SMD Operations Procedures Manual

8.1.3.17 CRYOGENIC OPERATION OF TEST DEWAR #2&#3

Text Pages 1 through 9

Hand Processed Changes

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8.1.3.17 Cryogenic Operation of Test Dewar #2&#3

1.0 Purpose & Scope

This procedure provides instruction on the following operation of the Test Dewar #2&#3

- Pump & Purge Cable Test Dewar #2
- Cooldown to 100K for Cable Test Dewar #2
- Cooldown to 4.5K and 4.5K Operation for Cable Test Dewar #2
- Cooldown to 1.9K and 1.9K Operation for Cable Test Dewar #2

2.0 Responsibilities

Operator is responsible for the cryogenic operations associated with testing cable sample in Cable Test Dewar #2

2.1 After Magnet is installed in the dewar and all cryogenic lines are connected, the operator is responsible for the pump & purge operation to make sure the system is clean and leak tight.

2.2 After pump & purge is completed, the operator is responsible for cooling the Dewar including a magnet to 100K using the liquid nitrogen heat exchanger (Helium chiller). Typically, it takes twelve (72) hours to reach 110K, and overnight operation is required.

2.3 After Test Dewar #2 reaches 110K, the operator is responsible to cool the Magnet to 4.5K using helium. Unlike other Test Dewars, Dewar 2 can provide cooling at both 4.5 and 1.9K. For 1.9K operation, the operator shall follow the procedure given within. Throughout the test, the operator is responsible for maintaining proper liquid level in the dewar. Since the test demands stable temperature, the operator shall control pressure accurately. Occasionally, the magnet will quench. The stored energy is dumped into liquid helium and the pressure will rise in the dewar. The operator is responsible to cool the system back to the operating condition.

2.4 At the conclusion of the test, the operator is responsible for warming up the system to room temperature using helium flow through, keeping less then a 50k differential from top to the bottom of the magnet in test.

3.0 Prerequisites

3.1 Operator shall be instructed by a supervisor or an authorized operator.

3.2 Instruction shall include the operation of vacuum pumps, liquid nitrogen (helium chiller) heat exchangers, 1000 gallon and 10,000 Liter liquid helium storage Dewars, and warm up heaters, helium compressors and 40,000 liter Ln^2 Dewar and piping.

3.3 Instruction shall include the computer display page of the magnet in test dewar.

3.4 Instruction shall also include basic understanding of the magnet as the pressure rises after a quench is proportion to the release of magnetic stored energy.

3.5 If over-pressure protection is dependent on relief valves, the relief valves must have been tested within the previous 5 Years.

4.0 Precautions

4.1 For magnets with large magnetic stored energy, for example the DX and LHC magnets, the pressure rise after a large magnet quench could be fast and high. Without control venting, the relief valve will open and sometimes burst disc ruptures. While safety relief valves will protect the cryogenic system under such event, it takes substantial amount of effort to recover the system. In SMD operation, the magnet test operator informs the cryogenic operator prior to a magnet quench. The cryogenic operator shall respond promptly to avoid over pressure in the system.

4.2 Transfer liquid helium to test dewar involves pressurizing the liquid storage dewar in use. The operator shall follow the operating procedure not to over pressure the liquid storage dewar.

4.3 Some of the Helium compressor discharge is used for warm-up and cooldown. The operator shall follow the procedure to not over pressurize the magnet.

5.0 Procedure

5.1 Pump & Purge Test Dewar #2 &#3

5.1.1 Make sure the supply, return, lines and all current leads are properly connected for Test Dewar 2 & 3. Make sure that Lab View is running.

5.1.2 Make sure the following valves in the supply header are **closed**

AHE10	Liquid helium supply,
AHE 11	Liquid helium supply,
AOV 23	Suction return
H1001A	Quench Valve
AOV 25	Sullair Suction
AOV 24	Sullair Suction
AOV 18	Suction return
AOV 22	Suction return
AOV 21	OLD quench recovery (not in use)
AOV 20	OLD quench recovery (not in use)
AHE 12	Top fill valve (not in use)
AHE 13	Top fill valve (not in use)
MOV3	Warm up supply
MOV1	100K cool down supply
MOV4	Warm up supply
MOV2	100K cool down supply
SV3003	Aux 4.5K Fill

5.1.3 Open the following: valves

AHE9	
AOV3005	1.8K Heat Exchanger Fill Valve
	Quench Relief Valve on Lambda Plate
SV3002	Top Feed Solenoid (Below Lambda Plate Fill)
SV3004	Bottom Feed Solenoid (Main 4.5K fill)
AOV 19	Suction return

