

# SECTION 10 - MAGNET AND CRYOGENS

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**10-5-1 CHECK CRYOGEN LEVELS (PHONE SITE FOR INFO)**

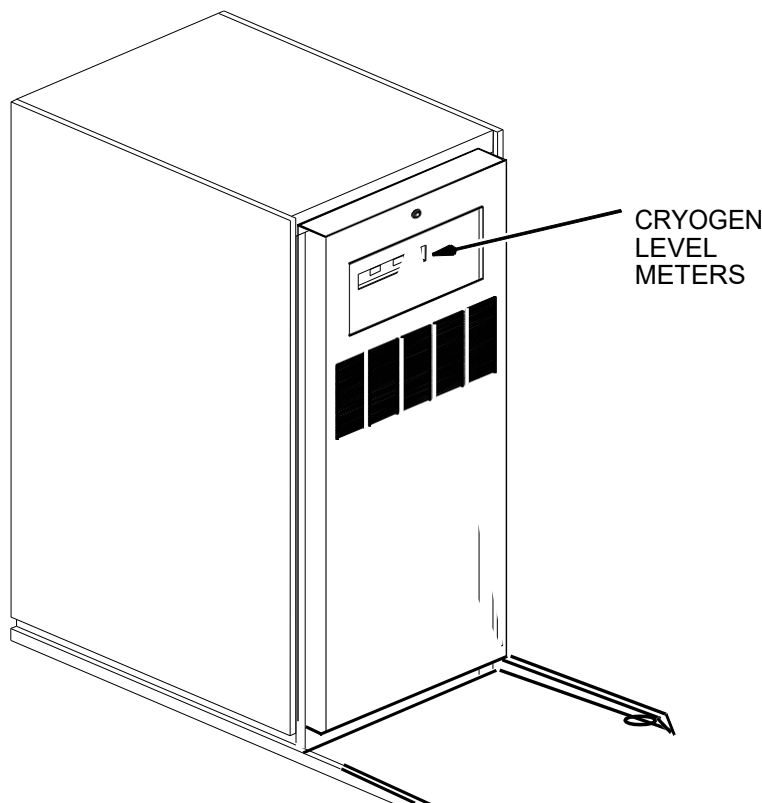
Magnet PM data recording serves to build up a history or trend of magnet operating parameters. This data is extremely useful in identifying symptoms and diagnosing magnet problems.

Throughout the PM procedure you will be asked to record data onto the Magnet PM 4 X Year schedules (Direction 2215703). This data becomes part of our presentation to the customer of our fulfillment of GE’s promise to perform per the Magnet Service Agreement. You may want to log this same data on the Cryostat Performance Log (Table 10-1) so you can see trends in magnet performance at a single glance instead of sorting through the collection of PM Reports.

Future revisions to this manual will incorporate changes as they are developed. With this in mind don’t hesitate to offer your feedback on how we can further optimize the Magnet PM procedure. You may send your ideas to the On Line Center (OLC) Magnet Support Group at 1-800-321-7937.

Illustration 10-1 shows location of Cryogen Level Meter in System Cabinet.

- For GE magnet, go to Section 10-1-1.
- For Oxford magnet, go to Section 10-1-2.



**SYSTEM CABINET**  
 ILLUSTRATION 10-1

**10-1-1 GE Magnets**

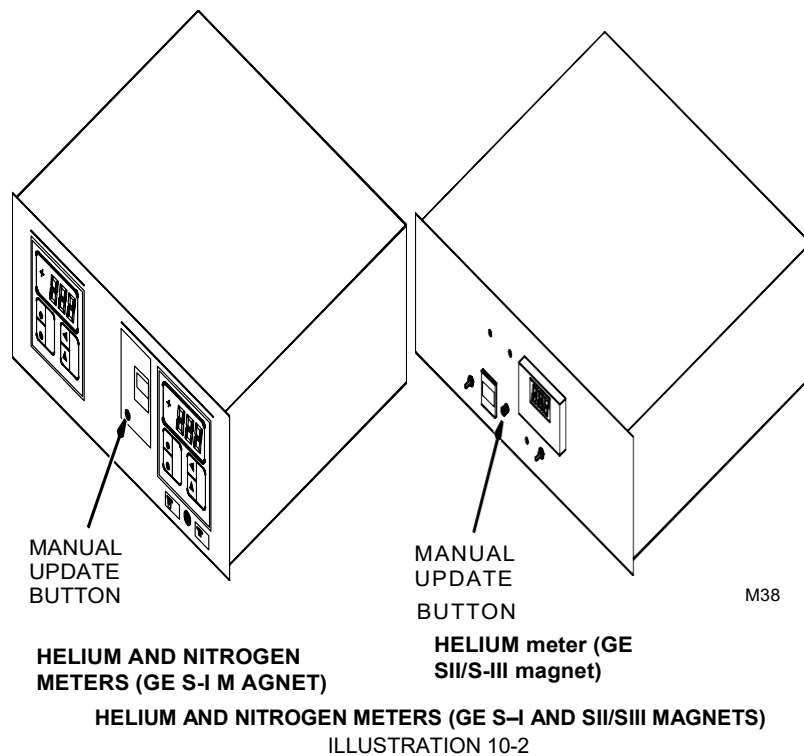
1. Turn ON power to meters.
2. Press MANUAL UPDATE button for current helium level reading. See Illustration 10-2.

**Note**

The GE Magnet Helium meter is available in two models, AMI Model 133G and 111GE. Located in the Systems Cabinet. See Illustration 10-1.

In AMI Model 133G: Press MANUAL UPDATE button, the meter reading starts initially at 100% and decrements until a stable reading is realized. The meter continues to display the level reading until the button is pressed again or until power is removed from the meter.

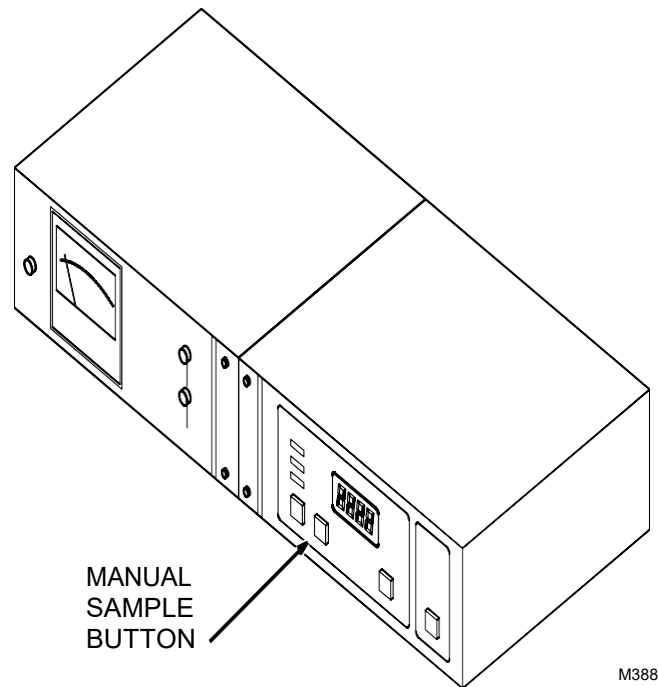
Model 111GE: Operator must press and hold the button until the reading decrements from 100% to stable reading. The reading disappears as soon as the button is released so the operator must take note of the meter display prior to releasing the MANUAL UPDATE button.



3. Record nitrogen (GE S-I only) and helium level readings on PM Report and the Cryostat Performance Log.
4. If this is a Keep Cold or Non Keep Cold site without an EDM4 or if the EDM4 is out of service, report levels weekly by phoning site for info.

**10-5-1 Oxford Magnets**

1. Turn ON power to meters.
2. Plug in nitrogen meter power cord.
3. Press MANUAL SAMPLE button for a current helium level reading. See Illustration 10-3.



**HELIUM AND NITROGEN METERS (OXFORD MAGNET)**  
 ILLUSTRATION 10-3

4. Record nitrogen and helium level readings on Signa PM Report and the Cryostat Performance Log.

**Note**

When finished recording cryogen levels, make sure power is removed from nitrogen meter. Otherwise, it will cause system artifacts.

5. Unplug nitrogen meter power cord.
6. If this is a Keep Cold or Non Keep Cold site without an EDM4 or if the EDM4 is out of service, report levels weekly by phoning site for info.

**10-5-1 CALCULATE CRYOGEN BOIL-OFF RATES & RECORD COMPRESSOR RUN TIMES (PHONE SITE FOR INFO)**

Boil-off rate is the top level test of the magnet system. It is the first indication of trouble in:

- **Magnet**
- **Cryogen meters**
- **Cold-head subsystems**
- **Transfill line**
- **Baffle condition**
- **Cryogen handling**
- **Magnet vacuum/P3 Plug vacuum**

**Note**

Review any abnormal trends (good or bad) with your MAC TEAM leader or to the Magnet Support Line at OLC, 1-800-321-7937. OLC Magnet Support is available 24 hr./day in case you need to talk over magnet related situations.

1. Review cryogen level readings recorded on Site Logbook, the Site Cryogen Logbook, or the Cryostat Performance Log (See Table 10-1 in this section.) Calculate the magnet boil-off rate using the Laptop Boil-off Calculator Program. The boil-off specification for each magnet type is automatically reported on the Boil-off Calculator. For better accuracy, be sure to enter the hour of the readings when calculating boil-off rates using reading intervals shorter than 10 days apart.

**Note**

Contact your MAC Team representative for help if you are not familiar with using the Laptop Boil-off Calculator.

2. Record average boil-off rate on Magnet PM Report 4 X Year schedules (Direction 2215703). Also make a copy of Table 10-1 and use it for recording magnet parameters such as cryogen boil-off rates and for keeping current copies in the Site Logbook. This information will help you detect changes in boil-off rates, coldhead temperature performance and other magnet parameters. Changes in any of these parameters will give you advance warning of potential magnet problems. The reason for recording this data is to establish trends and will help you to diagnose causes for future changes in Helium boil-off performance.
3. Compare calculated boil-off rate with the specification reported for your magnet type on the Laptop Boil-off Calculator. Notify the site responsible FE or the MAC Team Leader if an increasing trend in the boil-off rate is detected. Escalate sudden changes in boil-off rate for immediate service.

**Note**

With Oxford Magnets, check for potential causes, such as, ice build up within service turret. Refer to Appendix I.

**10-5-1 CALCULATE CRYOGEN BOIL-OFF RATES & RECORD COMPRESSOR RUN TIMES (PHONE SITE FOR INFO) (continued)**

**Note**

Mobile magnets will usually exceed nominal boil-off specifications unless they are stationary and the current probe is removed. In stationary applications mobiles will perform as well as the better fixed-site magnets. There are no standard boil-off specs for mobiles as the boil-off rate is impacted by:

- **Number of moves per week**
- **Number of magnet ramps per week (Oxfords)**
- **Number of miles per week**
- **Driving habits of van driver**
- **Length of time shield coolers are without power**
- **Altitude differences encountered over routing**

**Note**

Establish an average boil-off for a particular route and compare future calculations against this average.

**Note**

For Magnets with Liquid Nitrogen cooled heat shields (Fixed Oxfords & GE S-1's) the nitrogen boil-off rate will usually vary inversely with helium boil-off rate. It is not unexpected, for example, to have the nitrogen boil-off rate increase after an excessive helium boil-off problem is corrected.

4. Record current shield cooler compressor(s) Hour Meter reading(s) onto Cryostat Performance Log (Table 10-1) along with the date and hour of the reading. Calculate the difference between current Hour Meter reading/s and the previous Hour Meter reading(s) using the Laptop Boil-off Calculator Program and enter it on Cryostat Performance Log as the "Compressor Run Time."

The meter reading should be 168 hours for a 7-day interval. Determine and correct any problems in the shield cooler system that could lead to system downtime as soon as possible in order to minimize cryogen losses. Should the reason for lapses in the compressor operation be in the arena of Customer responsibility, escalate those issues to the Customer for resolution. For magnets with one or two-shield cooler systems, lapses in system operation will cause extra losses of cryogen that are not necessarily covered by GE under the Magnet Service Agreement.

**10-5-1 CALCULATE CRYOGEN BOIL-OFF RATES & RECORD COMPRESSOR RUN TIMES (PHONE SITE FOR INFO) (continued)**

TABLE 10-1  
 CRYOSTAT PERFORMANCE LOG

<b>CRYOSTAT PERFORMANCE LOG</b>												
(COPY THIS TABLE FOR USE IN SITE MANUAL)												
CUSTOMER: _____						<b>SHIELD COOLER SYSTEM TYPE</b>						
SYSTEM I.D.: _____						CIRCLE ONE						
FIELD ENGINEER: _____						CTI	BALZERS	LEYBOLD				
ASPEN #: _____						<b>KEEP COLD SITE</b>						
MINIMUM HELIUM LEVEL _____ %						YES						NO
MINIMUM NITROGEN LEVEL _____ %						<b>KEEP COLD SITE ID</b>						
<b>DATE:</b>												
<b>TIME:</b>												
Front Compressor Run Time (should = 168hrs. per week)												
Rear Compressor Run Time (should = 168hrs. per week)												
Date of last helium fill/ nitrogen fill												
Present Lhe level (0 to 100%)												
Lhe fill start/stop levels (0 to 100%)												
Present LN2 level (0 to 100%)												
LN2 fill start/stop levels (0 to 100%)												
He vessel pressure (typical = 0.5psi)												
F1 Flow = ____ scfh												
F2 Flow = ____ scfh												
1 <sup>st</sup> stage temp (mv or K) (typical = 40 to 58K)												
2 <sup>nd</sup> stage temp (mv or K) (typical = 10 to 19K)												
Compressor pressure (psi) Supply or Front CTI												
Compressor pressure (psi) Return (Balzers only) or Rear CTI												
Compressor (Front) Hour Meter Reading (hrs)												
Compressor (Rear) Hour Meter Reading (hrs)												
Calculated Helium Boil-off Rate												
Calculated Nitrogen Boil-off Rate												

**10-5-1 EVALUATE CRYOGEN DELIVERY SCHEDULE (IF APPLICABLE)**

1. Site Engineers are responsible for having cryogen levels monitored and reporting to the GE mainframe magnet monitoring system at least every 7 days or more often. All data collected is transferred to Air Products daily. Air Products uses this information to determine the logistics necessary to schedule cryogen availability and deliveries. This process insures Keep Cold magnets are maintained above critical cryogen levels. For magnets filled directly by GE FE's, use the following procedure to evaluate if the cryogen level in the magnet will suffice until the next scheduled cryogen delivery. Reschedule the next cryogen fill should the calculation indicate the cryogen levels will fall below critical levels prior to the next scheduled fill.
  
2. Use boil-off calculator to evaluate cryogen delivery schedule as follows:



**In order to reduce the potential for a magnet quench and maintain cryogen boil rates at specification levels, cryogens must be replenished before cryogen fluid levels drop to critical minimum levels. New minimum target levels are being established for specific sites that qualify so you should consult with your MAC Team Leader for the minimum levels for your site, then enter it on the Cryostat Performance Log in Table 10-1 and also enter it on the Site Cryogen Log. Standard cryogen refill target levels remain at 55% for helium and 25% for nitrogen except for GE S-IV Magnets. Use 70% as the minimum level for the GE S-IV Magnet. These levels should be used for calculating cryogen delivery schedules.**

- a. Enter current cryogen levels along with current date and time.
  
- b. Enter the minimum target refill level along with the next scheduled cryogen delivery date.
  
- c. Compare the calculated boil-off rates with current boil-off rate performance.
  - **If the calculated boil-off rate is higher than the current trend (worse) the scheduled delivery date is OK.**
  - **If the calculated boil-off rate is lower than the current trend (Better than) the scheduled delivery date will have to be changed so cryogens can be loaded before the magnet reaches critically low cryogen levels.**

10-5-1 EVALUATE HELIUM TRANSFILL EFFICIENCY (IF APPLICABLE)

**Note**

Assuming a good transfer line and proper transfer pressure are used, poor transfill efficiency can be an early indication of a number of magnet-related problems inside magnet (such as ice build-up).

1. Check Site Log for frequency of cryogen transfills. Look for a change in transfill schedule. If transfills are occurring more frequently, find out why.
2. Check helium meter level change for each dewar. Average transfill from a 250 liter dewar should increase helium level 23% to 25% (~1000 liter cryostat magnets). Enter average transfill efficiency on PM Report. If transfill efficiency changes suddenly or is **not** to this level, find out why.

**Note**

Some sites cannot meet recommended transfill efficiencies because of known circumstances, such as cryogen losses in the dewars prior to delivery to the site. Extended transport distance or long storage times will reduce the amount of cryogen remaining in the dewars for transfilling into the magnet and reduce the apparent transfill efficiency. For these sites review your average transfill efficiencies with your MAC TEAM Leader to establish a "Normal Target." Use variations from the norm as indicators of possible magnet problems.

3. If transfill information is **not** being entered in Site Log, contact cryogen loader. Cryogen loader should be entering the following information into Site Log:
  - **Amount of cryogen transfilled**
  - **Before and after meter readings**
  - **Date of fill**
  - **Any abnormalities or problems**

**10-5-1 VERIFY CRYOGEN METER CALIBRATION – GE MAGNETS**

**10-5-1 Calibrating AMI Model 130A Helium Meter (S-1 Meter)**

The following calibration procedure is used for helium meters used on GE magnet models S1. This calibration procedure is for calibrating the helium meter only. There is no calibration or adjustment on the helium sensor probes.

Contact the MAC Team Representative, Region Service Engineer, or the On Line Center if helium level sensor problems are encountered during calibration.

**Procedure:**

Make sure helium meter assembly is installed in the Signa Systems cabinet per procedures in Magnet Subsystems CD ROM, *Direction 2180500-1, GE 1.5T S-I Magnet & Cryogenics, Set Up and Calibrations Tab, Magnet System Installation/Checks, Section 2-1-5.*



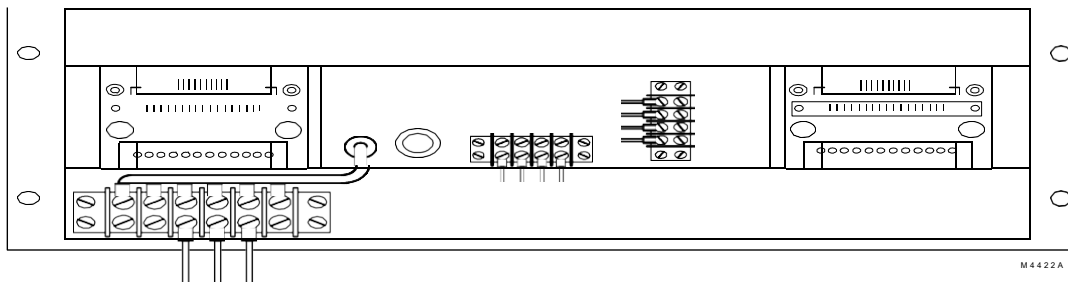
**Verify meter is wired for the proper line voltage available at the site. For SIGNA, line voltage is 115 VAC. For International installations, verify power input at site. Reference the vendor manual if line voltage set-up is required.**

**Resistance/Continuity Checks**

**Note**

This section is to verify there are no shorted wires in the helium circuit cabling from the meter to the sensors within the magnet.

1. Disconnect cable P101 (25 pin “D” connector) from back panel of Cryogen Meter Assembly. See Illustration 10-4.



**HELIUM METER (Rear View)**  
 ILLUSTRATION 10-4

**10-5-1 Calibrating AMI Model 130A Helium Meter (S-1 Meter) (continued)**

**Resistance/Continuity Checks (continued)**

2. With an ohmmeter, check for open circuit on P101, pin 11 to system cabinet ground. P101 is the cable that is going to the magnet.
3. Similarly, verify open circuit on P101, pins 13, 23, 25 to system cabinet ground. If any wire measures 0 ohms ground, troubleshoot the problem.
4. Disconnect cable P403 from the present helium sensor, and reconnect to the other sensor at the Magnet Terminal Box located on rear side of magnet.
5. Perform Steps 2 and 3 for second sensor.

