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SMD Operations Procedures Manual

8.1.3.13 OPERATION OF MODEL 4000 REFRIGERATOR (MAGCOOL REFRIGERATOR)

Text Pages 1 through 10

Hand Processed Changes

HPC No.	Date	Page Nos.	Initials

Revision No. 03 Approved:

Signature on File 5/14/2013
Division Head Date

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8.1.3.13 Operation of Model 4000 Refrigerator (MAGCOOL Refrigerator)

1.0 Purpose

This procedure provides instruction for STARTUP/SHUTDOWN and operation of the MAGCOOL Refrigerator Model 4000 for either testing a magnet in MAGCOOL or for liquefying helium for vertical test.

2.0 Responsibilities and Scope

2.1 Operator is responsible for STARTUP/SHUTDOWN and operation of the refrigerator.

2.2 Operator is responsible for the control of environmental aspects as defined in course number AM-ENV-FS6 “Cryogenic System Maintenance”.

3.0 Prerequisites

3.1 Operator shall be instructed by a supervisor or designee.

3.2 Instruction shall include the MYCOM compressor, Low Temperature System on MAGCOOL, MODEL 4000 Refrigerator and the WET EXPANDER.

4.0 Precautions

4.1 Hearing protection shall be worn in the Compressor Rooms.

4.2 Ensure only authorized personnel are near units to be operated.

5.0 Procedure

Refrigerator can be operated for testing magnet in MAGCOOL or liquefying helium for vertical test. On the CRISP control page D7, turn ON Low Temp. logic to allow helium to be circulated from Refrigerator through Low Temperature Cold Box. DOV3 should be opened automatically, if not open manually.

5.1 Set pressure controller to 220 psig.
Start MYCOM compressor.
At Refrigerator set the following valves:

5.1.1 Turn on LN_2 supply valve #N1001A from the LABVIEW page on the PC.

5.1.2 PC-1 Controller in **MANUAL** and closed.

5.1.3 PI/TC-1 Controller in **MANUAL** and closed.

5.1.4 PC-3 Controller in **MANUAL** and closed.

5.1.5 TC-1 Controller in **MANUAL** and open.

5.1.6 At CRT, display page D23 "Refrigerator Cooldown By-pass Control Logic". D24, D23, D22 and D20 are the four by-pass valves given in the simplified schematic of the MAGCOOL refrigerator as shown in Figure 1. Temperature TI15, located in front of the Ejector in the Low Temp Cold Box, is used for cooldown by-pass control since helium flow through the ejector under most operations.

When TI15 is greater than 140 K, helium returns through D24.
When TI15 is between 140 and 80 K, helium returns to D23.
When TI is between 80 and 11 K, helium returns to D22.
Below 11 K, helium returns to D20.

The cooldown criteria can be switched to Manual Mode. When MAGCOOL refrigerator is used in conjunction with Wet Expander for liquefaction mode, the last by-pass D20 can be switched in when TI15 reaches about 20 K.

Trends for helium leaving and returning the refrigerator are given in the lower portion of page D23 for process monitoring.

Figure 1 Display of control page D23 for cooldown control of HEUB refrigerator

5.1.7 Close valves D22, D23 and D20.

5.1.8 Open valve D24.

5.1.9 Set "**ENABLE/RESET By-pass Valve Logic**" Flag **RED** move cursor to **RED PART OF FLAG** and **PRESS CLOSE or OFF KEY** then **PRESS OPEN or ON KEY.**

5.1.10 The **FLAG** should be all **RED** and this means the computer logic will operate the refrigerator bypass valves.

5.2 For testing a magnet in MAGCOOL, Cooldown 1 or Cooldown 2 must be completed. Helium will flow through DOV3 when gas flow is started. Start gas flow through refrigerator and Low Temperature system.

5.2.1 Crack open refrigerator inlet valve MV 205.

5.2.2 When pressure at PI1002 reaches 245 PSIA open valve fully.

5.2.3 Remove jacks from engine.

5.2.4 Start engines E-19 and E-20, set speed at 180 RPM.

5.2.5 Manually crack open valve PI/TC-1 controller until pressure is 165 psi then switch controller to auto.

5.2.6 If magnet in Cooldown 1 has a DONE flag and TI78 is at 80 K (in Low Temp. Cold Box), one can install Test and Measure and cool down a magnet to 4.5 K.

5.2.7 After the magnet is cold and pre and sub cooler pots are full, throttle E-19 and E-20 to approximately 120 to 150 rpm

5.2.8 Shut one of the engines off. The Refrigerator and the LOW TEMP system are now ready for testing a magnet and /or the operation of Cool Down 2. (see OPM 8.1.3.12 for Test & Measure – Bay D & E, and OPM 8.1.3.16 for Test & Measure – Bay C).

