the following:

3. Turn the cold head Drive Switch to "OFF"

4. Shut off the helium gas supply, and then disconnect the high-pressure hose from the "Supply" charge/vent adapter.

5. Remove the charge/vent adapters from the "Supply" and "Return" fittings on the cold head using the two-wrench technique.

6. Shut off the CHHC main switch.

7. Close the yellow-handled ¼-turn vent ball valve.

8. Inspect and clean the gas-line Aeroquip fittings.

9. Reconnect the supply and return gas lines to the cold head using the two-wrench method.

10. Leave the compressor off, until the pressure in the magnet reaches 60 hPa, then leak-check all fittings and O-ring joints.

11. With the compressor off, check the compressor-pressure gauge. Verify that the pressure reading is in the range 1.6 MPa to 1.8 MPa. If the pressure is outside that range, proceed as follows:

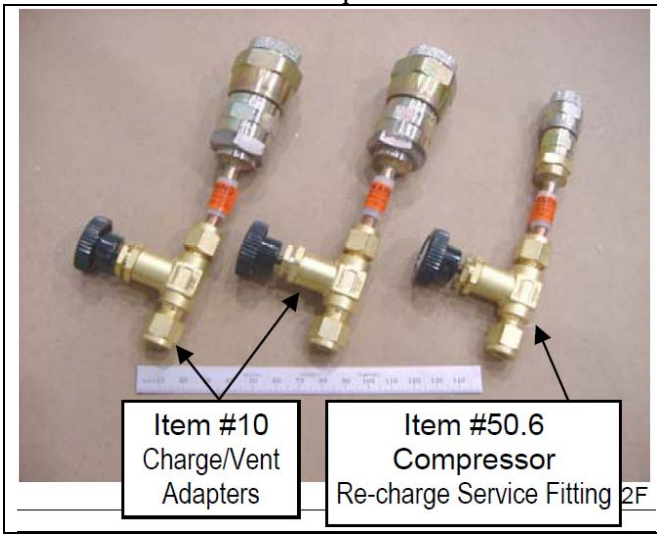
- Connect the compressor charge/vent tool (Item #50.6 from the kit) to the He-gas charge connector on the compressor.
- If the pressure is too high, bleed some gas from the compressor by opening the valve slightly, until the pressure is within range.
- If the pressure is too low, add some gas from the high-pressure gas bottle using the high-pressure hose.

  CAUTION - Verify that only helium gas with purity of 99.999% is used. Charging with improper gas will cause the cold head to malfunction. The charging line must be properly purged of air, using helium gas, before connection to the charge/vent tube.

12. Restart compressor by turning the compressor main switch on the front panel of the compressor to the "|" (ON) position.

6.0 Gas clean-up of compressor and Gas Lines

The recirculated helium gas within the refrigeration system normally remains pure and clean. However, under certain abnormal conditions, gas contamination may occur. (A gas contaminant is defined as any gas in the refrigeration system other than helium.) These abnormal conditions occur very infrequently. Any gas contamination within the refrigeration system will be collected within the cold head. This occurs because the cold temperatures within the cold head freeze out all contaminant gases and the frozen molecules are trapped on cold surfaces within the cold head. Usually, gas clean-up of only the cold head effectively cleans the entire refrigeration system.
If it is decided to also clean up the compressor and gas lines, the following procedure may be followed.
Note: Following the procedure below, requires tooling items found in the Refrigerator 4K Cold Head Service Tool Kit code number 4522 150 42712. See documented Cold Head procedure 49011. Three items from this kit are required.



One charge vent adaptor is needed.

The compressor re-charge service fitting is needed.

	High Pressure Hose is needed. (item 8 as described in 49011)

A high pressure helium gas cylinder with high pressure regulator is also required. **VERIFY** that the gas is helium with a purity level of 99.999%.

CAUTION

This procedure should only be carried out on a compressor that has been operating normally for at least one hour.
This procedure should NOT be carried out on a compressor that has been "off" for more than 1 hour.

The procedure below depressurizes the compressor and one gas line at a time.
Depressurization takes place ONLY through the Charge/Vent Adaptor mounted to the supply fitting on the compressor front panel.
Pressurization takes place ONLY through the Compressor Recharge Service Fitting mounted on the compressor front panel.

1. Shut off the compressor.
2. Attach the compressor re-charge service fitting to the front panel of the compressor. (Valve closed)
3. Attach the high pressure gas hose to the high pressure regulator on the helium gas cylinder and connect the hose to the compressor re-charge service fitting. (Valve closed)
4. Detach gas lines from cold head.
5. Detach the supply gas line from the front panel of the compressor.
6. Attach a charge vent adaptor fitting to the male SUPPLY fitting on the front panel of the compressor. (Valve closed)
7. Open the valve on the charge vent adaptor fitting and depressurize the compressor and attached gas line. Depressurize to approximately 0.1 Mpa. Close the valve on the charge vent adaptor.
8. Re-pressurize compressor and attached gas line via the compressor re-charge service fitting valve. Pressurize to 1.65 Mpa.

9. Repeat steps 7 and 8 five times.

10. Next, switch the gas lines at the compressor front panel. Temporarily, attach the SUPPLY gas line to the RETURN gas line fitting on the compressor front panel.

11. Repeat venting and charging per steps 7 and 8 five more times.

12. Return system to run condition.
    - Remove the charge/vent adaptor from the supply fitting on the front panel of the compressor.
    - Attach gas lines properly to the front panel of the compressor. SUPPLY to SUPPLY and RETURN to RETURN.
    - Attach gas lines properly to the cold head.
    - Adjust compressor pressure to 1.65 MPa if required.
    - Remove the compressor re-charge service fitting from the front panel of the compressor
    - Remove high pressure hose from adaptor and cylinder regulator.

13. Procedure complete.

14. Turn on compressor and cold head.

15. Turn-ON mains-power to the RMMU OR re-connect DC power to connector MJ-X1 on the MEU.

Procedure Complete