**Note**

If both sensors have the same “incorrect” resistance readings, the problem is likely to be the P403 cable. If the readings are different, the problem is likely to be within the magnet, or from the Magnet Terminal Box to the magnet penetration.

6. Disconnect P403 from Magnet Terminal Box located on rear side of magnet.
7. With an ohmmeter, check pin-to-pin resistance for all pins on P403. All should read an open circuit.
8. Reconnect J101 to P101 at rear of Cryogen Meter Assembly.

**Current Calibration**

**Note**

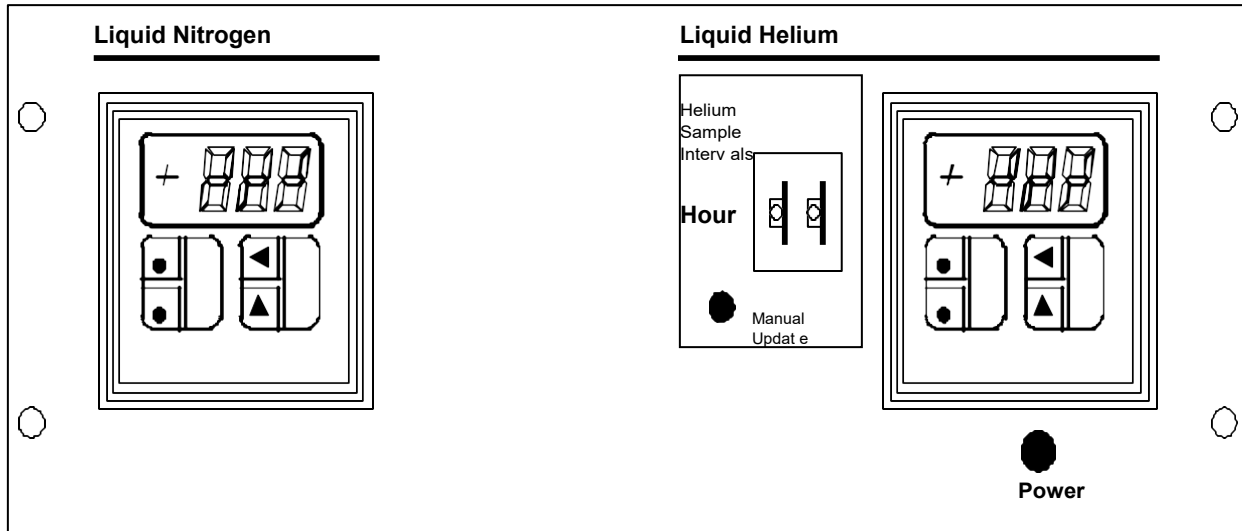
This section will check for a minimal 75 mA out of the meter required for proper operation of the sensors.

1. Connect the helium calibration box (46-265286G1) to P403 at the cable end, which connects to the Magnet Terminal Box.
2. Adjust calibration box to “0” ohms by connecting ohmmeter to meter jacks on calibration box, push and hold the momentary button, then adjust the variable resistor for “0” ohms. This will simulate a full cryostat or 100% helium reading.
3. Disconnect the red wire going to the SENSOR terminal strip (+) on rear panel of Cryogen Meter Assembly.
4. Place a current meter in series from SENSOR terminal strip (+) where the red wire was removed to the red wire.

10-5-1 Calibrating AMI Model 130A Helium Meter (S-1 Meter) (continued)

Current Calibration (continued)

- Turn helium meter on and set the Helium Sample Interval Thumbwheels to “99”. Allow meter to warm up for 15 minutes. See Illustration 10-5.



HELIUM METER (Front View)  
 ILLUSTRATION 10-5

- Set the Helium Sample Interval Thumbwheels to “00”.
- Verify 75 mA,  $\pm 1$  mA on current meter.
- Re-adjust calibration box for “686” ohms using the same adjustment method as in Step 2 above. This will simulate an empty cryostat.
- Verify circuit current between SENSOR terminal strip (I+) to the red wire is still 75 mA. If the reading is more than 5 mA **less than** the current set in Step 7 (75 mA), the constant current source in the helium meter may be faulty under loaded conditions and the meter should be replaced.
- Reconnect red wire to SENSOR terminal strip (I+) on rear of Cryogen Meter Assembly.

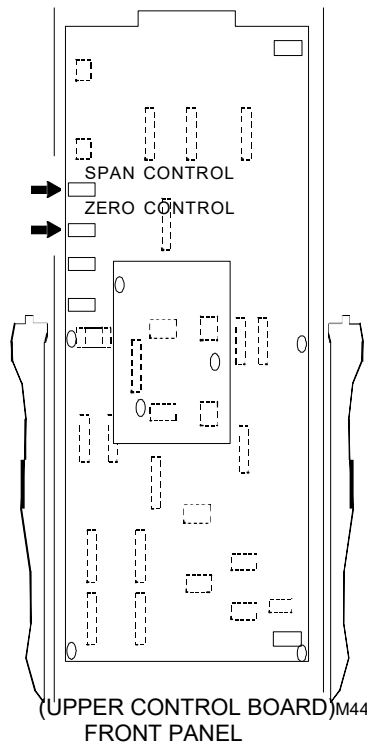
**10-5-1 Calibrating AMI Model 130A Helium Meter (S-1 Meter) (continued)**

**Meter Calibration**

**Note**

This section will adjust the display and recorder output for proper output with a given input.

1. With the Helium Sample Interval Thumbwheels set to "00" (continuous) and "686" ohms on the calibration box, adjust the "ZERO" control pot found on the Upper Control Board for a reading of "0.0" on the Analogic Monitroller display. See Illustration 10-6. (The Upper Control Board is located on the tray between the Nitrogen and Helium Analogic display modules.)



**HELIUM METER CIRCUIT BOARD**  
 ILLUSTRATION 10-6

2. Meter Calibration Re-adjust calibration box for "0" ohms.
3. Adjust "SPAN" Control pot located on the Upper Control Board for a reading of "100.0" on the Analogic Monitroller display.
4. With a voltmeter on TB1 ANALOG (+) and TB1 BOARD REF (-), adjust the "REC METER ADJ" pot on the Upper Control Board for 0.1 volt.
5. Re-adjust calibration box for "343" ohms.

### 10-5-1 Calibrating AMI Model 130A Helium Meter (S-1 Meter) (continued)

#### Meter Calibration (continued)

6. Adjust "SPAN" Control pot located on the Upper Control Board for a reading of "50.0" on the Analog Monitroller display.

**Note**

It is necessary to re-check all settings because "ZERO" and "SPAN" control pots are interactive.

7. Re-check the 0%, the 100%, and the 50% settings with the appropriate resistance dialed into the meter calibration box.
8. Re-verify Recorder Output of 0.1 volt on TB1 ANALOG (+) and TB1 BOARD REF (-) with "0" ohms on calibration box.
9. Return the Helium Sample Interval thumbwheels to desired setting. Recommend "24".
10. Reconnect helium cable to desired sensor.



### 10-5-2 Calibrating AMI Model 133GE Helium Meter (S2/S3/S4/S5/SX/MAX/CX)

#### Description:

The following calibration procedure is used for helium meters used on GE magnet models S2/S3/S4/SX/MAX. This calibration procedure is for calibrating the helium meter only. There is no calibration or adjustment on the helium sensor probes.

Contact the MAC Team Representative, Region Service Engineer, or the On Line Center if helium level sensor problems are encountered during calibration.

#### Procedure:

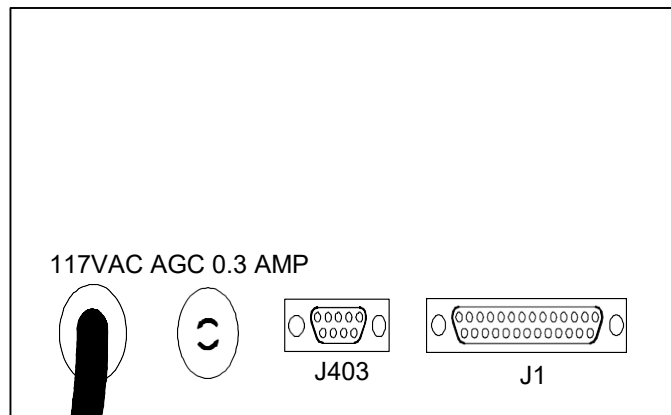
Make sure helium meter assembly is installed in the Signa Systems cabinet per procedures in Direction 15100, Signa Installation (3.x); or Direction 15306, Signa Advantage Installation (4.x); or Direction 15406, Signa Advantage 1.5T Installation (5.x).



**Verify meter is wired for the proper line voltage available at the site. For SIGNA, line voltage is 115 VAC. For MAX, line voltage is 100 VAC. For International installations, verify power input at site. Reference vendor manual for line voltage set-up if required.**

#### Resistance/Continuity Checks

1. Disconnect cable P403 from back panel of helium meter. See Illustration 10-8.



**CRYOGEN MONITOR REAR PANEL**  
ILLUSTRATION 10-8

**10-5-2 Calibrating AMI Model 133GE Helium Meter (S2/S3/S4/S5/SX/MAX/CX) (continued)**

**Resistance/Continuity Checks (continued)**

2. With an ohmmeter, check for open circuit on P403, pin 1 to system cabinet ground.
3. Similarly, verify open circuit on pins 2, 3, 4, 5, 6, and 7 to system cabinet ground. If any wire measures 0 ohms ground, troubleshoot the problem.
4. Disconnect P403 from Magnet Terminal Box located on rear side of magnet.
5. With an ohmmeter, check pin-to-pin resistance for all pins on P403. All should read an open circuit.

**Note**

The following steps will require the engineer to remove the covers on the helium meter to access the adjustment pots identified if adjustments are required.

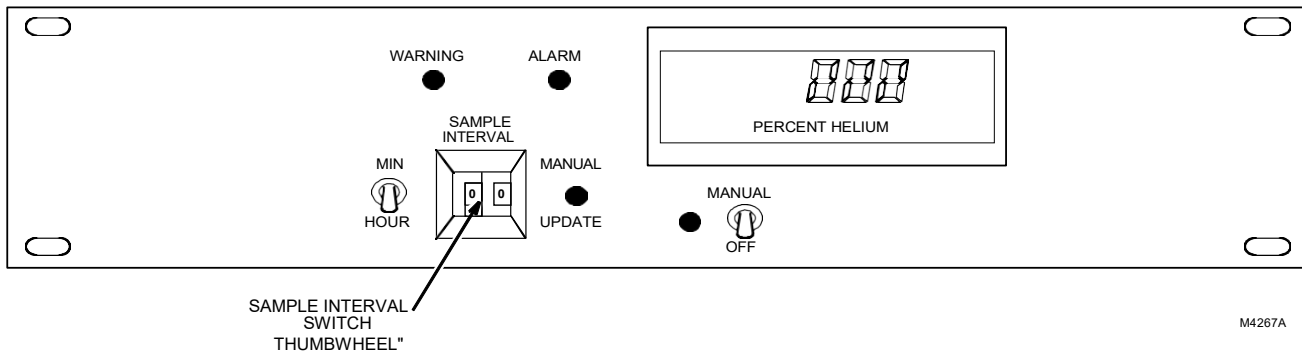
**Current Calibration**

1. Connect the helium calibration box (46-265286G1) to P403 at Magnet Terminal Box.
2. Adjust calibration box to “686” ohms by connecting ohmmeter to meter jacks on calibration box, push and hold the momentary button, then adjust the variable resistor for 686 ohms. This will simulate an empty cryostat or 0% helium reading.
3. Connect ammeter between J403, pin 1 (I+) on rear panel of helium meter and P403 cable, pin 1 (I+).
4. Place a jumper between J403, pin 7 (I-) on rear panel of helium meter and P403 cable pin 7 (I-). The jumper provides the return path to the meter for the sample current which drives the helium sensor probe.
5. Turn helium meter on and set the sample interval thumbwheel switch to “00” (continuous). See Illustration 10-2.

10-5-2 Calibrating AMI Model 133GE Helium Meter (S2/S3/S4/S5/SX/MAX/CX) (continued)

Current Calibration (continued)

- Adjust “current” pot (P9) until 75 mA is attained on ammeter. See Illustration 10-9.



CRYOGEN MONITOR FRONT PANEL  
 ILLUSTRATION 10-9

- Re-adjust calibration box for "0" ohms using the same adjustment method as in Step 2 above.
- Verify current on J403, pin 1 (I+) is still 75 mA. If the reading is more than 5 mA **less than** the current set in Step 6 (75 mA), the constant current source in the helium meter may be faulty under loaded conditions and the meter should be replaced.
- Reconnect P403 on Magnet Terminal Box.

Scaling Calibration

- Connect Helium Calibration Box to J403 on rear panel of Helium Meter.
- With power removed from the Cryogen Meter connect an ohmmeter between R40 and R42. Adjust P3 to 6,000 ohms to simulate a 60-inch sensor length range. (See Illustration 10-10 for resistor locations.)
- While measuring the voltage on connector J1, pin 7 to pin 8 (common) on the rear of the helium meter, adjust the “Full Scale” POT (P4) until the output voltage is exactly 10 volts.
- Re-adjust calibration box to "686" ohms.
- Adjust the "inch" pot (P1) until "0" volts is read between J1, pin 7 and pin 8.



## 10-5-2 Calibrating AMI Model 133GE Helium Meter (S2/S3/S4/S5/SX/MAX/CX) (continued)

### D/A Converter Calibration

1. Re-adjust calibration box to "0" ohms.
2. With thumbwheel switches set to "00", verify pin 7 to pin 8 of connector J1 reads 10 volts.
3. Change thumbwheel selector to some non-zero time such as "10".
4. Push "manual update" button and adjust the D/A pot (P10) until the output voltage is 10 volts on J1, pin 7 to pin 8.

### Recorder Output Calibration

With "00" on the helium meter thumbwheel, "0" ohms on calibration box, and 10 volts still present on pin 7 and 8 of J1, adjust "recorder pot" (P11) for 1 volt on pin 20 to pin 8 on J1.

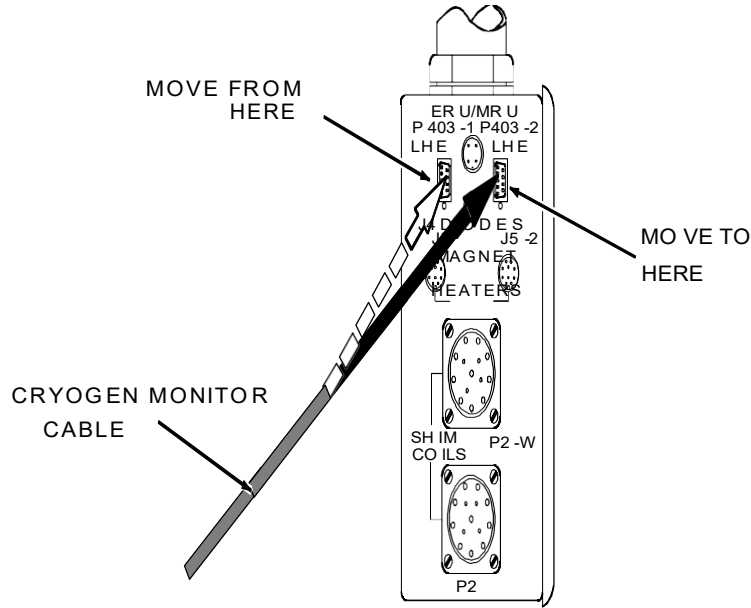
### Helium Display Calibration

1. With "00" on the helium meter thumbwheel, "0" ohms on calibration box, and 10 volts still present on pin 7 and 8 of J1, adjust "Display pot" (P8) until 100% is displayed on the helium meter digital output display.
2. Replace cable P403 on rear of Helium meter and check helium reading on the display.

10-5-2 Calibrating AMI Model 133GE Helium Meter (S2/S3/S4/S5/SX/MAX/CX) (continued)

Helium Display Calibration (continued)

3. Change Helium Level Sensor by swapping Cryogen Monitor Cable at Magnet Instrumentation Connector Box (from LHe P403-1 to LHe P403-2 ). See Illustration 10-11.



**MAGNET INSTRUMENTATION BOX**  
 ILLUSTRATION 10-11

4. Compare readings. Helium level readings should be within 1%. Non-comparable readings indicate a Helium Level Sensor problem.
5. Reset helium meter thumbwheel switches to desired setting (i.e., 24).
6. Connect Helium Calibration Box to J403 on rear panel of Helium Meter.

## 10-5-2 Calibrating AMI Model 133GE Helium Meter (S2/S3/S4/S5/SX/MAX/CX) (continued)

### Alarm Setpoints

1. To set the warning set point, place set point select toggle switch (SW1) located on right rear of printed circuit board in the warning setpoint position (to the left or towards the circuit board).
2. Adjust pot P7 until the desired setting is read on the helium display.
3. To set the alarm set point, place set point select toggle switch (SW1) located on right rear of printed circuit board in the alarm setpoint position (to the right or away from the circuit board).
4. Adjust pot P6 until the desired setting is read on the helium display.
5. Fill out calibration sticker located on the helium meter with required information. See Illustration 10-7.

**10-5-3 Calibrating AMI Model 110P Helium Meter (Compact)**

**Description:**

The following calibration procedure is used for the helium meter used on GE Compact Magnet. This calibration procedure is for calibrating the helium meter only. There is no calibration or adjustment on the helium sensor probes.

Contact the MAC Team Representative, Region Service Engineer, or the On Line Center if helium level sensor problems are encountered during calibration.

**Procedure:**

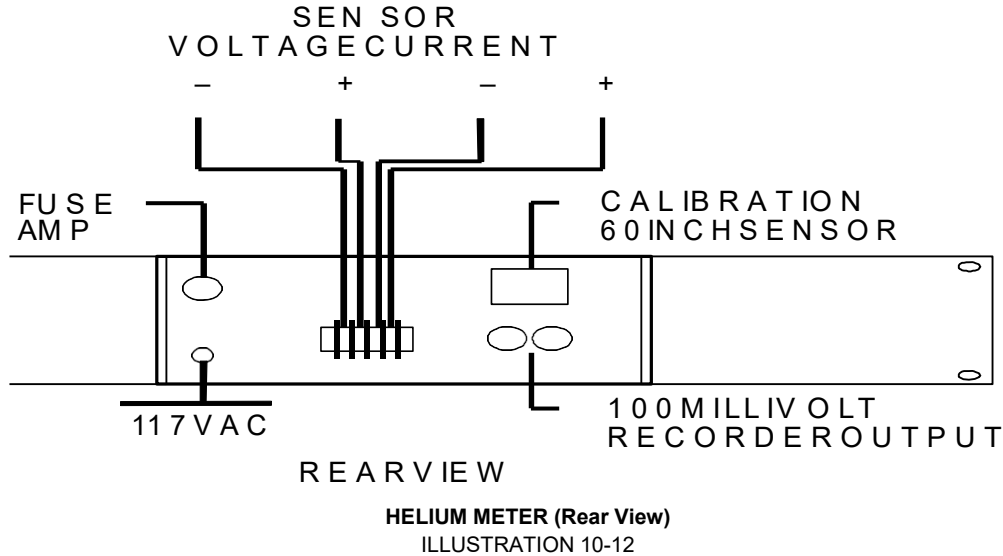
Make sure helium meter assembly is installed per Direction 15180, the 0.5T Compact Magnet & Cryogen Subsystem Manual, Set-Up & Cal.



**Verify meter is wired for the proper line voltage available at the site. For VECTRA systems, line voltage is 100 VAC. For International installations, verify power input at site. Reference vendor manual for line voltage set-up if required.**

**Resistance/Continuity Checks**

1. Disconnect the four wires from “sensor” terminal strip on back panel of helium meter. Make sure wires are properly labeled for proper reconnection. See Illustration 10-12.



2. With an ohmmeter, separately check for open circuit on each wire to system cabinet ground.
3. Disconnect P302 from magnet connector assembly located on magnet.
4. With an ohmmeter, check pin-to-pin resistance for all pins on P302. All should read an open circuit.
5. Reconnect all wires to the proper connections on the rear of the meter except the red wire (I+).