5.2.9 Set Cold Engine By Pass to avoid expanders from running too cold

5.2.9.1 At the refrigerator control panel, set Nullmatic Controller TC-1 to 10^0K in **AUTO.**

5.2.9.2 Display page D21, bring cursor to valve D-24. Press **OPEN or ON**

NOTE: ***This procedure allows some cold return helium to bypass the heat exchangers in the refrigerator if the discharge temperature of expander falls to 10 K.***

5.2.10 During the operation, the operator should periodically check pressure and temperature readings on the refrigerator local control panel.

5.2.10.1 Pressure gages PI 1002, PI 1003, PI 004, PI 1005, PI 1006, purifier on line either PI 1007 or PI 1008, PI 1009 and PI 1010.

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5.2.10.2 When the refrigerator is healthy, the pressure drop between the inlet and the outlet of the purifier should be less than 3 psi.

5.2.10.3 When the nitrogen heat exchanger is clean and valve control is proper, there should only be a 1 degree K differential between TI 1002 and TI 1010. Readings 82K to 79K and 81K to 78K depending if Refrigerator is liquefying or in the refrigeration mode

5.2.10.4 It is an indication that when Heat Exchanger E6 & E11 are clean and Engines are healthy, there should not be more then a 4 degree K differential between TI 1005 and TI 1009. Readings 3K to 19K and 19K to 17K depending if Refrigerator is liquefying or in the refrigeration mode

5.3 Control page for liquefying helium using M4000 refrigerator is given D21 as shown in Figure2. The Storage Dewars are connected to the refrigerator through Low Temp. Cold Box and the MAGCOOL Test Bay A. High pressure cold helium from HEUB and the Low Temp. Cold Box is provided to the inlet of Wet Expander and/or JT-Valve. The vapor return line is connected to AOV52 in the Low Temp. Cold Box. For liquefying helium in Storage Dewar 2 or 3 using MAGCOOL Refrigerator

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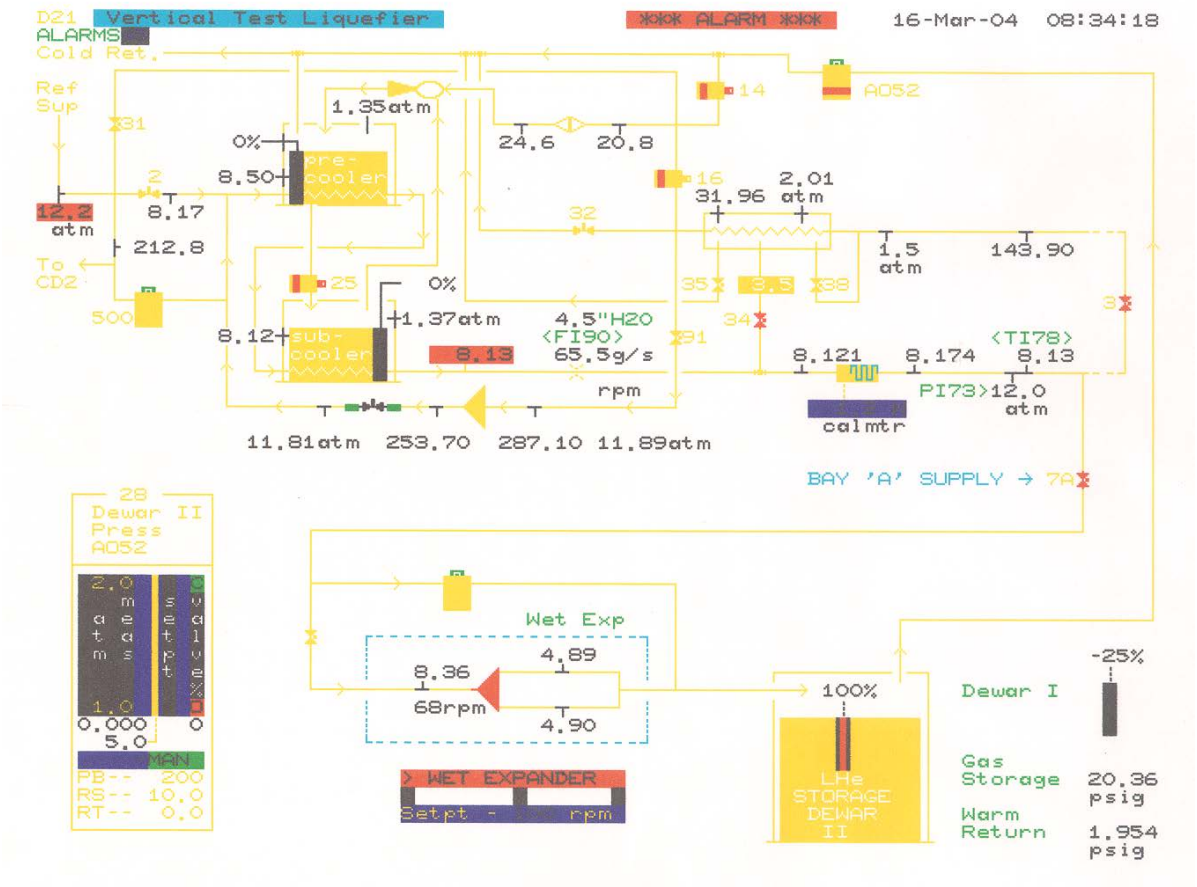

Figure 2 Display of control page D21 for operating HEUB as a liquefier

5.3.1 When inlet temperature to low temperature system is approximately 50 degrees K. Start cooldown of Return Transfer Line.