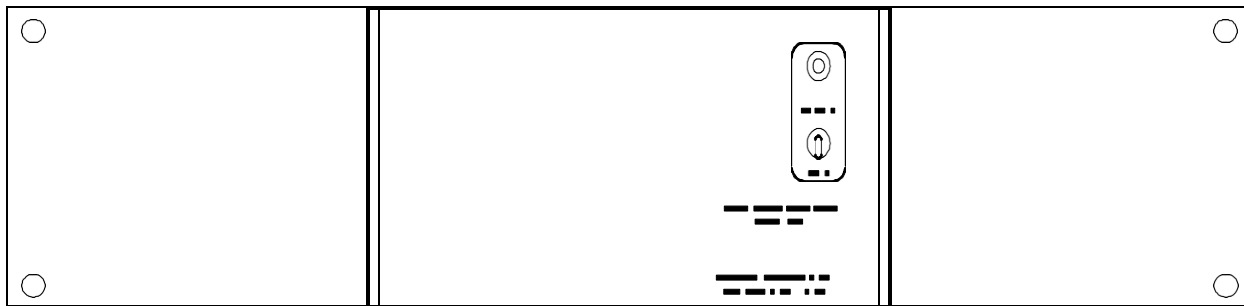
**10-5-3 Calibrating AMI Model 110P Helium Meter (Compact) (continued)**

**Note**

The following steps will require the engineer to remove the covers on the helium meter to access the adjustment pots identified if adjustments are required.

**Current Calibration**

1. Connect the helium calibration box (46-265286G1) to P302.
2. Adjust calibration box to "686" ohms by connecting ohmmeter to meter jacks on calibration box, push and hold the momentary button, then adjust the variable resistor for 686 ohms. This will simulate an empty cryostat or 0% helium reading.
3. Connect ammeter between the red wire (I+) and it's terminal lug on the rear of the helium meter.
4. Turn helium meter on. See Illustration 10-13.



FRONTVIEW

M4419A

HELIUM METER (Front View)  
 ILLUSTRATION 10-13

5. Press and hold the READ button on front of the helium meter.
6. Adjust CURRENT ADJ pot (P7) until 75 mA is attained on ammeter.
7. Re-adjust calibration box for "0" ohms using the same adjustment method as in Step 2 above.
8. Verify I+ current on ammeter is still 75 mA. If the reading is more than 5 mA **less than** the current set in Step 6 (75 mA), the constant current source in the helium meter may be faulty under loaded conditions and the meter should be replaced.
9. Reconnect the red wire (I+) on rear of helium meter.

**10-5-3 Calibrating AMI Model 110P Helium Meter (Compact) (continued)**

**Scaling Calibration**

1. With power removed from the Cryogen Meter connect an ohmmeter between R40 and R42. Adjust P3 to 6,000 ohms to simulate a 60-inch sensor length range.
2. Depress and hold the front panel READ pushbutton.
3. While measuring the voltage on TP OUTPUT and ground, adjust the FULL SCALE pot (P4) until the output voltage is exactly 10 volts.
4. While holding the READ pushbutton down, adjust METER pot (P5) for 100% reading on display.
5. Re-adjust calibration box to "686" ohms.
6. Depress and hold the front panel READ pushbutton.
7. While measuring the voltage on TP OUTPUT and ground, adjust the INCH pot (P1) until "0" volts is read on the voltmeter.

**Recorder Output Calibration**

1. Re-adjust calibration box to "0" ohms.
2. Connect voltmeter to RECORDER OUTPUT jacks on rear of helium meter.
3. Depress and hold the front panel READ pushbutton.
4. Adjust REC pot (P6) for 100 millivolts
5. Disconnect helium meter calibration box and reconnect to P302, LHE-1 on Magnet Connector Assembly.
6. Fill out calibration sticker located on the helium meter with required information. See Illustration 10-7.

**10-5-4 Calibrating AMI Model III Cryogen Meter**

**Current Calibration**

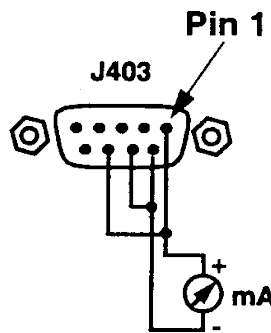
**Note**

This instrument was calibrated at the factory for 60" AMI LHe level sensors. The following information is furnished in the event the instrument is suspect of not being in calibration or for routine maintenance.



**THIS CALIBRATION PROCEDURE IS TO BE PERFORMED ONLY BY TRAINED SERVICE PERSONNEL FAMILIAR WITH ELECTRICAL SAFETY PRECAUTIONS AND PROPER ELECTRICAL SAFETY PROCEDURES. THE MODEL 111GE CONTAINS HIGH VOLTAGES CAPABLE OF PRODUCING LIFE-THREATENING ELECTRICAL SHOCK. DO NOT PERFORM ANY OPERATIONS ON ANY AMI EQUIPMENT WITH THE COVER REMOVED UNLESS QUALIFIED TO DO SO AND ANOTHER PERSON QUALIFIED IN FIRST AID AND CPR IS PRESENT.**

1. Turn power off by disconnecting power cord. Lock and tag power cord.
2. Disconnect the helium probe cable from the helium sensor connector, J403 and the remote monitoring cable from the remote monitoring connector, J1 located on the rear panel of the instrument. Remove the instrument cover.
3. Short J403 pins 1 & 8 together. Short J403 pins 6 & 7 together.
4. Attach a current meter between the sensor current pins J403 pin 1 (+) and J403 pin 7 (-) located on the rear panel of the instrument. The sensor current pins and current meter should now be wired as shown in Illustration 10-14.

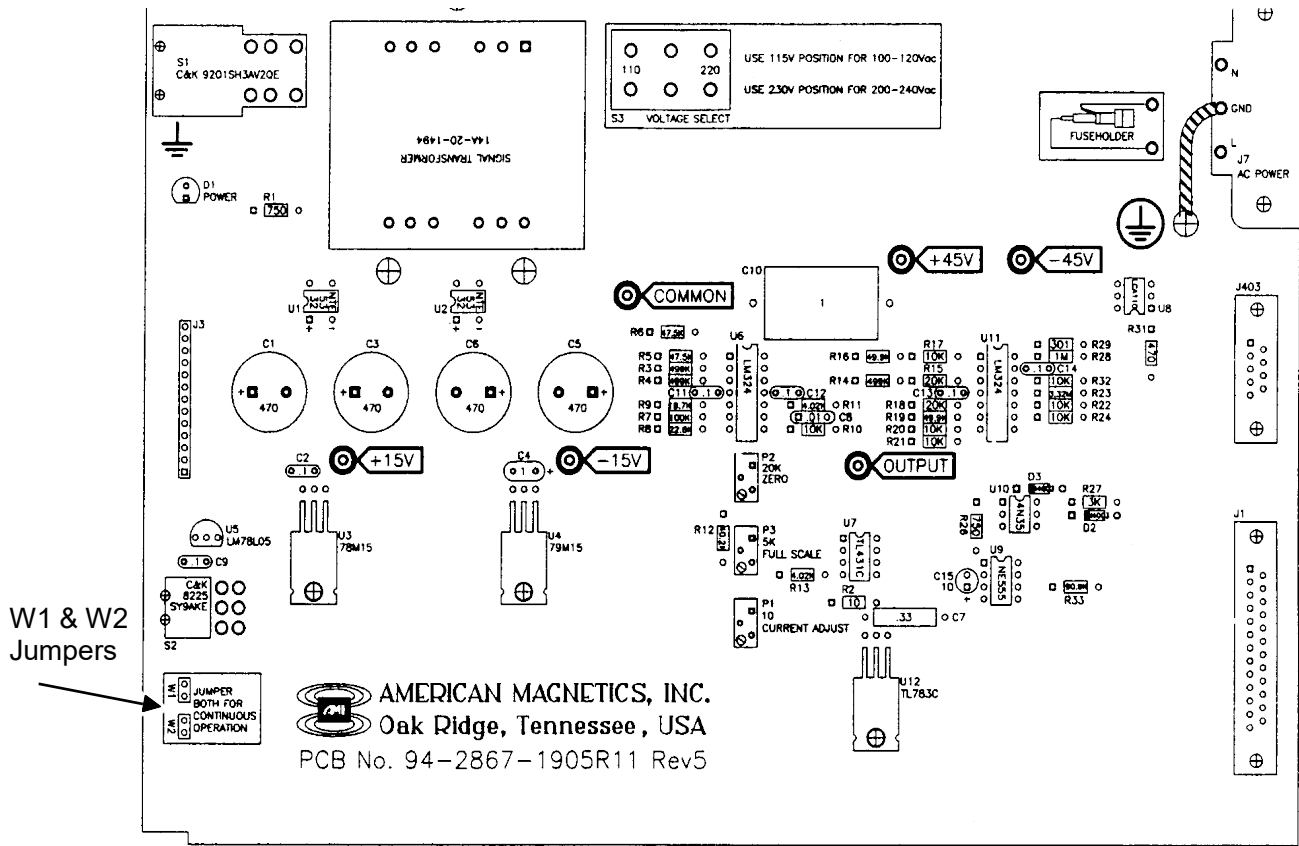


**CURRENT METER CONNECTIONS**  
 ILLUSTRATION 10-14

10-5-4 Calibrating AMI Model III Cryogen Meter (continued)

Current Calibration (continued)

- To operate the meter with continuous sensor current, short jumpers W1 and W2 located on the printed circuit board near the front panel. See Illustration 10-15. This operation performs the same function as continually pressing the front panel READ pushbutton.

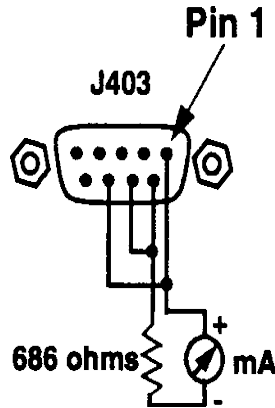


- Observe the correct electrical equipment safety precautions and set power switch on front panel to the up position.
- If the sensor current was not jumpered for continuous operation as described in Step 5, press the front panel READ pushbutton to power the sensor current.
- Adjust potentiometer, P1-CURRENT ADJUST (shown in Illustration 10-15) on the printed circuit board until the current meter displays 75.0 mA. Turn power off by placing the front panel power switch in the down position.

**10-5-4 Calibrating AMI Model III Cryogen Meter (continued)**

**Current Calibration (continued)**

9. Attach a 686 ohm resistor (46-265286G1) capable of dissipating 4 watts in series with the current meter between the sensor current pins J403 pin 1 (+) and J403 pin 7 (-) located on the rear panel of the instrument. The sensor current pins and current meter should now be wired as shown in Illustration 10-16.



**CURRENT METER CONNECTIONS**  
 ILLUSTRATION 10-16

10. To operate the meter with continuous sensor current during this calibration procedure, short jumpers W1 and W2 (shown in Illustration 10-15) located on the printed circuit board near the front panel. This operation performs the same function as continually pressing the front panel READ pushbutton.
11. Observe the correct electrical equipment safety precautions and place power switch on the front panel to the up position.
12. If the meter is not operating with continuous sensor current as described in Step 10, press the front panel READ pushbutton to activate the sensor current.
13. Verify the current meter displays  $75.0 \pm 0.1$  mA. Turn power off by placing the front panel power switch in the down position.

10-5-4 Calibrating AMI Model III Cryogen Meter (continued)

Level Calibration

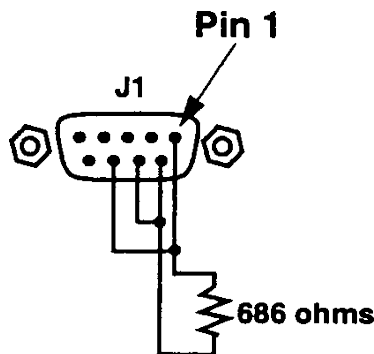


**THIS CALIBRATION PROCEDURE IS TO BE PERFORMED ONLY BY TRAINED SERVICE PERSONNEL FAMILIAR WITH ELECTRICAL SAFETY PRECAUTIONS AND PROPER ELECTRICAL SAFETY PROCEDURES. THE MODEL 111GE CONTAINS HIGH VOLTAGES CAPABLE OF PRODUCING LIFE-THREATENING ELECTRICAL SHOCK. DO NOT PERFORM ANY OPERATIONS ON ANY AMI EQUIPMENT WITH THE COVER REMOVED UNLESS QUALIFIED TO DO SO AND ANOTHER PERSON QUALIFIED IN FIRST AID AND CPR IS PRESENT.**

**Note**

This procedure is a continuation of the calibration procedure and should be performed after the Sensor Current Calibration procedure above.

1. Verify the Cryogen Meter has been powered off.
2. Remove the current meter from the helium sensor connector, J403, and keep the 686 ohm resistor (46-265286G1) capable of dissipating 4 watts in the circuit. The sensor connector pins should now be wired as shown in Illustration 10-17.



**CURRENT METER CONNECTIONS**  
 ILLUSTRATION 10-17

3. Connect a voltmeter between OUTPUT and COMMON located on the printed circuit board. See Illustration 10-15.
4. Power the Cryogen Meter and sensor current by placing the power switch in the up position.
5. Adjust potentiometer, P2 (ZERO) until the voltmeter displays 0.000 VDC.
6. Verify the front panel meter displays 0.0% ±1.0%.
7. Turn power off by placing the power switch in the down position.
8. Place a shorting jumper across the 686 ohm test resistor.
9. Power the Cryogen Meter and sensor current by placing the power switch in the up position.

#### 10-5-4 Calibrating AMI Model III Cryogen Meter (continued)

##### Level Calibration (continued)

10. Adjust the potentiometer, P3 (FULL SCALE) until the voltmeter displays 1.000 VDC.
11. Verify the front panel meter displays 100.0%  $\pm$ 1.0%.
12. Turn power off by placing the power switch in the down position, remove the shorting jumpers and test resistor, remove jumpers W1 and W2 for constant read mode (if installed), reinstall the cables to J1 and J403, and replace the Cryogen Meter cover. The Cryogen Meter calibration is complete.

**10-5-5 Calibrating the Granite Magnet Monitor**

**Note**

This procedure is for calibrating the Granite Magnet Monitor. The Granite Magnet Monitor was the first Magnet Monitor to be shipped with LCC magnets.

**Note**

This instrument was calibrated at the factory for 60" AMI LHe level sensors. The following information is furnished in the event the instrument is suspect of not being in calibration or for routine maintenance.



**THIS CALIBRATION PROCEDURE IS TO BE PERFORMED ONLY BY TRAINED SERVICE PERSONNEL FAMILIAR WITH ELECTRICAL SAFETY PRECAUTIONS AND PROPER ELECTRICAL SAFETY PROCEDURES. THE MODEL 111GE CONTAINS HIGH VOLTAGES CAPABLE OF PRODUCING LIFE-THREATENING ELECTRICAL SHOCK. DO NOT PERFORM ANY OPERATIONS ON ANY AMI EQUIPMENT WITH THE COVER REMOVED UNLESS QUALIFIED TO DO SO AND ANOTHER PERSON QUALIFIED IN FIRST AID AND CPR IS PRESENT.**

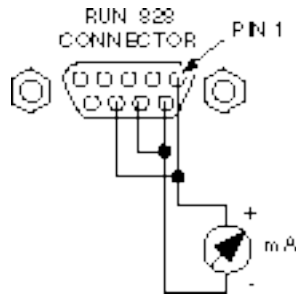
Determine if the Magnet Monitor is in need of calibration by using the Helium Meter Calibration Box, part number 46-265286G1. Set the resistances to the values shown in table 10-5-1. If your values are in spec, the magnet monitor is calibrated. If the values are out of spec, proceed with the calibration procedure at Step 1.

**RESISTANCE CHECK**  
 TABLE 10-5-1

<b>Resistance setting</b>	<b>Nominal value</b>	<b>Specification</b>
230 ohms	66.4%	63.4% to 79.4%
460 ohms	32.7%	29.7% to 35.7%
686 ohms	0.0%	0.0% to 3.0%

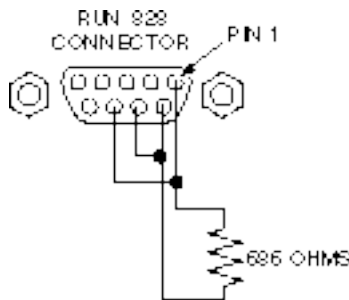
1. In the magnet room, remove Run 828 from P403 (MS1-A3-A1-P403).
2. On the connector of Run 828:
  - a. Short pins 1 and 8 together.
  - b. Short pins 6 and 7 together.
  - c. Attach the Multimeter between pin 1 (+) and pin 7 (-). See Illustration 10-18.

10-5-5 Calibrating the Granite Magnet Monitor (continued)



WIRING FOR SENSOR CALIBRATION  
 ILLUSTRATION 10-18

3. Plug the Magnet Monitor's power cord into an outlet. Turn on the Magnet Monitor.
4. Wait approximately two minutes to allow the system to settle.
5. Press the `SAMPLE` button.
6. Verify the Multimeter reads 75.0 mA.
7. Turn off the Magnet Monitor's power switch.
8. On the connector of Run 828: replace the Multimeter with a 686 ohm resistor capable of dissipating four watts, or use the Helium Resistance Box (46-265286G1) to simulate 686 ohms. The connector pins should now be wired as shown in Illustration 10-19.



WIRING FOR CURRENT SOURCE VOLTAGE CALIBRATION  
 ILLUSTRATION 10-19

9. Connect the Multimeter between TP1 on the Magnet Monitor Interface Board and the chassis common.
10. Turn on the Magnet Monitor.
11. Wait approximately two minutes to allow the system to settle.
12. Press the `SAMPLE` button.
13. Adjust the `R7 GAIN` potentiometer until the Multimeter reads 5.000 Vdc. See Illustration 10-19 for the location of R7.

**10-5-5 Calibrating the Granite Magnet Monitor (continued)**

14. Verify the front panel reads 0% ±1.0%.
15. Turn off the Magnet Monitor's power switch.
16. Place a shorting jumper across the 686 ohm test resistor (or set the Helium Resistance Box to zero ohms).
17. Turn on the Magnet Monitor.
18. Wait approximately two minutes to allow the system to settle.
19. Press the SAMPLE button.
20. Verify the voltmeter reads 0.000 VDC.
21. Verify the front panel reads 100% ±1.0%.
22. Repeat from Step 12 until no further changes are necessary.
23. Reconnect Run 828 to P403.

**10-5-6 Calibrating the Advantech Magnet Monitor**

**Note**

There are no adjustments for calibrating the Advantech Magnet Monitor. There is a functional check. If the following functional check procedure is out of limits, the Magnet Monitor should be replaced.

Obtain the helium meter calibration box, part number 46-265286G1. Set the resistances to the values shown in table 10-5-2. If you do not meet the specifications, your Magnet Monitor should be replaced.

**RESISTANCE CHECK**  
 TABLE 10-5-2

<b>Resistance setting</b>	<b>Nominal value</b>	<b>Specification</b>
230 ohms	65.7%	61.7% to 69.7%
460 ohms	31.3%	28.3% to 34.3%
686 ohms	1.2%	0.0% to 2.5%

**10-6 VERIFY CRYOGEN METER CALIBRATION - OXFORD MAGNETS**

**10-6-1 Calibrating Oxford Mobile Helium Meter (Model 4017)**

**Description:**

The helium level meter is calibrated at 0% full by using a resistance estimate of 100 ohms. The 100% full reading is calibrated by using a resistive load of zero ohms.

**Procedure:**

Move helium meter into Signa Systems cabinet per procedures in *Direction 15406, Signa Advantage 1.5T Installation (5.x)*.

**Note**

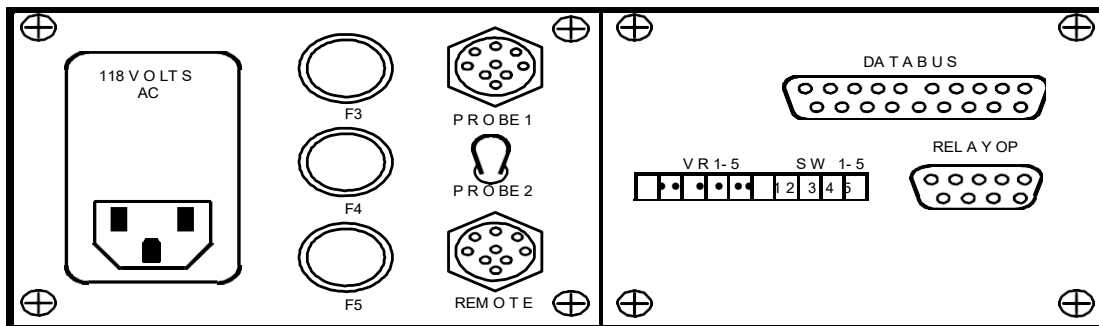
Mobile magnets contain no nitrogen vessels; therefore, only a helium meter is installed in the Systems cabinet.



**Verify the line voltage selector switch on the back panel of the helium meter is set to match the line voltage available at the site. Failure to do so will result in either equipment damage or erroneous readings.**

**Resistance/Continuity Checks**

1. Disconnect cable from PROBE connector on back panel of helium meter. See Illustration 10-20.



R E A R V I E W

M 2307A 1

**HELIUM METER - MODEL 4017 (Rear View)**  
 ILLUSTRATION 10-20

2. With an ohmmeter, check for open circuit on PROBE cable, pin B, to system cabinet ground.
3. Similarly, verify open circuit on pins A, D, and E to system cabinet ground. If any wire measures 0 ohms ground, troubleshoot the problem.
4. Disconnect Helium Sensor cable from service turret on top of the magnet.
5. With an ohmmeter, check pin-to-pin resistance for all pins on Helium Sensor cable at either the helium meter end or the magnet end. All should read an open circuit. If not, troubleshoot the problem.

**10-6-1 Calibrating Oxford Mobile Helium Meter (Model 4017) (continued)**

**Current Calibration**

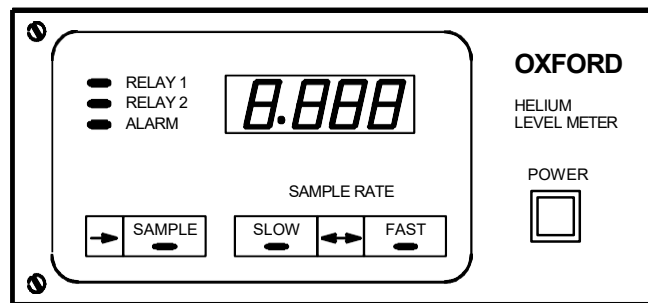
1. Connect the Helium Calibration Box (46-255770G1) to Helium Sensor cable at magnet service turret.
2. Adjust calibration box to “0.0” ohms by connecting ohmmeter to meter jacks on calibration box, push and hold the momentary button, then adjust the variable resistor for “0.0” ohms. This will simulate a full cryostat or 100% helium reading.
3. Connect ammeter between PROBE output pin B (I+) on back of helium meter and pin B (I+) of the Helium Sensor cable.
4. Place a jumper between PROBE output pin D (I-) on back of helium meter and pin D (I-) of the Helium Sensor cable. The jumper provides the return path to the meter for the sample current which drives the helium sensor.
5. Turn helium meter on and press the SAMPLE arrow on front of meter. See Illustration 10-21.

**Note**

The SAMPLE arrow may have to be pressed several times during calibration procedure since meter reading only changes when current flows through the probe. Another option for getting a constant current out of the meter for real-time adjustments of the current, the 0%, and 100% adjustments, is to place SW9 on the meter’s Main Circuit Board “ON.” This will illuminate the SAMPLE LED on the front of the meter indicating constant current.

**Note**

To access the meter’s Main Circuit Board, the Alarm Interface Board must be removed. This is done by removing the meter’s cover panel, then removing the four screws and ribbon cable to the Alarm Interface Board.



FRONT VIEW

**HELIUM METER (Front View)**

ILLUSTRATION 10-21

6. Adjust “current” pot (RV1) on meter’s Main Circuit Board for 250 mA.
7. Re-adjust calibration box for “100” ohms using the same adjustment method as in Step 2 above.
8. Verify current on PROBE output pin B (I+) on back of helium meter is still 250 mA. If the reading is more than 5 mA **less than** the current set in Step 6 (250 mA), the constant current source in the helium meter may be faulty under loaded conditions and the meter should be replaced.
9. Disconnect Helium Calibration box from Helium Sensor cable and reconnect on Magnet Service Turret.

**10-6-1 Calibrating Oxford Mobile Helium Meter (Model 4017) (continued)****Display Calibration**

1. With Helium Calibration Box adjusted for “100” ohms, connect the box directly to the PROBE output on the helium meter.
2. Press and release the SAMPLE arrow on the Helium meter (or select SW9 on the meter’s Main Circuit Board), then adjust RV2 on the meter’s Main Circuit Board for a reading of “0.0” on the display.

**Note**

Remember, the SAMPLE arrow may have to be pressed several times during calibration procedure if SW9 is not selected, since the meter reading only changes when current flows through the probe.

3. Re-adjust the Calibration Box for “0.0” ohms.
4. Press and release the Sample arrow on Helium meter, then adjust RV3 on the meter’s Main Circuit Board until meter indicates 100% full.
5. Remove the Calibration Box and reconnect SENSOR cable to helium meter.
6. Verify proper sample reading on meter.

**10-6-1 Calibrating Oxford Mobile Helium Meter (Model 4017) (continued)**

7. Switch helium meter cable from present sensor connection and hook up to the second sensor on Magnet Service Turret. Locations “A” and “B” are the helium sensor connections on the Magnet Service Turret. Location “C” is for measuring the Magnet’s Cryostat Carbon Resistors and is not used in this procedure.
8. Verify correct reading on meter by taking another sample.
9. Place SW9 in the OFF position if previously selected; then replace Alarm Interface Board, and replace meter cover panel.

**Alarm Settings:**

1. Set helium meter relay settings as appropriate for your site. Some suggested levels are as follows:

- Low-level Alarm Setting = 50% (RV1 and SW1 on rear of meter used for adjustment)**
- Relay 1 lower limit = 55% (RV2 and SW2 on rear of meter used for adjustment)**
- Relay 1 upper limit = 60% (RV3 and SW3 on rear of meter used for adjustment)**
- Relay 2 lower limit = 50% (RV4 and SW4 on rear of meter used for adjustment)**
- Relay 2 upper limit = 55% (RV5 and SW5 on rear of meter used for adjustment)**

**Note**

Refer to *Oxford Magnet Technology, Liquid Helium Level Meter Instruction Manual*, Section 3.7.2, Alarm-Interface PCB.

2. Set sample time to 20 seconds and sample rate as desired (11 hour setting is recommended). Refer to *Oxford Magnet Technology, Liquid Helium Level Meter Instruction Manual*, Section 3.7.1, Basic PCB Adjustments, for setting sampling time and rate.

**Note**

Sample rate setting can affect helium boil-off. Avoid minimum sample rate settings to prevent unwarranted helium boil-off due to frequent level sampling.

3. Fill out calibration sticker located on the helium meter with required information. See Illustration 10-7.

**10-6-2 Calibrating Oxford Fixed Helium Meter (Model 4016)**

**Description:**

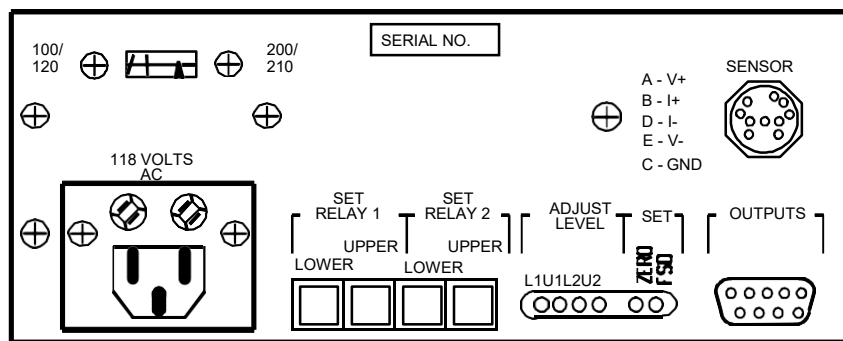
The helium level meter is calibrated at 0% full by using a resistive load of 100.0 ohms. The 100% full reading is calibrated by using a resistive load of zero ohms.

**Procedure:**

Move helium and nitrogen meter assembly into Signa Systems cabinet per procedures in Direction 15100, Signa Installation (3.x), or Direction 15306, Signa Advantage Installation (4.x), or Direction 15406, Signa Advantage 1.5T Installation (5.x).

**Resistance/Continuity Checks**

1. Disconnect cable from SENSOR connector on back panel of helium meter. See Illustration 10-22.
2. With an ohmmeter, check for open circuit on SENSOR cable, pin B, to system cabinet ground.
3. Similarly, verify open circuit on pins A, D, and E to system cabinet ground. If any wire measures 0 ohms ground, troubleshoot the problem.
4. Disconnect Helium Sensor cable from service turret on top of the magnet.
5. With an ohmmeter, check pin-to-pin resistance for all pins on Helium Sensor cable at either the helium meter end or the magnet end. All should read an open circuit. If not, troubleshoot the problem.



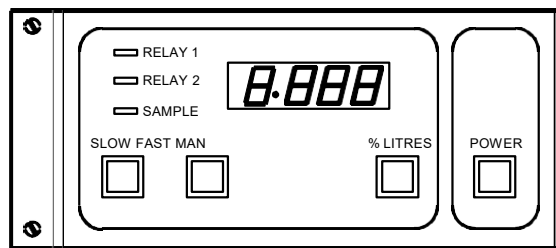
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**HELIUM METER (Rear View)**  
 ILLUSTRATION 10-22

**10-6-2 Calibrating Oxford Fixed Helium Meter (Model 4016) (continued)**

**Current Calibration**

1. Connect the Helium Calibration Box (46-255770G1) to Helium Sensor cable at magnet service turret.
2. Adjust calibration box to “0.0” ohms by connecting ohmmeter to meter jacks on calibration box, push and hold the momentary button, then adjust the variable resistor for “0.0” ohms. This will simulate a full cryostat or 100% helium reading.
3. Connect ammeter between SENSOR output pin B (I+) on back of helium meter and pin B (I+) on the Helium Sensor cable.
4. Place a jumper between SENSOR output pin D (I-) on back of helium meter and pin D (I-) of the Helium Sensor cable. The jumper provides the return path to the meter for the sample current which drives the helium sensor probe.
5. Turn helium meter on, verify %/LITRES switch in the “%” position and the SLOW/FAST Switch in the “SLOW” position.
6. Hit the MAN button on front of meter. See Illustration 10-23.



FRONT VIEW

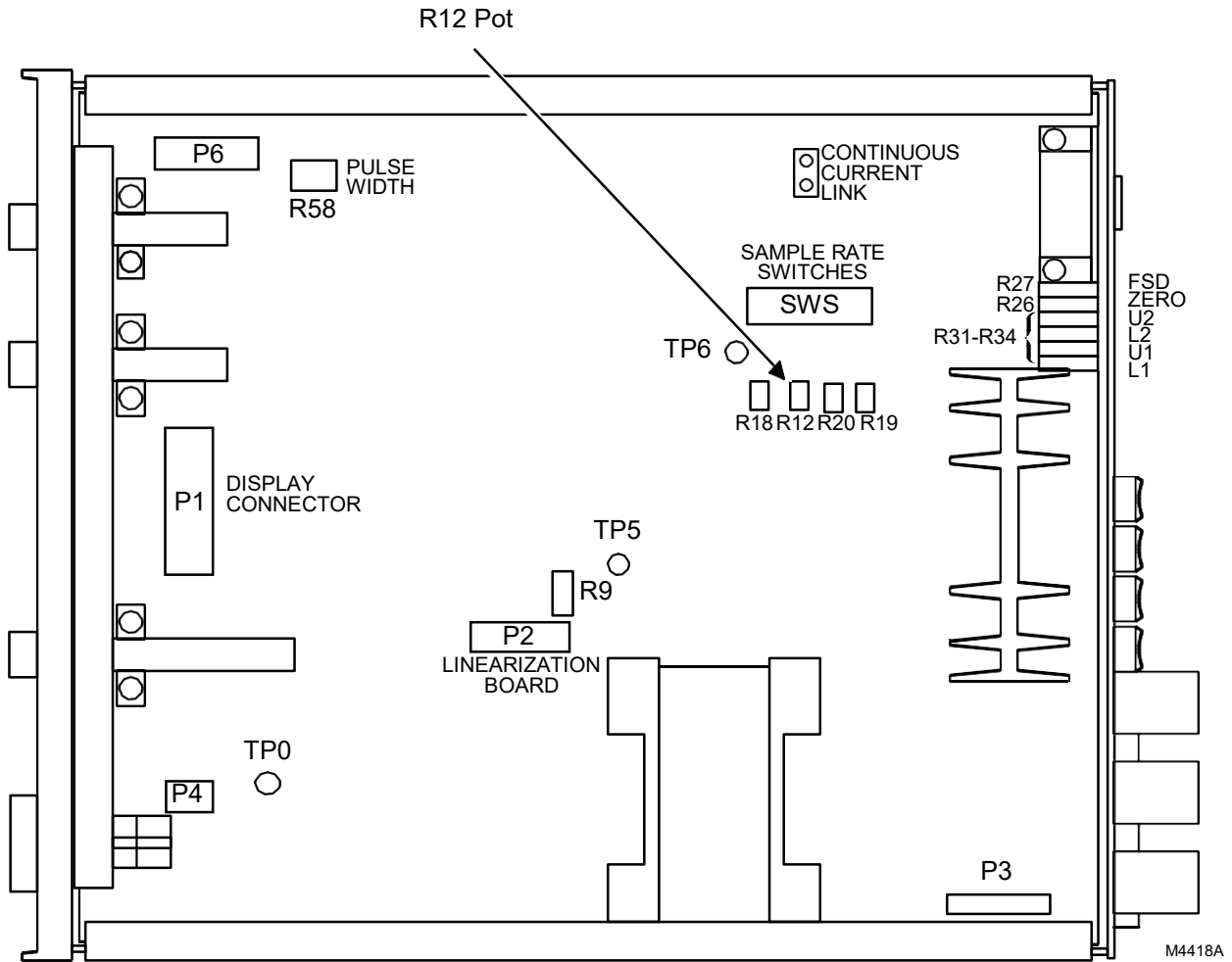
**HELIUM METER (Front View)**  
 ILLUSTRATION 10-23

**10-6-2 Calibrating Oxford Fixed Helium Meter (Model 4016) (continued)**

7. Adjust “current” pot (R12) on meter circuit board for 250 mA. See Illustration 10-24.

**Note**

If 250 mA cannot be obtained with the adjustment of R12, R18 on meter circuit board may be incorrect and the meter would need to be replaced.



**OXFORD FIXED HELIUM METER CIRCUIT BOARD**  
 ILLUSTRATION 10-24

8. Re-adjust calibration box for “100” ohms using the same adjustment method as in Step 2 above.
9. Verify current on SENSOR output pin B (I+) on back of helium meter is still 250 mA. If the reading is more than 5 mA **less than** the current set in Step 6 (250 mA), the constant current source in the helium meter may be faulty under loaded conditions and the meter should be replaced.
10. Disconnect Helium Calibration box from Helium Sensor cable and reconnect on Magnet Service Turret.

**10-6-2 Calibrating Oxford Fixed Helium Meter (Model 4016) (continued)****Display Calibration**

1. With Helium Calibration Box adjusted for "100" ohms, connect box directly to the SENSOR output on the helium meter.
2. Connect voltmeter to TP5 (+) and TP0 (-) on Helium Meter Circuit Board.
3. Press and release the MAN button on the Helium meter, then adjust the ZERO pot (R24) on the rear of the Helium Meter Circuit Board for a reading of "0.0" volts on the voltmeter which should be "0.0" on the display.

**Note**

The MAN button may have to be pressed several times during calibration procedure since meter reading only changes when probe samples.

4. Re-adjust the Calibration Box for "0.0" ohms.
5. Press and release the MAN button on the Helium meter, then adjust FSD pot (R27) on the rear of helium meter until meter indicates 100% full.
6. Remove the Calibration Box and reconnect SENSOR cable to helium meter.
7. Verify proper sample reading on meter.
8. Switch helium meter cable from present sensor connection and hook up to the second sensor on Magnet Service Turret. Locations "A" and "B" are the helium sensor connections on the Magnet Service Turret. Location "C" is for measuring the Magnet's Cryostat Carbon Resistors and is not used in this procedure.
9. Verify correct reading on meter by taking another sample.

**10-6-2 Calibrating Oxford Fixed Helium Meter (Model 4016) (continued)**

**Alarm Settings:**

1. Set helium meter relay settings as appropriate for your site. Some suggested levels are as follows:
  - **Relay 1 lower limit = 55%**
  - **Relay 1 upper limit = 60%**
  - **Relay 2 lower limit = 50%**
  - **Relay 2 upper limit = 55%**

**Note**

The Alarm settings are set by pressing the appropriate button on the rear of the Helium Meter, then adjusting L1, U1, L2, U2 for the proper relay setting on the display. Refer to *Oxford Magnet Technology, Liquid Helium Level Meter Instruction Manual*, Section 2.3.5, Setting Relay Levels.

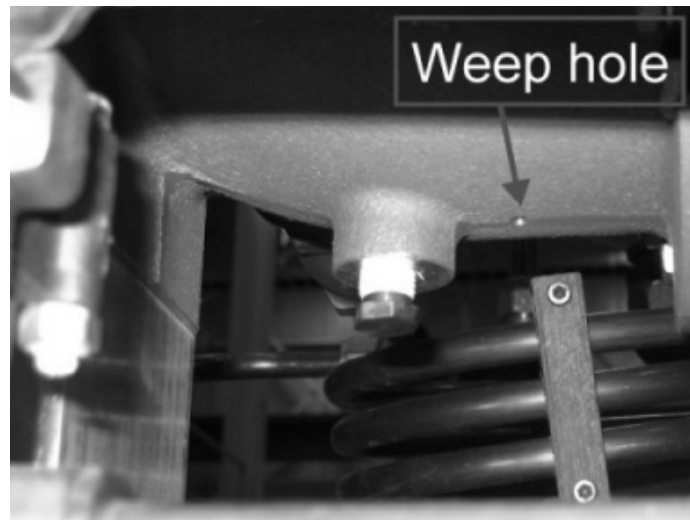
2. Confirm the %/LITERS switch to display %.
3. Confirm the FAST/SLOW switch to FAST.
4. Set sample time to 20 seconds and sample rate as desired (11 hour setting is recommended). Refer to *Oxford Magnet Technology, Liquid Helium Level Meter Instruction Manual*, Section 2.3.6, Setting the Sampling Rate.
5. Fill out calibration sticker located on the helium meter with required information. See Illustration 10-7.

10-7 INSPECT CRYOGEN VENT



**SAFETY HAZARD! THOROUGHLY INSPECT VENT SYSTEMS IN SITES THAT HAVE EXPERIENCED A MAGNET QUENCH. VENT SYSTEMS HAVE SUFFERED VENT JOINT FAILURES ON 2ND OR 3RD QUENCH. FAILURE TO DO SO WILL RESULT IN RUPTURE OF VENT SYSTEM.**

1. Inspect the vent glass connection inside the magnet room and repair if necessary.
2. Inspect the weep hole underneath the magnet manifold. See Illustration 10-25.
  - a. To determine if debris is preventing drainage of condensation, place a toothpick or other thin, nonmagnetic item into the hole to a depth of one inch.
  - b. If debris is present, remove it.



**WEEP HOLE UNDER MAGNET MANIFOLD**  
 ILLUSTRATION 10-25

3. Inform the customer that it is time for the annual inspection of their quench duct.

10-8 TEST MAGNET EMERGENCY RUNDOWN UNIT (ERU)

Refer to appropriate section:

- Oxford magnet, Section 10-9-1
- GE magnet, Section 10-9-2

10-8-1 Oxford Magnet ERU Test



**AVOID A QUENCH OF MAGNET! DO NOT ATTEMPT ANY TESTS OR MAINTENANCE ON ERU MODULE UNLESS YOU ARE THOROUGHLY FAMILIAR WITH IT. NO PM STEP WILL ASK YOU TO PRESS RED [STOP] BUTTON IN CENTER OF ERU MODULE.**

1. Locate yellow button labeled **[Press To Test Quench Heater Circuits]** on lower left quadrant of front cover of ERU. Press yellow button to test quench heater circuits. If circuit indicator lamp fails to light, a failed circuit has been found.