5.3.1.1 OPEN AOV 52, H 331M, H 332M and HE 4.
5.3.1.2 Crack OPEN HE 5.

5.3.2 When inlet temperature to Low Temp. system is approximately 20 degrees K. Start cool down Supply Transfer Line.

5.3.2.1 OPEN DOV 7A, MV 415 and start WET EXPANDER, typically 60 rpm.

5.3.2.2 OPEN RETURN VALVE of Storage Dewar you will use

5.3.3 When inlet temperature to Low Temp. system is approximately 10 degrees K. Select either Storage Dewar 3 or 2 for use. Start cool down into Storage Dewar you will use.

5.3.3.1 Crack open the inlet valve for the Storage Dewar you will use.

5.3.3.2 Note: pressure in the Storage Dewar will rise.

5.3.3.3 When pressure in the Storage Dewar starts to drop, close H 331M, H332M, DOV 3, DOV 34, HE 4 and HE 5.

5.3.3.4 OPEN storage dewar you will use, inlet valve.

5.3.3.5 On the local control panel of the Wet Expander, manually open the air pressure regulator of AV 7B (JT) to 1 psi open. Note: AV7B is installed in parallel with Wet Expander and is physically located above the Wet Expander.

5.3.3.6 When TI 1007 temperature (at local control panel of MAGCOOL/HEUB refrigerator) is 16 degrees K, install refrigerator into the last BY-PASS, if not there already.

5.3.3.7 When inlet temperature to Low Temp. system is approximately 9 degrees K. CLOSE AV 7B (JT) and run only the wet expander.

5.3.3.8 The system can run with JT valve AV 7B only. Set AV7B air pressure regulator to 1 3/4 psi. The liquefaction capacity is approximately 2/3 of that using Wet Expander. This mode is to be used whenever Wet Expander is not available or for the purpose of reducing liquefaction capacity.

5.3.3.9 To avoid the refrigerator (mainly expanders E19 & E20) from being too cold, a 3 way air solenoid is implemented so that JT valve will open in case the Wet Expander trips. Note: The air pressure regulator should be set for 1 ¾ psi with air supply on.

5.4 <u>To Shut down MAGCOOL Refrigerator</u>

5.4.1 If the refrigerator is to be shutdown after testing a magnet,

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5.4.1.1 On page D9, bring cursor to **TEST and MEASURE, press CLOSE or OFF. (NOTE: MAGNET needs to go into WARM UP).**

5.4.1.2 Reduce interstage press to ~45 psig at MYCOM. Reduce discharge press to ~225 psig.

5.4.1.3 Close MV 205- inlet to refrigerator, stop engines and let pressure drop to return pressure.

5.4.2 If liquefying helium into a storage dewar.

5.4.2.1 OPEN DOV 3, CLOSE DOV 7A

5.4.2.2 Stop WET EXPANDER.

5.4.2.3 Close Inlet and Outlet VALVES on storage dewar in use.

5.4.2.4 Open AV 7B (JT), H 331M, H 332M, HE 4 and HE 5

5.4.2.5 Close AOV 52, reset DOV 34.

5.4.2.6 Unload MYCOM to ~50%. Leave enough capacity to handle pump back of returning gas. When system is stable, unload and stop compressor.

5.4.3 Shut LN_2 Valve N1001A

6.0 Documentation

Documentation is kept in the CRYOGENIC Logbook located in Building 902.

7.0 References

7.1 Operations and Maintenance manual provided by CVI is kept in the CRYOGENIC Control Room located in Building 902.

7.2 An Operators Problem Guide and Operations Guide is given to all operators and a copy is kept in the CRYOGENIC Control Room located in Building 902.

7.3 Operator's Manual Model 4000 Helium Refrigerator for Brookhaven National Laboratory, August 1975. A copy is kept in the CRYOGENIC Control Room located in B902.

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7.4 Operator's Manual, Model 1600 Wet Reciprocating Helium Expansion Engine Assembly. Part No. A35421108. For Brookhaven National Laboratory, August 1985. A copy is kept in the CRYOGENIC Control Room located in B902.

8.0 Attachments

None