**AVOID A QUENCH OF MAGNET! DO NOT USE AN OHMMETER ON QUENCH HEATER CIRCUITS OR IN SWITCH HEATER CIRCUITS ON AN ENERGIZED MAGNET. CONSULT WITH YOUR MAC TEAM LEADER, MR RSE, OR CALL THE OLC 24 HR. MAGNET SUPPORT LINE AT 1-800-321-7937 TO DETERMINE APPROPRIATE ACTION.**

2. Locate orange button labeled **[Press For Battery Test]** on upper left quadrant of front cover of ERU. Press and hold orange button for 10 seconds to test battery. “Pass” indicator (green) will light if battery is charged. If indicator does **not** light, arrange for an immediate recharge and retest of ERU battery.

**Note**

Check storage area for location of battery charger in the event ERU battery needs recharge. The external high current charger is required to initially charge replacement batteries or to recharge batteries that are found to be discharged.



**IF ERU FAILS TEST, ARRANGE FOR IMMEDIATE REMEDIAL SERVICE. FAILURE TO HAVE AN OPERATING ERU WILL PREVENT BRINGING DOWN THE MAGNETIC FIELD IN THE EVENT OF AN EMERGENCY.**

10-8-2 GE Magnet ERU Test

**WARNING!**

**AVOID A QUENCH OF MAGNET! DO NOT ATTEMPT ANY TESTS OR MAINTENANCE ON ERU MODULE UNLESS YOU ARE THOROUGHLY FAMILIAR WITH IT. NO PM STEP WILL ASK YOU TO PRESS [EMERGENCY RUNDOWN] BUTTON IN CENTER OF ERU MODULE.**

**WARNING!**

**AVOID A QUENCH OF MAGNET! MERCURY WETTED RELAY IN ERU FRONT PANEL MUST NOT BE BUMPED OR TILTED BEYOND  $\pm 15^\circ$  WHILE SWITCH HEATER CABLE IS CONNECTED TO PANEL. BEWARE OF ERU'S MOUNTED ON HINGED OR SLOPING PANELS.**

1. Verify green LED on front panel is lit (indicating battery charger has power).
2. Press TEST BATTERY switch. Green LED labeled BATTERY will light if battery is OK. If LED lights, go to Step 7. Otherwise, go to Step 3.
3. Check for 27.6V between TP-1 and TP-2 on circuit board. If the voltage is 27.6V or greater, the voltage comparator or LED driver on the circuit board needs adjustment or repair. Check with the OLC Support Group at 1-800-321-7937 if additional help is needed. If the voltage is less than 27.6V, continue with Step 4.
4. Check for an open battery fuse F2. If blown, replace with a 2A fuse.
5. Visually inspect battery for signs of leakage.
6. Remove fuse F2 and check battery voltage. If battery replacement is needed, order two 12V, Ni-Cad batteries (46-281302P14).

**WARNING!**

**AVOID A QUENCH OF MAGNET! DO NOT USE AN OHMMETER ON QUENCH HEATER CIRCUITS OR IN SWITCH HEATER CIRCUITS ON AN ENERGIZED MAGNET.**

7. Test heater A by pulling SELECT HEATER switch handle out while pushing handle left to position A.
8. Press TEST HEATER switch and verify green LED labeled HEATER lights. If LED lights, go to Step 11. Otherwise, go to Step 9.
9. Press TEST HEATER LED switch to verify LED is working. If LED is OK, but does **not** light when TEST HEATER switch is pressed, a serious circuit failure has been detected.

**10-8-2 GE Magnet ERU Test (continued)**

10. Contact your MAC Team Leader, MR RSE, or the OLC 24hr. Magnet Support Line at 1-800-321-7937 for correct troubleshooting procedure.
11. Test heater B by pulling SELECT HEATER switch handle out while pushing handle right to position B.
12. Press TEST HEATER switch and verify green LED labeled HEATER lights. If LED lights, go to Step 15. If LED does **not** light, go to Step 13.
13. Press TEST HEATER LED switch to verify LED is working. If LED is OK, but does **not** light when TEST HEATER switch is pressed, a serious circuit failure has been detected.



**AVOID A QUENCH OF MAGNET! DO NOT USE AN OHMMETER ON QUENCH HEATER CIRCUITS OR IN SWITCH HEATER CIRCUITS ON AN ENERGIZED MAGNET.**

14. Contact your MAC Team Leader, MR RSE, or the OLC 24hr. Magnet Support Line at 1-800-321-7937 for correct troubleshooting procedure.
15. Return SELECT HEATER switch to center position.



**IF ERU FAILS TEST, ARRANGE FOR IMMEDIATE REMEDIAL SERVICE. FAILURE TO HAVE AN OPERATING ERU WILL PREVENT BRINGING DOWN THE MAGNETIC FIELD IN THE EVENT OF AN EMERGENCY.**

**Note**

ERU units with serial number 049 and higher include an unlabeled red LED (DS4) above EMERGENCY RUN DOWN switch. This indicator will light and stay lit under the following conditions:

- TEST HEATER switch is pressed and SELECT HEATER switch is in center position.
- Selected heater is an open circuit.
- Someone attempted to quench magnet and either the heater circuit was open or SELECT HEATER switch was **not** set to A or B position.

DS-4 is only an indicator and will **not** inhibit ERU operation once SELECT HEATER switch is changed to A or B position.

Reset DS-4 by momentarily pressing S-6 on printed circuit board.

**10-9 INSPECT MAGNET EMERGENCY RUNDOWN UNIT (ERU)**

Refer to appropriate section:

- Oxford magnet, Section 10-9-1
- GE magnet, Section 10-9-2 10-

**9-1 Oxford Magnet ERU Inspection**

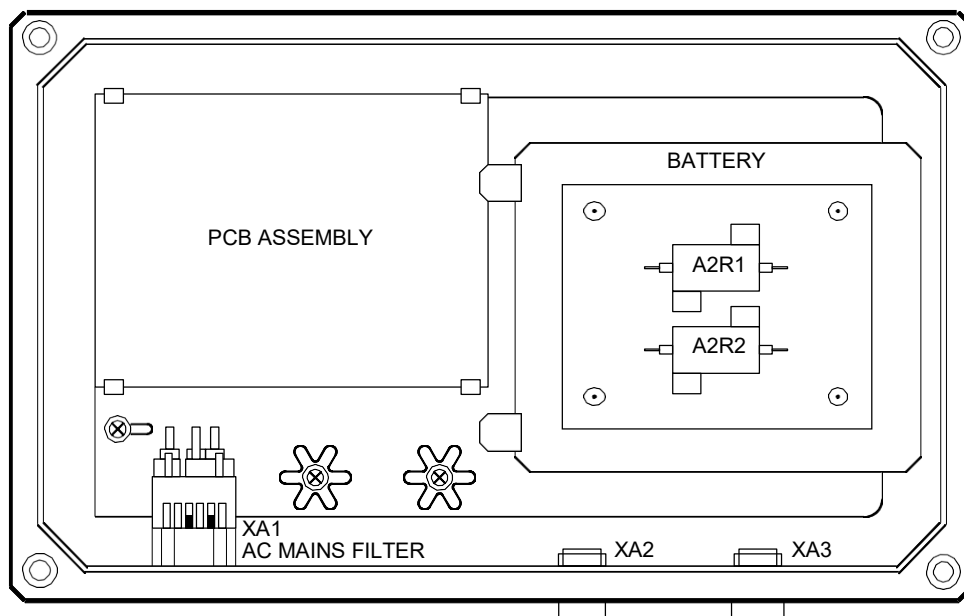


**AVOID A QUENCH OF MAGNET! DO NOT ATTEMPT ANY TESTS OR MAINTENANCE ON ERU MODULE UNLESS YOU ARE THOROUGHLY FAMILIAR WITH IT.**

**Note**

Check storage area for location of battery charger in the event ERU battery needs recharge. The Oxford ERU has an internal low current trickle charger. The external high current charger is required to initially charge replacement batteries or to recharge batteries that are found to be discharged.

1. Make and install a sticker indicating Panel location and Breaker location.
2. Locate facility electrical power panel and shut OFF appropriate circuit breaker to disconnect power to ERU.
3. Open front cover and inspect entire ERU for overheating or discoloration.
4. Remove battery hold-down plate and look for evidence of corrosion around battery or at battery terminals. See Illustration 10-25. If any signs of leakage are found, arrange for a battery replacement (46-235706P403).



**ERU INTERNAL LAYOUT (OXFORD MAGNET)**  
 ILLUSTRATION 10-25

**10-9-1 Oxford Magnet ERU Inspection (continued)**

5. Reinstall battery hold-down plate.
6. Reconnect ERU power.
7. Replace battery every 3 years.
  - a. Determine data for next battery replacement.
  - b. Mark this date on a piece of tape and affix to battery.
8. Enter in the Site Log the date the battery is due for replacement. (You may want to indicate the replacement battery part number is 46-235706P403.)

**10-9-2 GE Magnet ERU Inspection**



**AVOID A QUENCH OF MAGNET! DO NOT ATTEMPT ANY TESTS OR MAINTENANCE ON ERU MODULE UNLESS YOU ARE THOROUGHLY FAMILIAR WITH IT.**

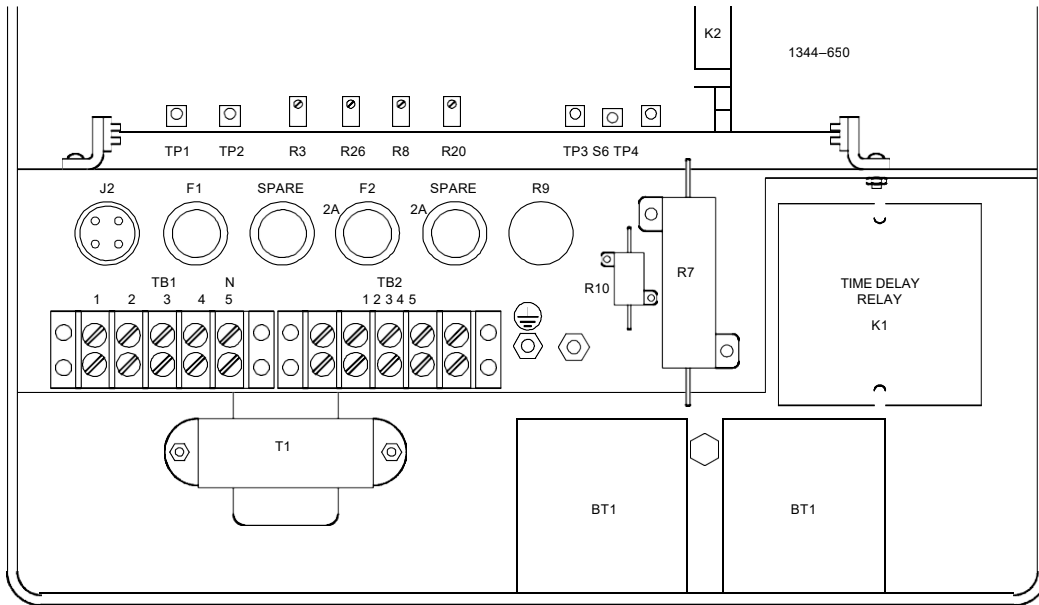


**AVOID A QUENCH OF MAGNET! MERCURY WETTED RELAY IN ERU FRONT PANEL MUST NOT BE BUMPED OR TILTED BEYOND ±15° WHILE SWITCH HEATER CABLE IS CONNECTED TO PANEL. BEWARE OF ERU'S MOUNTED ON HINGED OR SLOPING PANELS.**

1. Make and install a sticker indicating Panel location and Breaker location.
2. Locate facility electrical power panel; shut off appropriate circuit breaker to disconnect power to ERU.
3. Open front cover and inspect entire ERU for overheating or discoloration.
4. Remove fuse F2 to isolate batteries from ERU circuits.

10-9-2 GE Magnet ERU Inspection (continued)

5. Remove battery hold-down plate and look for evidence of corrosion around battery or at battery terminals. See Illustration 10-26. If any signs of leakage are found, arrange for a battery replacement (46-281302P14).



ERU INTERNAL LAYOUT (GE MAGNET)  
 ILLUSTRATION 10-26

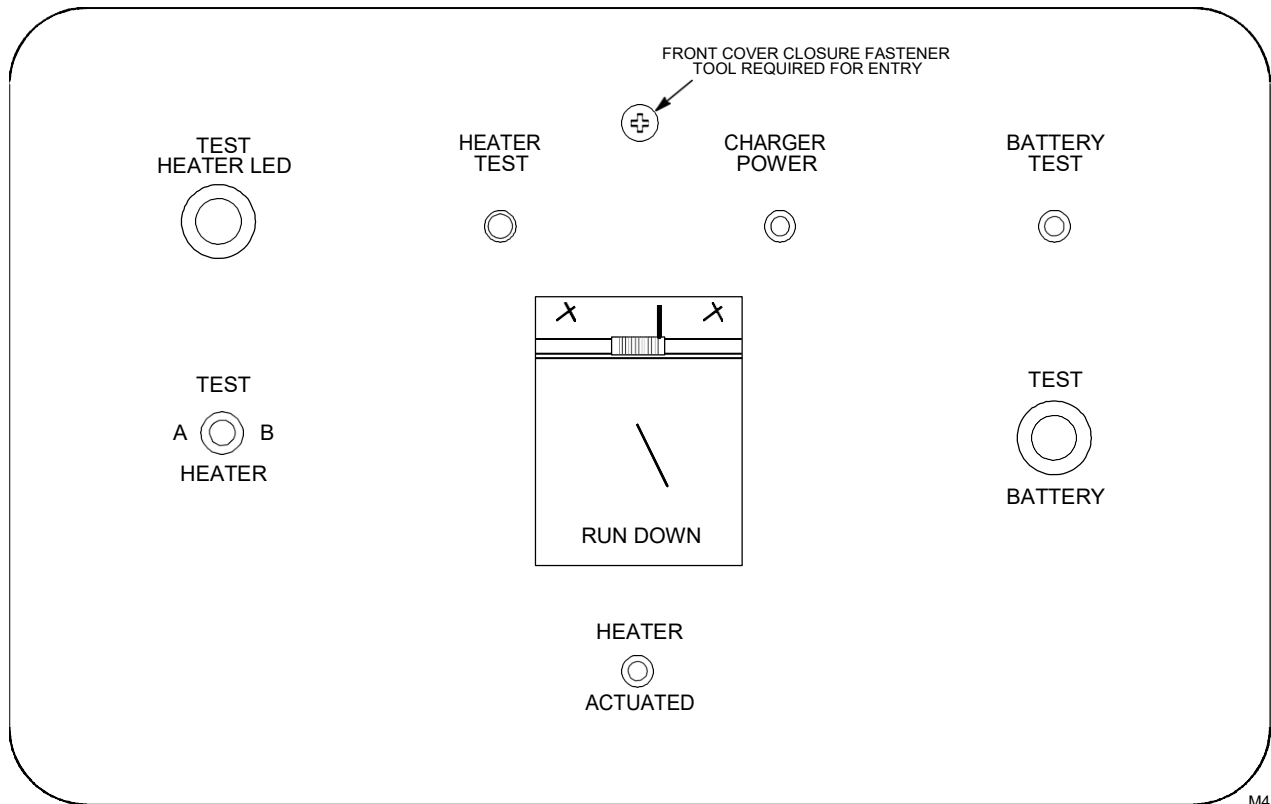
6. Check capacitor C1 on circuit board for leakage.
7. Reinstall fuse F2 and battery hold-down plate.
8. Reconnect ERU power.
9. Replace battery every 3 years.
  - a. Determine date for next battery replacement.
  - b. Mark this date on a piece of tape and affix to battery.
10. Enter in the Site Log the date the battery is due for replacement. (You may want to indicate the replacement battery part number is 46-281302P14.)

10-10 TEST GE MAGNET RUNDOWN UNIT (MRU)



**AVOID A QUENCH OF MAGNET! DO NOT ATTEMPT ANY TESTS OR MAINTENANCE ON MRU MODULE UNLESS YOU ARE THOROUGHLY FAMILIAR WITH IT. NO PM STEP WILL ASK YOU TO PRESS [EMERGENCY RUNDOWN] BUTTON IN CENTER OF MRU MODULE.**

1. Verify green LED on front panel is lit (indicating battery charger has power). See Illustration 10-27.



**MRU FRONT PANEL LAYOUT**  
 ILLUSTRATION 10-27

2. Press TEST BATTERY switch. Green LED labeled BATTERY will light if battery is OK. If LED lights, go to Step 7. Otherwise, go to Step 3.
3. Open front cover and check for 20.7V between TP-1 and TP-2 on circuit board. If voltage is 20.7V or greater the comparator circuit or the LED driver circuit require adjustment or repair. If the voltage is below 20.7V, proceed with Steps 4, 5, and 6.
4. Check for an open battery fuse F2. If blown, replace with a 2.5A fuse.

**10-10 TEST GE MAGNET RUNDOWN UNIT (MRU) (continued)**

5. Visually inspect battery for signs of leakage.
6. Remove fuse F2 and check battery voltage. If battery replacement is needed, order three 6V, Gel Cell batteries (46-294231P5 ).
7. Press TEST HEATER switch to position A and verify green LED labeled HEATER lights. If LED lights, go to Step 10. Otherwise, go to Step 8.
8. Press TEST HEATER LED switch to verify LED is working. If LED is OK, but does **not** light when TEST HEATER switch is pressed, a serious circuit failure has been detected.



**AVOID A QUENCH OF MAGNET! DO NOT USE AN OHMMETER ON QUENCH HEATER CIRCUITS OR IN SWITCH HEATER CIRCUITS ON AN ENERGIZED MAGNET.**

9. Contact your MAC Team Leader, MR RSE, or the NSC 24hr. Magnet Support Line at 1-800-321-7937 for correct troubleshooting procedure.
10. Press TEST HEATER switch to position B and verify green LED labeled HEATER lights. If LED lights, go to Step 13. If LED does **not** light, go to Step 11.
11. Press TEST HEATER LED switch to verify LED is working. If LED is OK, but does **not** light when TEST HEATER switch is pressed, a serious circuit failure has been detected.
12. Contact your MAC Team Leader, MR RSE, or the NSC 24hr. Magnet Support Line at 1-800-321-7937 for correct troubleshooting procedure.
13. Replace front cover.



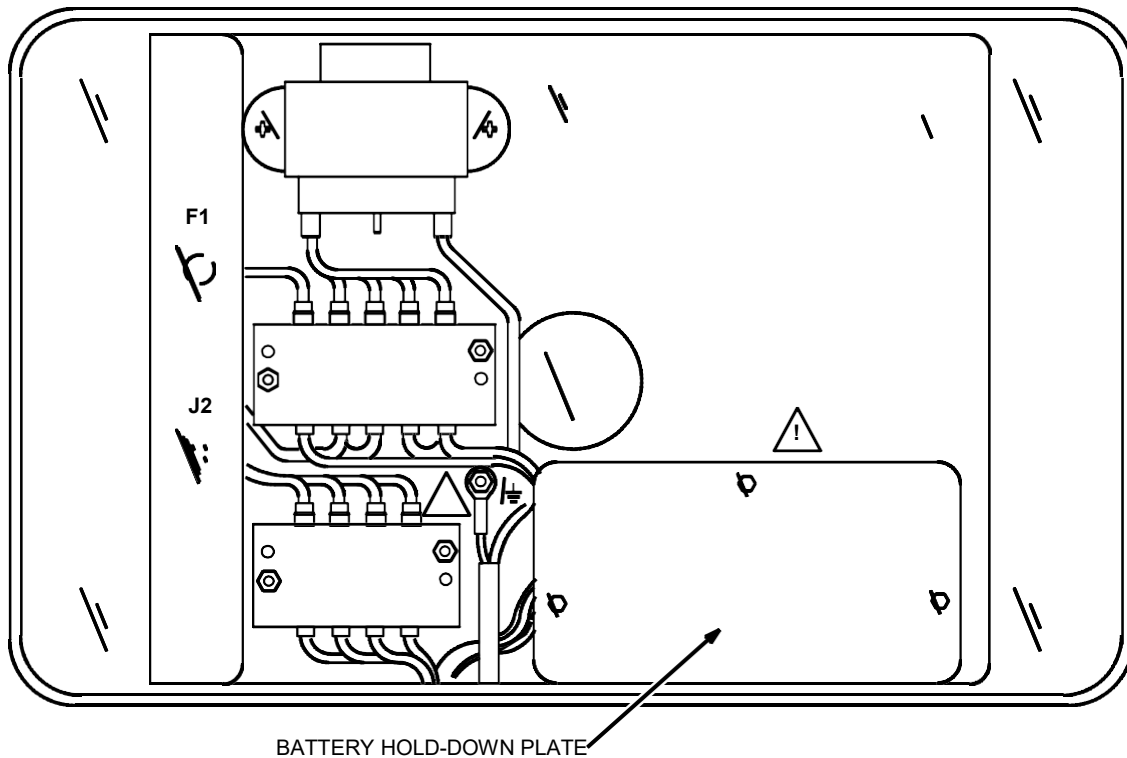
**IF ERU FAILS TEST, ARRANGE FOR IMMEDIATE REMEDIAL SERVICE. FAILURE TO HAVE AN OPERATING MRU WILL PREVENT BRINGING DOWN THE MAGNETIC FIELD IN THE EVENT OF AN EMERGENCY.**

10-11 INSPECT GE MAGNET RUNDOWN UNIT (MRU)



**AVOID A QUENCH OF MAGNET! DO NOT ATTEMPT ANY TESTS OR MAINTENANCE ON MRU MODULE UNLESS YOU ARE THOROUGHLY FAMILIAR WITH IT.**

1. Make and install a sticker indicating Panel location and Breaker location.
2. Locate facility electrical power panel and shut off appropriate circuit breaker to disconnect power to MRU.
3. Open front cover and remove fuse F2 to isolate batteries from MRU circuits.
4. Remove quench heater connection from J2.
5. Inspect entire unit for overheating or discoloration.
6. Remove battery hold-down plate and look for evidence of corrosion around battery or at battery terminals. See Illustration 10-28. If any signs of leakage are found, arrange for a battery replacement (46-294231P5).



MRU INTERNAL LAYOUT  
 ILLUSTRATION 10-28

**10-11 INSPECT GE MAGNET RUNDOWN UNIT (MRU) (continued)**

7. Check capacitor C1 on circuit board for leakage.
8. Reinstall fuse F2 and battery hold-down plate.



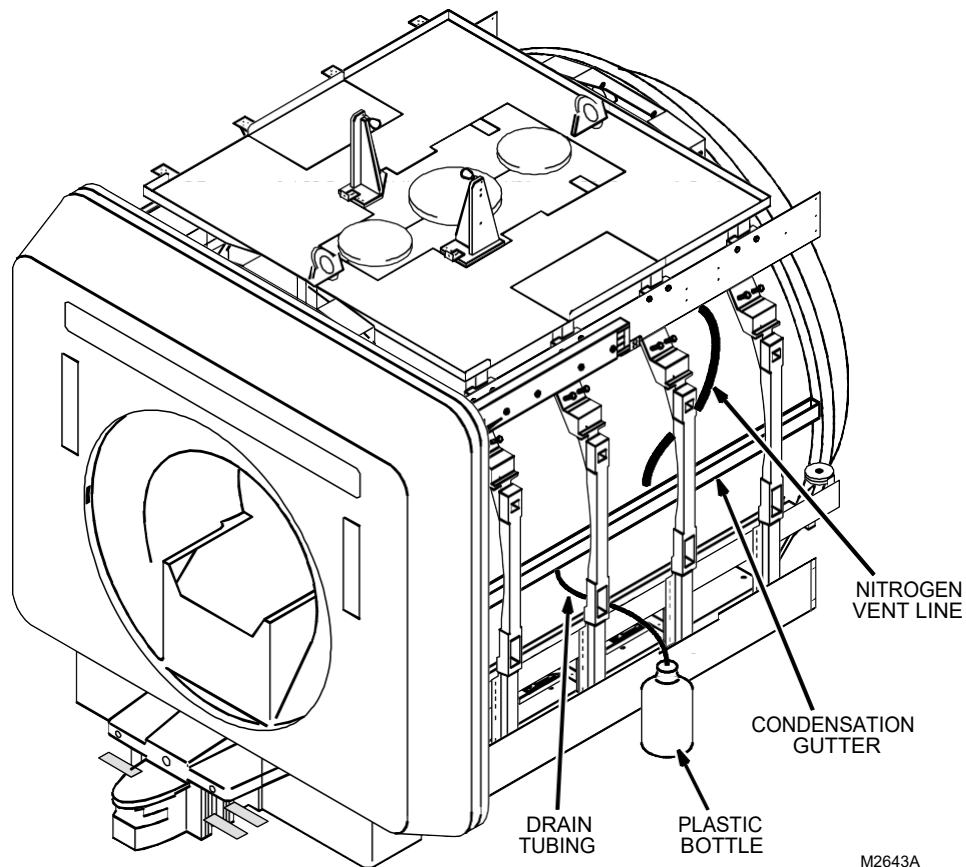
**PREVENT AN INADVERTENT MAGNET QUENCH BY ENSURING THAT HEATERS ARE NOT CONNECTED TO J2.**

9. Connect 20 ohm 5% 20 watt ceramic test resistor between lugs 1 and 2 of TB2.
10. Connect a DVM across the resistor.
11. Press the RUN DOWN button. The DVM should read approximately 20 volts for more than 30 seconds.
12. Allow at least three minutes for thermal time switch S4 to reset.
13. Move the test resistor from lugs 1 and 2 of TB2 to lugs 3 and 4 of TB2.
14. Connect a DVM across the resistor.
15. Press the RUN DOWN button. The DVM should read approximately 20 volts for more than 30 seconds.
16. Disconnect the DVM and remove the test resistor.
17. Reconnect MRU power.
18. Replace battery every 3 years.
  - a. Determine date for next battery replacement.
  - b. Mark this date on a piece of tape and affix to battery.
19. Enter in the Site Log the date the battery is due for replacement. (You may want to indicate the replacement battery part number is 46-294231P5.)

**10-12 CHECK AND EMPTY COLLECTION BOTTLES (GE S-I AND OXFORD MAGNETS ONLY)**

FMI 60181 provided a means to collect and remove condensation that forms on the magnet service turret and exhaust lines during filling, ramping, and normal operation. The following parts were installed on both the left and right sides of the magnet: a nitrogen vent line, a condensation gutter, a drain tube, and a collection bottle. See Illustration 10-29.

1. Open enclosure covers on one side of magnet.
2. Check liquid level in collection bottle, and empty as necessary.
3. Make sure nitrogen vent line is directed toward condensation gutter.
4. Also, check that drain tube is securely attached to gutter on one end and fully inserted into bottle at the other end.
5. When check is complete, close side covers.
6. Repeat Steps 1 through 5 on other side of magnet.



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**CONDENSATION COLLECTION**  
 ILLUSTRATION 10-29

**10-13 INSPECT CTI SYSTEM (OXFORD MOBILE MAGNETS ONLY)**

**10-13-1 Inspect CTI System**

1. Visually inspect and listen to two cold-head refrigerators (70 rpm) at top of magnet for the following:
  - Sounds of ratcheting, knocking, or banging (may indicate contamination in cold-head system)
  - Look in sight glass on each cold-head for smooth clockwise rotation of drive crank
  - Look for signs of discoloration or debris (dirt, metal chips, etc).
2. Contact your support engineer if any problems are found.
3. Read pressure gauge on front of both CTI compressors. Dynamic pressure should read 60 to 90 psi while compressors are operating. Needle should fluctuate minimum of 15 psi. If less than 10 psi, cold head is suspect.
4. Turn compressors OFF and check for a static pressure of 230 to 240 psi at 70°F (21°C). Pressure may be less with colder cooling water temperature. See Illustration 10-28 for details.
5. Turn ON compressors.
6. Record compressor's static pressure on PM Report, and if desired on the Cryostat Performance Log (Table 10-1) in Site Log Book.

**Note**

Refer to Appendix F to increase (recharge) or decrease (bleed off) helium gas pressure.

- a. If pressure is low, schedule recharging with 99.999% purity helium gas (certified gas).
  - b. If pressure is high, bleed off excessive gas.
7. Use your hand to check that water temperature of inlet is slightly cooler than temperature of discharge cooling water from operation compressors.
  8. If discharge water temperature is warm to touch, check temperature with a thermometer. If temperature is above 85°F (29°C), arrange for chiller repair as soon as possible.
  9. Check inlet water temperature with a thermometer. If temperature is above 75° F (24° C), arrange for chiller repair as soon as possible.
  10. Determine last replacement date of adsorbers. Schedule semi-annual CTI adsorber replacement (refer to Section 10-13-2 for adsorber replacement procedure). Separate site access time must be arranged with customer for adsorber replacement. Approximate replacement time for both adsorbers varies with trailer type:
    - Ellis & Watts Van: approximately 2 hours
    - Calumet Coach (compressors mounted side-by-side): approximately 2 hours
    - Calumet Coach (one compressor mounted in front of the other): approximately 8 to 12 hours.

**10-13-1 Inspect CTI System (continued)**

**Note**

The six month CTI adsorber replacement interval varies from manufacturer's original recommendation of annual replacement. CTI determined that charcoal filter in adsorber breaks down with mobile van vibration, and small bits of charcoal are released contaminating cold-heads. Vans that are not moved can extend the replacement interval to one year.

- Record each adsorbers replacement date in Site Log. You may want to also mark the next date replacement is due on an external tag on the compressor. Indicate the replacement adsorber part number is 46-255952P656.

**10-13-2 Replace CTI Adsorber**



**SHOCK HAZARD! ALWAYS DISCONNECT CRYOCOOLER FROM ALL SOURCES OF ELECTRICAL POWER BEFORE PERFORMING ANY MAINTENANCE.**

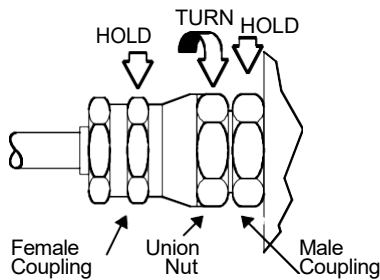
- Disconnect input power cable of compressor from electrical power source.

**Note**

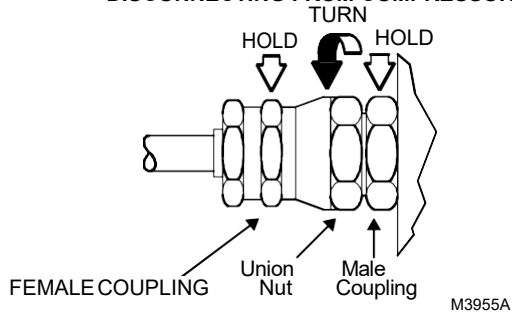
For detailed instructions on connecting and disconnecting Aeroquip couplings, refer to Appendix G.

- Disconnect self-sealing couplings from gas-return and gas-supply connectors at rear of compressor. Hold one wrench on male coupling while loosening union nut with other wrench. See Illustrations 10-30 and 10-29. Next, hold body of fitting with a wrench to prevent it from rotating while further loosening union nut.

**CONNECTING TO COMPRESSOR**



**DISCONNECTING FROM COMPRESSOR**



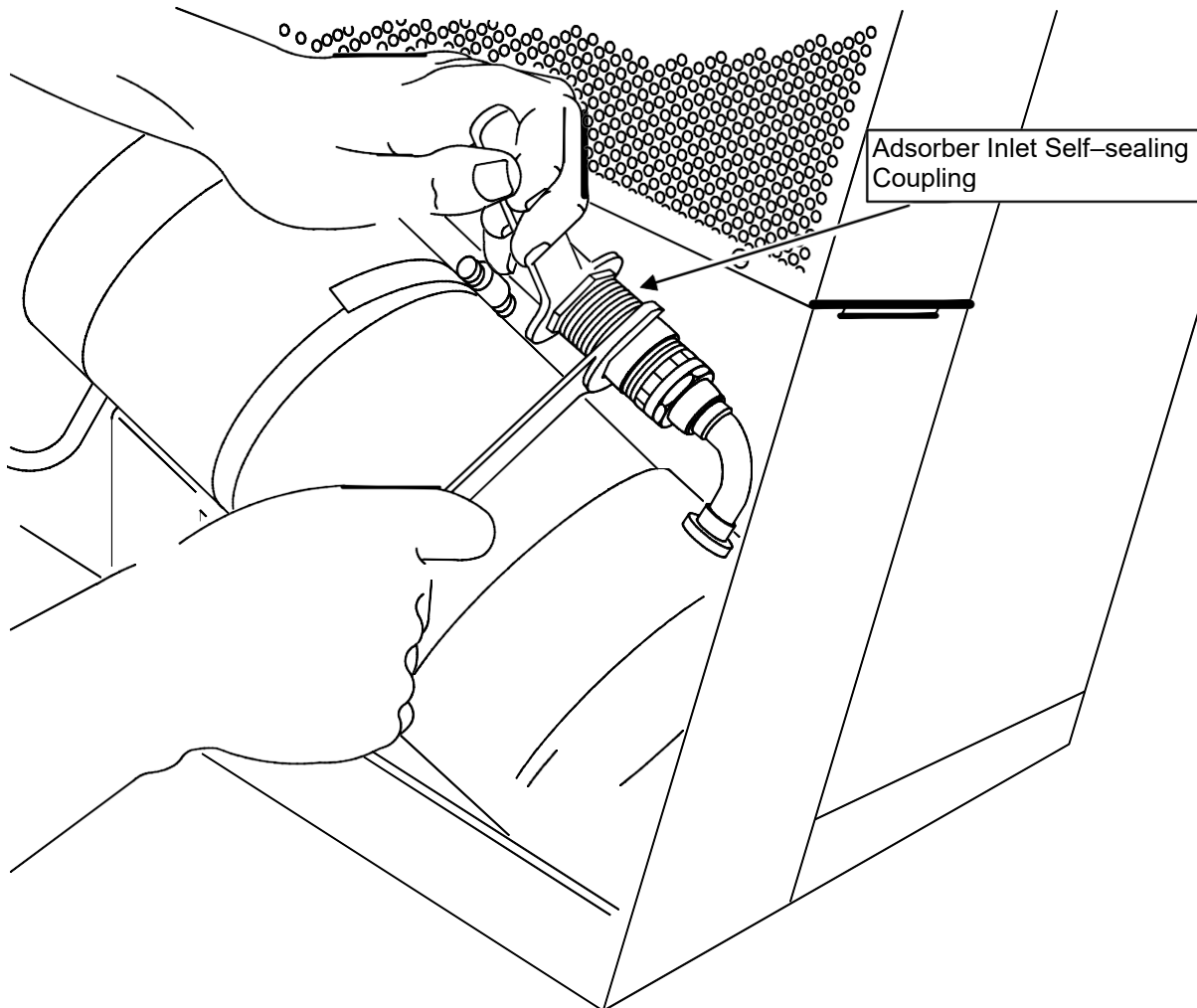
**COMPRESSOR COUPLING  
 ILLUSTRATION 10-30**

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**10-13-2 Replace CTI Adsorber (continued)**

**Note**

Use two wrenches to avoid twisting flexible tube from compressor. See Illustration 10-31.



**DISCONNECTING ADSORBER SELF-SEALING COUPLING**  
 ILLUSTRATION 10-31

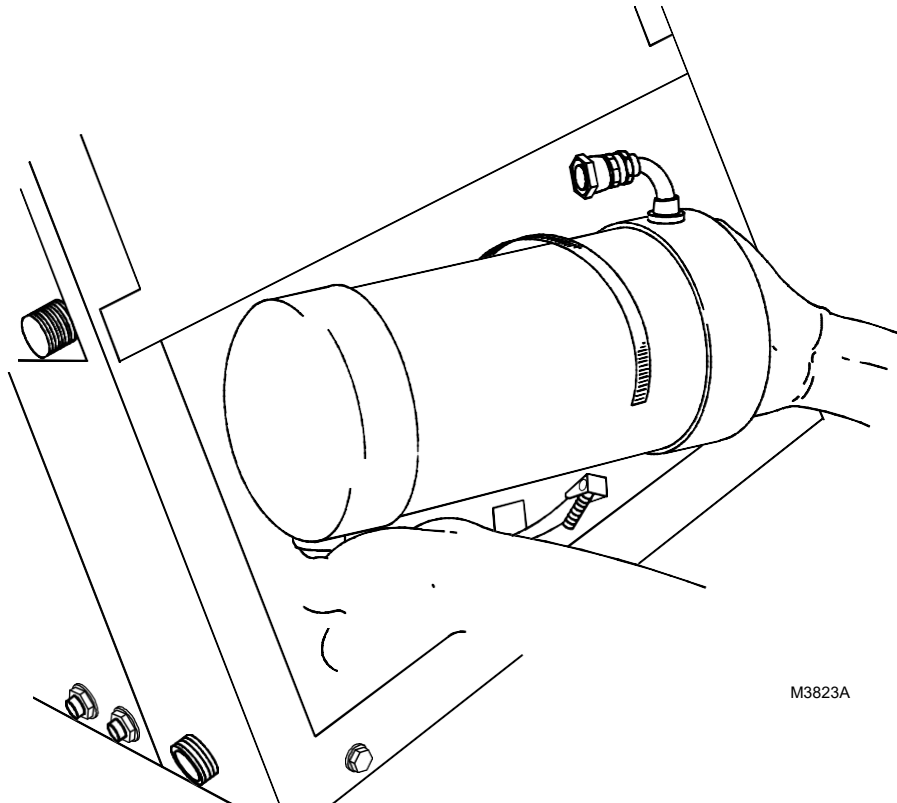
**Note**

Complete disconnection quickly to minimize gas loss.

3. Unscrew two self-sealing coupling halves. Minor gas leakage may occur while turning connecting half.
4. Remove cover from compressor by loosening four screws that secure cover to compressor.
5. Disconnect adsorber inlet self-sealing coupling. See Illustration 10-31. Save all hardware.
6. Remove jam nut and washer that secure adsorber outlet self-sealing coupling to chassis.

**10-13-2 Replace CTI Adsorber (continued)**

7. Disconnect clamp from around body of adsorber. Carefully slide adsorber forward until outlet self-sealing coupling clears chassis. Remove adsorber, referring to Illustration 10-32.



REMOVING ADSORBER  
 ILLUSTRATION 10-32

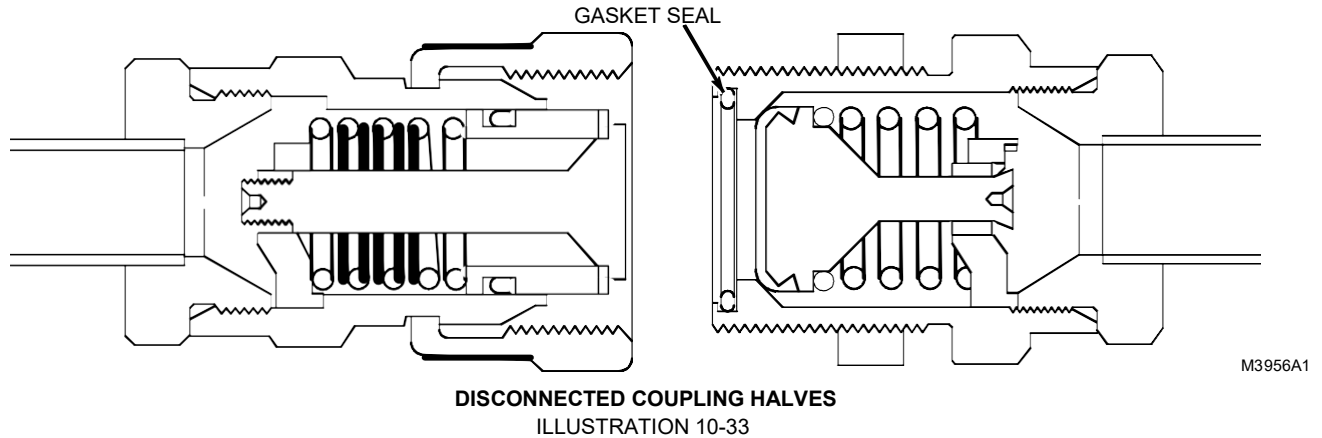


**DEPRESSURIZE ADSORBER BEFORE DISPOSING OF IT. THE ADSORBER IS UNDER SYSTEM PRESSURE OF 230PSI WHEN DISCONNECTED FROM THE CHASSIS. THIS COULD CAUSE SERIOUS PERSONAL INJURY IF NOT DEPRESSURIZED BEFORE DISPOSAL.**

8. To depressurize adsorber, attach depressurization fitting (#12 Aeroquip, included in installation tool kit) to coupling at either end of adsorber and slowly tighten. Dispose of depressurized adsorber, but do not dispose of hardware.
9. Remove dust caps from self-sealing coupling halves at each end of replacement adsorber.
10. Install replacement adsorber using hardware saved during removal procedure.

**10-13-2 Replace CTI Adsorber (continued)**

11. Check that gasket seal is clean and in place before connecting self-sealing coupling. See Illustration 10-33.



**Note**  
 Use two wrenches to avoid twisting flexible tube from compressor.

**Note**  
 Complete connection quickly to minimize gas loss.

12. Screw two self-sealing coupling halves together. Turn by hand until threads engage. Minor gas leakage may occur while tightening coupling.
13. Be sure coupling is firmly seated; do **not** apply more than 35 foot-pounds of torque. Stop immediately if threads bottom out.
14. While compressor cover is off, confirm oil is visible in compressor sight glass. Refer to troubleshooting guide in CTI Compressor manual if no oil is visible.

**Note**  
 Complete connection quickly to minimize gas loss.

15. Reconnect self-sealing couplings from gas-return and gas-supply connectors at rear of compressor. Screw two self-sealing coupling halves together. Turn by hand until threads engage. Minor gas leakage may occur while tightening connection. If necessary, refer back to Step 2 and Illustration 10-31 for correct wrench locations.
16. Replace and secure cover on compressor.
17. Reconnect input power cable to electrical power source.
18. Check that pressure gauge reads 225–230 psig (1550–1585 kPa). If additional gas pressure is required, follow instructions in CTI Compressor manual.
19. Note date of adsorber replacement. Write this date on decal provided with replacement adsorber. Affix decal to front of compressor.

**10-14 RECORD CRYOSTAT PRESSURE AND FLOWRATES (GE MAGNETS ONLY)**

GE Magnets depend on helium exhaust vapor to cool various heat penetration paths into helium cryostat. Cryostats are designed to operate at a positive pressure to insure proper vapor flow. A balance of vapor cooling versus heat penetration must be maintained for efficient helium boil-off performance. Consult with your MAC (Magnet And Cryogen Team) engineer or your support engineer if abnormal pressures or flow rates are found.

1. With stable GE S-II, S-III, S-IV, 1.0T SX, and CX Magnets, check the following:
  - Cryostat pressure = 0.25 – 0.5 psig. Pressures over 0.5 psi may indicate problems that should be investigated. Confer with your magnet support people if the pressure problem persists or increases for no apparent reason.
  - F1 flow rate = 0.40 – 0.60 scfh (0.8 – 1.2) for S-IV and SX Magnets
  - F2 flow rate = 1.50 – 2.00 scfh (1.8 – 2.2) for S-IV and SX Magnets
  - Cryostat pressure gauge = 0.25 to 0.50 psig. (Refer to Direction 2159496, Setup & Cal, Section 1-1.)
  - F1 flow rate = 1.8 – 2.2 scfh for CX Magnets
  - F2 flow rate = 0.8 – 1.2 scfh for CX Magnets

Record flows to Table 10-1, Cryostat Performance Log.

2. Arrange for replacement of missing or broken gauges.
3. GE SI Magnets only: Increased boil-off or increasing cryostat pressure may indicate problems in the P-3 cryo-plug vapor cooling. Schedule a check of flowrates associated with the P-3 plug. (Refer to Appendix F.)
4. Check for ice build-up in fill port of GE S-II, S-III, and MAX Magnets. Observe cryogen safety precautions in the following procedure.
  - Put on cryogen safety faceshield and cryogen handler's gloves
  - Remove Fill Port Plug from fill valve (V-1), and slowly open V-1 until a plume is present coming out of Fill Port (V1). An ice buildup in the fill line will partially block or completely prevent a plume from forming. After noting the quality of the helium vapor plume, quickly close V-1 and reinstall the Fill Port Plug. If a blockage is found, arrange for a de-icing of the helium fill line. Contact your MAC Team Leader or OLC's 24 hr. Magnet Support line (1-800-321-7937) for the fill line deicing procedure currently being used.

**10-15 INSPECT LEYBOLD SYSTEM (REPLACE ADSORBER EVERY 24,000 HOURS) (GE MAGNETS ONLY)**

**10-15-1 Inspect Leybold System**

1. Check compressor hour meter on front of compressor. Adsorber must be replaced after 24,000 hours of compressor run time.
2. Review records to verify adsorber was replaced on schedule. If adsorber is **not** scheduled for replacement, go to Step 3. If adsorber should be replaced, order a replacement adsorber (T3487MP) and schedule an immediate adsorber replacement (refer to Section 10-15-2 for adsorber replacement procedure).
3. Calculate when next replacement is due (replace after 24,000 hours).
4. Record calculated adsorber replacement date on Site Log and on your schedule. You may also want to mark the next date replacement is due on an external tag on the compressor. Indicate the replacement adsorber part number is T3487MP.
5. Connect Lakeshore Diode Temperature Current Source Meter (46-317543G1) to the cable connected to the coldhead diode port (plug is located on coldhead mounting sleeve).

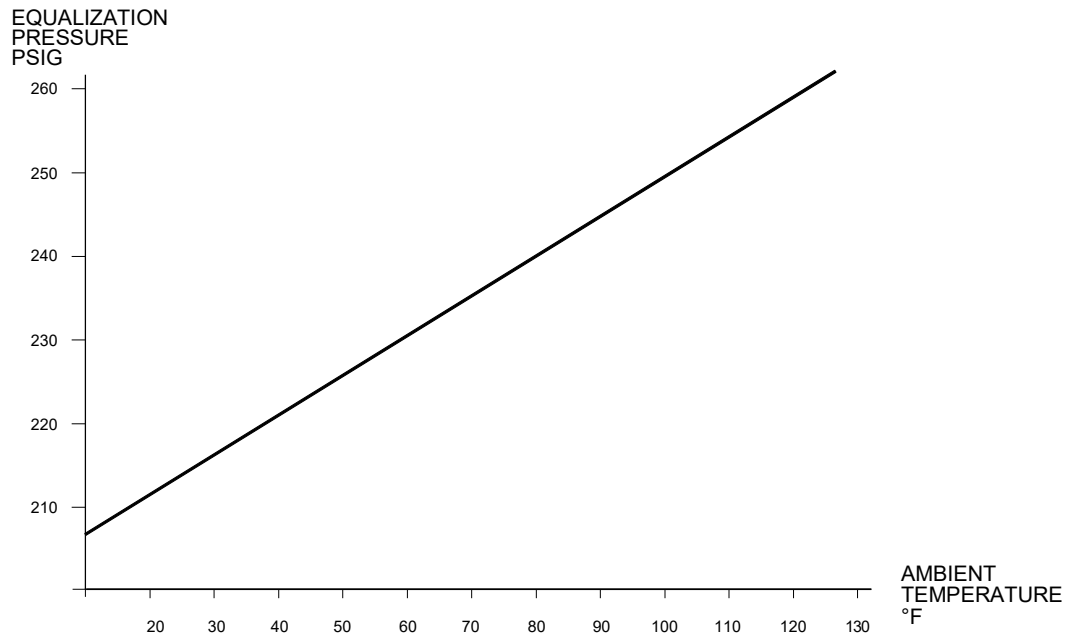
**Note**

The diode cable (46-318042P1) was added to each magnet via FMI 60374 to facilitate use of the low cost Lakeshore thermometer along with your DVM to take diode temperatures.

6. Temperature should read:
  - 32° to 60°K (First Stage Shield temperature)
  - 7° to 17°K (Second Stage Shield temperature).
7. Record First Stage and Second Stage shield temperatures on Magnet PM Report and on the Cryostat Performance Log (Table 10-1) in Site Log Book.
8. If shield temperature is out of spec, helium boil-off, cryostat pressure, and F1 and F2 flowrates can all increase. To find cause of temperature increase, check the following:
  - Is operator intermittently turning the Leybold OFF during scans?
  - Is something wrong with compressor cooling water temperature, flow rate or flow direction?
  - Is low equalized helium pressure indicated on compressor gauges?
  - Are cold-head mounting bolts tightened correctly? Refer to CD-ROM Direction 2180500-1, GE Magnet Subsystems, for the correct cold head procedures.
  - Is compressor phase incorrect?
  - Is cold-head contaminated?

**10-15-1 Inspect Leybold System (continued)**

9. Turn compressor OFF and allow static gas pressure to equalize on supply and return gauges located on front of compressor.
  
10. Record equalized pressure on PM Report and on the Cryostat Performance Log (Table 10-1) in Site Log Book. Pressure should be 218 - 232 psig at 70°F (21°C). Illustration 10-32 shows relationship of pressure to temperature. If pressure is **not** as specified, refer to Appendix F for instructions on increasing or decreasing helium gas pressure.



**Note**

If cooling water or room temperature is colder, helium gas contracts, and pressure will be lower. For instance, at 55°F (13°C), a pressure as low as 223 psig can be at lower end of acceptable pressure range. If compressor is at 110°F (43°C), normal 235 psig will increase to 254 psig. If compressor has been OFF for some time, cold water temperature will cause pressure to drop considerably. Running compressor for a while will bring it back up again. Refer to chart to determine appropriate pressure ranges for your site.

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**LEYBOLD PRESSURE RANGE**  
 ILLUSTRATION 10-32

**10-15-2 Replace Leybold Adsorber**

1. Disconnect electrical power to compressor.

**Note**

For detailed information on connecting and disconnecting Aeroquip couplings, refer to Appendix G.

2. Remove both supply and return gas lines at compressor to isolate cold-head from compressor.
3. Disconnect Aeroquip fitting between adsorber and compressor.
4. Loosen locking screw that holds adsorber to compressor frame and remove adsorber.

**Note**

Certian Leybold absorbers have 2 extra bolts that secure the absorber to the compressor. There are nuts that must be removed to replace the absorber which are accessed underneath the compressor. There are more details concerning this absorber in Direction 2213170, Errata Notes for Certian GE Magnet Systems on the magnet CD.

5. Inspect Aeroquip fittings to be sure they are clean and that all gaskets are in place.
6. Position replacement adsorber in place. Connect compressor Aeroquip fitting, then tighten locking screw. Since adsorber is shipped with a small helium charge, some sound may be heard as higher pressure gas from compressor enters adsorber. Tighten Aeroquip fittings completely.
7. Attach both supply and return gas lines at compressor.
8. Check static charge of compressor. Lower pressure within adsorber may have reduced overall pressure of system. If so, recharge system to required pressure. See Appendix F for procedure.



**DEPRESSURIZE ADSORBER BEFORE DISPOSING OF IT. THE ADSORBER IS UNDER SYSTEM PRESSURE OF 230 PSI WHEN DISCONNECTED FROM THE CHASSIS. THIS COULD CAUSE SERIOUS PERSONAL INJURY IF NOT DEPRESSURIZED BEFORE DISPOSAL.**

9. To depressurize adsorber, slowly screw depressurization fitting (#8 Aeroquip) onto top of Aeroquip fitting of used adsorber. Point bleed fitting away from personnel.

**10-16 INSPECT BALZERS SYSTEM (REPLACE ADSORBER EVERY 26,000 HOURS) (GE MAGNETS ONLY)****10-16-1 Inspect Balzers System**

1. Check compressor hour meter on front of compressor. Adsorber must be replaced after 26,000 hours of compressor run time.
2. Review records to verify adsorber was replaced on schedule. If adsorber is **not** scheduled for replacement, go to Step 3. If adsorber should be replaced, order a replacement adsorber (46-281034P11) and schedule an immediate adsorber replacement (refer to Section 10-16-2 for adsorber replacement procedure).
3. Calculate when next replacement is due (replace after 26,000 hours).
4. Record calculated adsorber replacement date on Site Log and on your schedule. You may also want to mark the next replacement due date on an external tag on the compressor. Indicate the replacement adsorber part number is 46-281034P11.
5. Connect Lakeshore Diode Temperature Current Source Meter (46-317543G1) to the cable connected to the coldhead diode port (plug is located on coldhead mounting sleeve).

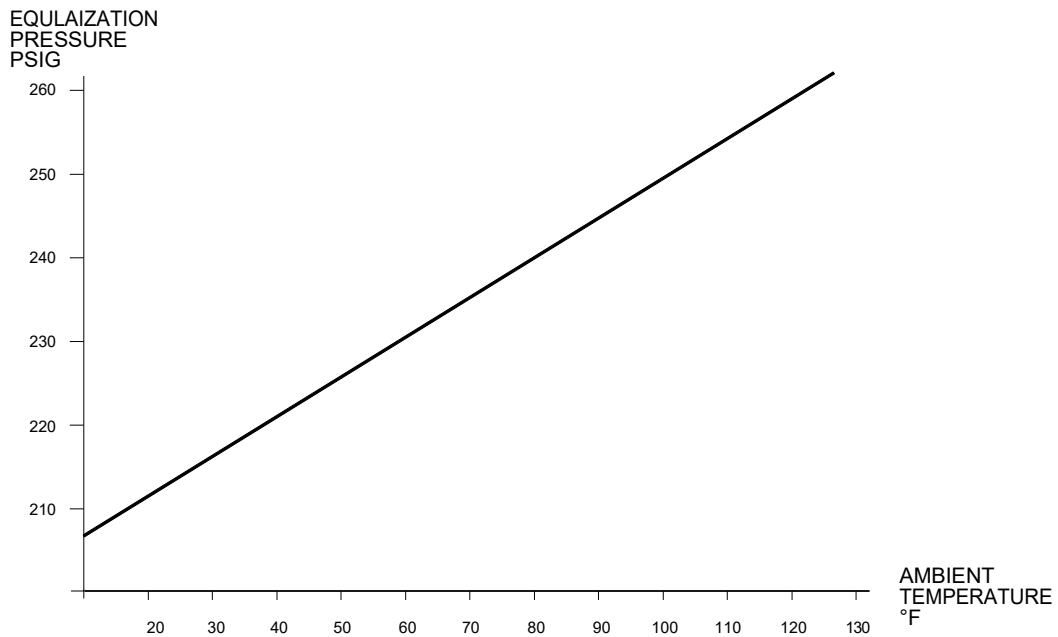
**Note**

The diode cable (46-318042P1) was added to each magnet via FMI 60374 to facilitate use of the low cost Lakeshore thermometer along with your DVM to take diode temperatures.

6. Temperature should read:
  - 32° to 60°K (First Stage Shield temperature)
  - 7° to 17°K (Second Stage Shield temperature).
7. Record First Stage and Second Stage shield temperatures on Magnet PM Report and on the Cryostat Performance Log (Table 10-1) in Site Log Book.

**10-16-1 Inspect Balzers System (continued)**

8. If shield temperature is out of spec, helium boil-off, cryostat pressure, and F1 and F2 flowrates can all increase. To find cause of temperature increase, check the following:
  - Is operator intermittently turning balzers OFF during scans?
  - Is something wrong with compressor cooling water temperature, flow rate or flow direction?
  - Is low equalized helium pressure indicated on compressor gauges?
  - Are cold-head mounting bolts tightened correctly? Refer to Direction 15120, GE Magnet & Cryogenics Subsystem, Replacement/Maintenance tab, Section 9, Cold-Head Replacement Procedure.
  - Is compressor phase incorrect?
  - Is cold-head contaminated?
9. Turn compressor OFF and allow static gas pressure to equalize on supply and return gauges located on front of compressor.
10. Record equalized pressure on PM Report and on the Cryostat Performance Log (Table 10-1) in Site Log Book. Pressure should be 230 - 240 psig at 70°F (21°C). Illustration 10-33 shows relationship of pressure to temperature. If pressure is **not** as specified, refer to Appendix F for instructions on increasing or decreasing helium gas pressure.



**Note**

If cooling water or room temperature is colder, helium gas contracts, and pressure will be lower. For instance, at 55°F (13°C), a pressure as low as 223 psig can be at lower end of acceptable pressure range. If compressor is at 110°F (43°C), normal 235 psig will increase to 254 psig. If compressor has been OFF for some time, cold water temperature will cause pressure to drop considerably. Running compressor for a while will bring it back up again. Refer to chart to determine appropriate pressure ranges for your site.

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**BALZER PRESSURE RANGE**  
 ILLUSTRATION 10-33

**10-16-2 Replace Balzers Adsorber**

1. Disconnect electrical power to compressor.

**Note**

For detailed information on connecting and disconnecting Aeroquip couplings, refer to Appendix G.

2. Remove both supply and return gas lines at compressor to isolate cold-head from compressor.
3. Remove cover and skin from compressor.
4. Loosen and remove two hex-head screws which attach adsorber to compressor frame.
5. Loosen top and bottom Aeroquip fittings of adsorber at the same time until both are completely free and adsorber can be removed.
6. Inspect Aeroquip fittings on tubes that lead to and from replacement adsorber to be sure they are clean and that all gaskets are in place.
7. Position replacement adsorber in place. Connect top and bottom Aeroquip fittings of adsorber at the same time. Since adsorber is shipped with a small helium charge, some sound may be heard as higher pressure gas from compressor enters adsorber. Tighten Aeroquip fittings completely. Stop when threads bottom out.
8. Record date and compressor hours on the new adsorber and also in the Site Log.
9. Bolt adsorber in place using two hex-head screws.
10. Check static charge of compressor. Lower pressure within adsorber may have reduced overall pressure of system. If so, recharge system to required pressure. See Appendix F for procedure.



**DEPRESSURIZE ADSORBER BEFORE DISPOSING OF IT. THE ADSORBER IS UNDER SYSTEM PRESSURE OF 230 PSI WHEN DISCONNECTED FROM THE CHASSIS. THIS COULD CAUSE SERIOUS PERSONAL INJURY IF NOT DEPRESSURIZED BEFORE DISPOSAL.**

11. To depressurize adsorber, slowly screw depressurization fitting (#12 Aeroquip) onto top of Aeroquip fitting of used adsorber. Point bleed fitting away from personnel.

**10-17 INSPECT SUMITOMO SYSTEM (REPLACE ADSORBER EVERY 20,000 HOURS) (GE MAGNETS ONLY)**

**10-17-1 Inspect Sumitomo 10 Kelvin Systems**

1. Check compressor hour meter on front of compressor. Adsorber must be replaced after 20,000 hours of compressor run time.
2. Review records to verify adsorber was replaced on schedule. If adsorber is **not** scheduled for replacement, go to Step 3. If adsorber should be replaced, order a replacement adsorber (2172241) and schedule an immediate adsorber replacement (refer to Section 10-17-3 for adsorber replacement procedure).
3. Calculate when next replacement is due (replace after 20,000 hours).
4. Record calculated adsorber replacement date on Site Log and on your schedule. You may also want to mark the next replacement due date on an external tag on the compressor. Indicate the replacement adsorber part number is 2172241.
5. Connect laptop to the magnet monitor using a 9 pin female to 9 pin female null modem cable. Login name is **MMService** password is **MagnetMonitor** (Case sensitive)
6. Go to the **Diagnose** -> **graph** screen. Plot out magnet vessel pressure for several hours. Verify that vessel pressure is cycling between 3.9psi and 4.1psi.
7. Select **HDC** (heater duty cycle). Plot the duty cycle for maximum number of days. A consistent duty cycle indicates that the magnet is thermally stable. A decreasing duty cycle indicates that the magnet thermal performance is decreasing. If HDC is decreasing or near zero perform the following checks.
8. Check shield temperature, it should read 32 to 60k.
9. Check RUO temps. Note, the magnet monitor is not accurate; there can be an error margin of 15%. You may need to use the RUO meter (part number 2171219) for accurate readings. Actual values should be between 4.1 and 4.5k. The delta "T" between coldhead and recondenser RUO should be less than .30K.
10. Select **Diagnose** -> **graph** -> **day**. Plot out helium level for maximum number of days. Verify a consistent helium level. If the helium level is decreasing, there may be a leak in the magnet. Perform leak troubleshooting as documented in the LCC Magnet manual 2192624.
11. Select **Diagnose** -> **graph** -> **day**. Plot out the water temp and water flow for maximum number of days. Verify that the water temp and flow to the compressor is consistent. Report any abnormalities to the site maintenance staff.
12. Select **Diagnose** -> **Table** -> **CDC** (Compressor Duty Cycle). View the last few month's data. Verify that the compressor has been on for greater than 95%. Report any abnormalities to the site maintenance staff.
13. Turn compressor OFF and allow static gas pressure to equalize on supply and return gauges located on front of compressor.
14. Record equalized pressure on PM Report and on the Cryostat Performance Log (Table 10-1) in Site Log Book. Pressure should be  $214 \pm 3$  psig at 70°F (21°C). If pressure is **not** as specified, refer to Appendix F for instructions on increasing or decreasing helium gas pressure.

### 10-17-2 Inspect Sumitomo 4 Kelvin Systems

1. Check compressor hour meter on front of compressor. Adsorber must be replaced after 20,000 hours of compressor run time.
2. Review records to verify adsorber was replaced on schedule. If adsorber is **not** scheduled for replacement, go to Step 3. If adsorber should be replaced, order a replacement adsorber (2172241) and schedule an immediate adsorber replacement (refer to Section 10-17-3 for adsorber replacement procedure).
3. Calculate when next replacement is due (replace after 20,000 hours).
4. Record calculated adsorber replacement date on Site Log and on your schedule. You may also want to mark the next replacement due date on an external tag on the compressor. Indicate the replacement adsorber part number is 2172241.
5. Connect laptop to the magnet monitor using a 9 pin female to 9 pin female null modem cable. Login name is **MMService** password is **MagnetMonitor** (Case sensitive)
6. Go to the **Diagnose** -> **graph** screen. Plot out magnet vessel pressure for several hours. Verify that vessel pressure is cycling between 3.9psi and 4.1psi.
7. Select **HDC** (heater duty cycle). Plot the duty cycle for maximum number of days. A consistent duty cycle indicates that the magnet is thermally stable. A decreasing duty cycle indicates that the magnet thermal performance is decreasing. If HDC is decreasing or near zero perform the following checks.
8. Check shield temperature, it should read 35 to 42k.
9. Check RUO temps. Note, the magnet monitor is not accurate; there can be an error margin of 15%. You may need to use the RUO meter (part number 2171219) for accurate readings. Actual values should be between 4.1 and 4.5k. The delta "T" between coldhead and recondenser RUO should be less than .30K.
10. Select **Diagnose** -> **graph** -> **day**. Plot out helium level for maximum number of days. Verify a consistent helium level. If the helium level is decreasing, there may be a leak in the magnet. Perform leak troubleshooting as documented in the LCC Magnet manual 2192624.
11. Select **Diagnose** -> **graph** -> **day**. Plot out the water temp and water flow for maximum number of days. Verify that the water temp and flow to the compressor is consistent. Report any abnormalities to the site maintenance staff.
12. Select **Diagnose** -> **Table** -> **CDC** (Compressor Duty Cycle). View the last few month's data. Verify that the compressor has been on for greater than 95%. Report any abnormalities to the site maintenance staff.
13. Turn compressor OFF and allow static gas pressure to equalize on supply and return gauges located on front of compressor.
14. Record equalized pressure on PM Report and on the Cryostat Performance Log (Table 10-1) in Site Log Book. Pressure should be  $236 \pm 3$  psig at 70°F (21°C). If pressure is **not** as specified, refer to Appendix F for instructions on increasing or decreasing helium gas pressure.

**10-17-3 Replace Sumitomo Adsorber**

The Oil Mist Adsorber is required to be replaced every 20,000 hours of operation.

TABLE 10-2  
**ADSORBER FOR COMPRESSOR UNIT**

ITEM	DESCRIPTION	QTY.	PART NUMBER	REMARKS
1	Adsorber	1	RE71TN0408	OD155 X H447

TABLE 10-3  
**REQUIRED TOOLS**

ITEM	TOOL	DESCRIPTION
1	1" Open-end wrench	For Aeroquip coupling
2	1-1/8" Open -end wrench	For Aeroquip coupling
3	1-3/16" Open-end wrench	For Aeroquip coupling
4	Liquid Leak Detector	For leak check
5	Cotton wipers	For leak check
6	13 mm Open-end wrench	For fixing nut for Adsorber
7	Phillips Screw driver (+)	For side panel of Compressor Unit



**ELECTRICAL SHOCK HAZARD! DISCONNECT THE COMPRESSOR UNIT FROM ALL ELECTRICAL POWER SOURCE BEFORE PERFORMING ANY MAINTENANCE PROCEDURE TO AVOID ELECTRICAL SHOCK.**

**Preparation**

1. Shut down the Cryocooler.
2. Disconnect the Input Power Cable from the Compressor Unit.
3. Disconnect the Supply and Return Flex Lines from the Compressor Unit.

**10-17-3 Replace Sumitomo Adsorber (continued)**

**Removing the Sumitomo Adsorber**

1. Loosen the screws that hold the compressor side panel and remove side panel. See Illustration 10-34.

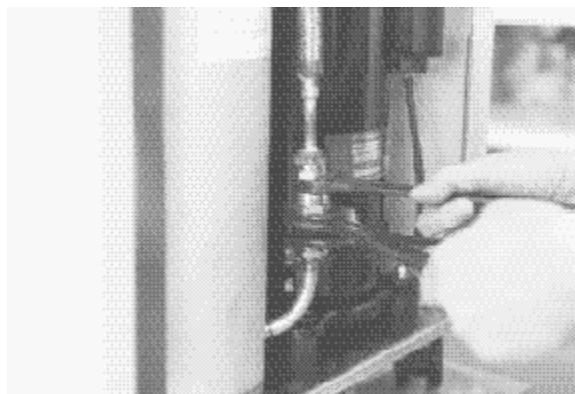


**SIDE PANEL REMOVED**  
 ILLUSTRATION 10-34



The aeroquip fittings will usually bleed off 3 bar (45 psi) of helium gas pressure each time the lines are disconnected and reconnected to the Coldhead or compressor. This requires a helium gas recharge with 99.999% purity helium gas any time the gas line connections are removed and reconnected.

2. Disconnect the Adsorber Self-Sealing Coupling. Use three wrenches. See Illustration 10-35.

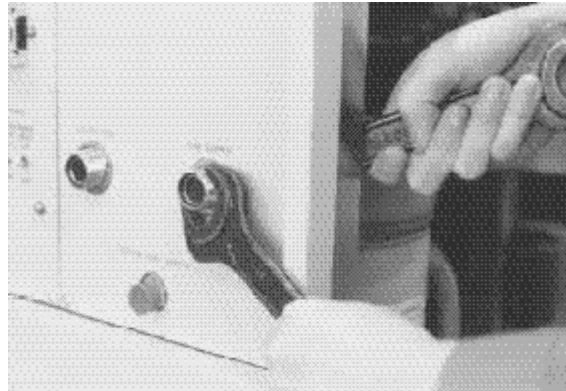


**DISCONNECTING ADSORBER SELF-SEALING COUPLING**  
 ILLUSTRATION 10-35

### 10-17-3 Replace Sumitomo Adsorber (continued)

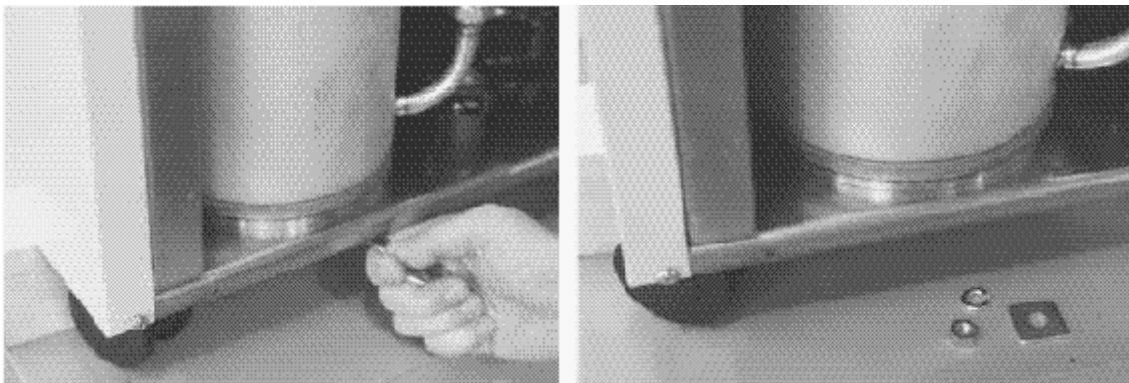
#### Removing the Sumitomo Adsorber (continued)

3. Remove the Nut securing the Adsorber to the Rear Panel. Use two wrenches. See Illustration 10-36.



**NUT SECURING ADSORBER TO REAR PANEL**  
ILLUSTRATION 10-36

4. Remove the nut and washer securing the Adsorber to the base panel of the Compressor Unit. See Illustration 10-37.



**REMOVING BASE PANEL NUT AND WASHER**  
ILLUSTRATION 10-37

**10-17-3 Replace Sumitomo Adsorber (continued)**

**Removing The Sumitomo Adsorber (continued)**

5. Remove the used Adsorber from the Compressor frame. See Illustration 10-38.



**REMOVING ADSORBER**  
 ILLUSTRATION 10-38

**Installing The Sumitomo Adsorber**

1. Place new Adsorber in the Compressor Unit.
2. Secure the Adsorber to the base panel of the Compressor Unit by tightening the nut and washer.
3. Secure the Adsorber to the rear panel by tightening nut.



**The aeroquip fittings will usually bleed off 3 bar (45 psi) of helium gas pressure each time the lines are disconnected and reconnected to the Coldhead or compressor. This requires a helium gas recharge with 99.999% purity helium gas any time the gas line connections are removed and reconnected.**

4. Connect the Adsorber Self-Sealing Coupling.



**Check the flat rubber gasket of the self-sealing connector to be clean and properly positioned before connection. Make the first turns by hand and the firmly seal the connection using three wrenches. Make the connection quickly to minimize minor gas leakage.**

5. Reinstall the side panel and secure them by tightening the screws.
6. Ensure that the pressure gauge indication is the specified value for the type of Cold head. Charge helium gas according to the steps in Appendix F.

**10-18 PERFORM OXFORD MOBILE SPECIFIC INSPECTIONS**

1. Check tightness of Oxford ramp lead connections at rear of Magnet Ramp Power Supply and at both sides of penetration panel. Check for signs of corrosion or arcing at these connections.
2. Check pressure in magnet helium vessel. If no pressure is indicated check for vapor leaks in the mobile helium exhaust circuit. Common leak sources have been found in the pressure relief valves and worn or chaffed O-Ring seals in the head assembly of the High Efficiency Ramp Probe.

**10-19 INSPECT OXFORD WATER COOLED POWER SUPPLY VALVE**

1. Visually inspect all water fittings to the water cooled ramp and shim supplies in the equipment room for signs of leaks or corrosion. Touch the fittings checking for signs of wetness, but do not try to check the tightness of an established fitting with a wrench as that may cause a leak at the fitting where none existed before your inspection. Arrange for any indicated remedial service.
2. This step calls for a shutdown of the Water Cooled Shim Power Supply. Verify that the water flow valve inside the Oxford water cooled Shim Power Supply stops the flow of water when the power supply is turned off. You can usually hear the water flowing through the cooling lines and the sound stops when the power supply is turned off. Arrange for a remedial service call should the water continue to flow with the power supply turned off. The valve can usually be restored by disassembly and cleaning (or replacement if indicated). Failure to stop the cooling water flow usually causes condensation to form on the water-cooled transistor heat sink assemblies when they are not operating. Of course this leads to failure of the transistor banks and sometimes replacement of the entire power supply when power is restored.
3. Allow 15 minutes for the shim field to stabilize after power is restored before performing subsequent Image Quality scanning.

**10-20 CHECK/REPLACE EDM BATTERY**

**Note**

This procedure applies only to Equipment Diagnostic Monitor (EDM) equipped systems. Field experience indicates the battery should be replaced every two years.

**Battery Replacement Check**

1. Check rear of EDM for a label mounted near the power supply following the previous battery replacement. It should indicate the date of the last battery replacement. Schedule the battery replacement on a date near a two-year interval from that time.
2. If the label is not found and the last battery replacement date is unknown. Schedule the battery replacement for the next site visit. If the label is not found but the date of the last battery replacement is known write it on a piece of tape and fix it to the rear of the EDM near the power supply.

**Battery Replacement**

Before you begin, you need the following tools:

- #2 Phillips screwdriver
- Static wrist strap
- Battery and label (2145430)

**10-20 CHECK/REPLACE EDM BATTERY (continued)**

**Remove the EDM Cover**

1. Do NOT turn off power to the EDM.

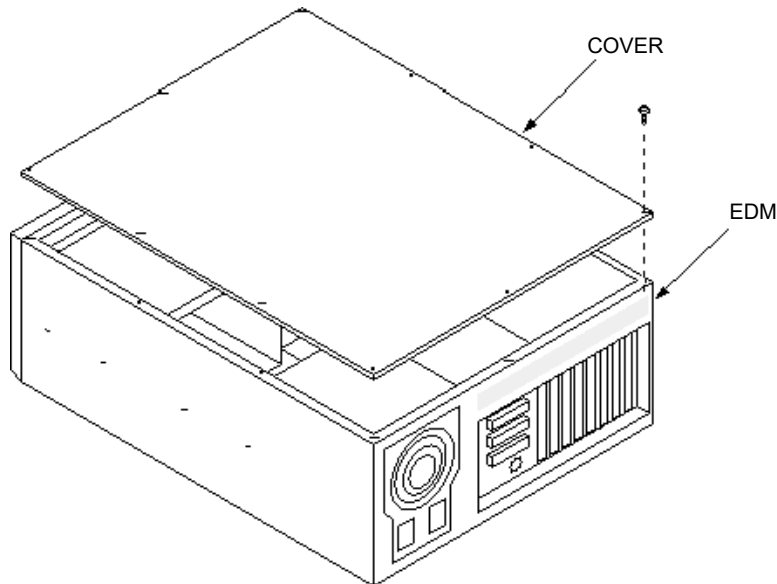


**Do NOT power down the EDM. If the EDM inadvertently loses power while the battery is disconnected, nonvolatile memory will be lost. You will need to replace the EDM.**

2. Turn off the power to the modem (switch on rear panel of modem). Remove the Interface Box (if already installed), modem, and any power supplies from the top of the EDM.
3. If the EDM is rack mounted, pull the EDM forward.
4. Remove the screws securing the top cover of the EDM and lift off the cover. See Illustration 10-39.



**Equipment Damage Potential. The EDM contains static sensitive components. These static sensitive components may be damaged if not handled in a static free environment. Take appropriate precautions (e.g., wear a properly grounded wrist strap) when handling the EDM.**



**REMOVING THE EDM COVER**  
 ILLUSTRATION 10-39

**10-20 CHECK/REPLACE EDM BATTERY (continued)****Replace the Battery****Note**

Some EDMs have a barrel-style battery that is soldered on to the motherboard and, therefore, cannot be removed. These motherboard styles have a connector that permits the addition of a new block battery (2145430) without the need to remove the existing battery.

1. Before removing the old battery from the EDM (if possible), note the position of the red wire in the battery.
2. Make sure that the EDM still has power. If the EDM loses power while the battery is removed, you will need to replace the EDM.
3. Remove the old battery.
4. With the red wire oriented in the same position as it was in the old battery, place the new battery (2145430) in the EDM.
5. Secure the battery to the chassis using the provided Velcro™.

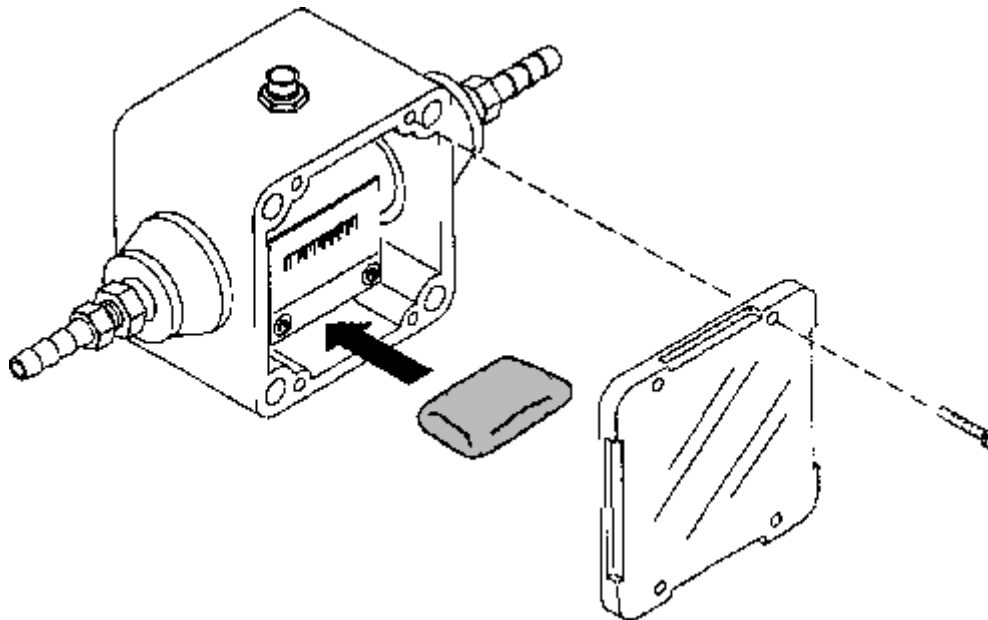
**Re-install the EDM**

1. Re-install the cover of the EDM using the original cover screws.
2. Reposition the EDM in the rack (if rack mounted).
3. Complete the label indicating when the battery was replaced.
4. Place the label near the power supply on the rear of the EDM.
5. Replace the Interface Box, modem, and any power supplies.

### 10-21 CHANGE DESICCANT PACK ON MAGNET MONITORING WATER FLOWMETER

Order a desiccant packet (2135979) to place in the sensor. To install the desiccant, refer to the following steps and Illustration 10-40.

1. Remove the four screws on the cover (viewing window) of the Water Flow & Temperature Sensor. Remove the cover.
2. Place the desiccant packet beside the plate, so the packet will not interfere with any moving parts in the sensor.
3. Check the cover gasket and reposition it (if necessary) to maintain a good seal.
4. Replace the cover and re-install the four screws.



PLACEMENT OF DESICCANT IN WATER FLOW & TEMPERATURE SENSOR  
ILLUSTRATION 10-40

## 10-22 INSPECT FLOW METER FOR MAGNET MONITOR

### Note

The water flow sensor has been known to fail with the physical sensor remaining in one position. The mode of failure can occur when fluids with a high mineral content are used to cool the compressor.

1. To test the sensor, restrict the water flow at the input of the water temperature/flow sensor. If there is a valve on the chiller output, close the valve half way.
  - If you do not have a valve you can use a vice-grip pliers on the hose to restrict water flow.
  - You should see the flow rate start to decrease.
2. If the mechanical flow meter does not move, the flow sensor (T3487PY) may be defective and should be replaced. Do not restrict water flow for more than 1 minute, or the cryocooler compressor could overheat.