5.1.4 Make sure water is flowing through vacuum pump. Then start vacuum pump.

5.1.5 Open AOV 19.

5.1.6 Crack open vacuum pump valve V3 to pump on Test Dewar 3. The vacuum pump is on. Avoid overloading the vacuum pump.

5.1.7 After the pressure decreases somewhat, fully open V3.

5.1.8 The dewar pressure, as shown on XGS-600 Vacuum page on Lab-View should reach 1000mm about 60 minutes

5.1.9 When the pressure is less than 200 microns, on the vacuum gauge XGS-600 Vacuum page on Lab-View, close V3.

5.1.10 Open HE15 to fill Dewar 2&3 with clean helium from warm return.

5.1.11 After the 1st pump down, leak check shall be performed for all connections on the top hat of Dewar 2&3.

5.1.11 Close HE15.

5.1.11.1 Open MOV3 (warm up) to fill Dewar 2&3 to 7 psi on Lab-View program

5.1.15.2 Use Leak Detector with a sniffer check all connections.

5.1.13 Repeat steps 5 through 9 three more times.

5.1.14 The pump and purge is completed of Dewar 2&3

5.2 Cooldown to 100 K for Test Dewar #2&3

5.2.1 Make sure Magnet Test Dewar 2&3 has been properly pumped and purged.

5.2.2 Make sure valves in the supply header are in the open position

AHE9- gas helium supply,
MOV3 – warmup supply, and
MOV1 – 100 K cooldown supply
Mixing valve or in control mode
Mixing valve for 100k cooldown supply in control mode
AOV 19 Suction return
AOV 23 Suction return
Dewar Pressure Regulator set for 17(psi)

5.2.3
Make sure the following valves in the supply header are **closed**

AHE 8	cooldown, warm-up vacuum
AHE10	Liquid helium supply,
AHE 11	Liquid helium supply,
H1001A	Quench Valve
AOV 25	Sullair Suction
AOV 24	Sullair Suction
AOV 18	Suction return
AOV 22	Suction return
AOV 21	OLD quench recovery (not in use)
AOV 20	OLD quench recovery (not in use)
AHE 12	Top fill valve (not in use)
AHE 13	Top fill valve (not in use)
MOV4	Warm up supply
MOV2	100K cool down supply
SV3003	Aux 4.5K Fill

5.2.4 Make sure valves in the return header AOV19and AOV23 are open.

5.2.5 Check to see 25 psi helium to the nitrogen heat exchanger.

5.2.6 Turn on power supply for cryogenic liquid level monitor making sure that unit is in the automatic fill position. Open liquid nitrogen supply valve NI6 slowly introducing liquid nitrogen to heat exchanger.

5.2.7 Wait until heat exchanger is full by the level monitor, at that time it is ready for flow of helium gas into Helium Chiller Dewar (heat exchanger).

5.2.8 Fully open MOV1 and MOV3 use mixing valves to control temperature of the helium flow.

5.2.8.1 Using Lab-View, monitor pressure in Dewar 2. This should stay around 17 psia.

5.2.9 Watch temperature on the computer for Magnet Test Page. The temperature will decrease with time. It takes about 72 hours for the magnet assembly in Dewar 2 to reach 100 K.

5.3 Cool down to 4.5K and 4.5K Operation for Magnet Test Dewar #2

5.3.1 After Dewar 2 is cooled to about 100 K, one can proceed 4.5 K cool down.

5.3.2 Close AHE 9

5.3.3 Close MOV 3

5.3.4 Close MOV 1

5.3.5 Close Mixing valves

5.3.6 Make sure valves in the return header or still in open position

5.3.7 AOV19 AOV 23

5.3.8 Select either Storage Dewar SD, 2 or 3 to provide liquid helium.

5.3.8.1 For SD 2 and L1610 is running, SD should be at 3.5 – 4 psi

5.3.8.2 For SD 3 and HEUB is running, close return valve X581M slightly to increase pressure in SD 3 to 7 psi

5.3.8.3 For SD 3 and HEUB is not running, use warm helium to pressure SD 3 to 7 psi by opening pressurizing valve H0334M (the red hoke valve) and set the pressure regulator. Close X581M all the way.

5.3.9 To get ready for transfer liquid helium to Test Dewar 2, open the helium supply valve on the storage dewar.

5.3.9.1 For Liquid SD 2, open AHE43.

5.3.9.2 For Liquid SD 3, open X580M, H329A and H326M

5.3.10 Open AHE15 and MOV8 to cool the liquid helium line. When liquid air drips from the line, close AHE15 and MOV8.

5.3.11 Open liquid helium supply valve AHE11 to cool Test Dewar 2.

5.3.12 Open bottom fill valve SV3004.

5.3.12.1 Adjust storage dewar supply valve to control the cool down from 100 K to 4.5 K. Watch the return pressure and pump back.

5.3.12.2 Open valves MOV10 and MOV11 for lead flow.

5.3.13 On the computer Magnet Test Page, observe temperature readings inside the dewar.

5.3.14 It takes hours for the temperature inside Dewar 2 to reach 4.5 K and liquid level in the lower gauge to occur.

5.3.15 Liquid level in the upper gauges will follow afterward.

5.3.16 Close the bottom fill valve.

5.3.17 Switch SV3002 to automatic for maintaining constant liquid level in the upper gauge. Dewar 2 is filled and ready for 1.9K pumping.

5.3.18 1.9K Pumping for Test Dewar #2

After filling of liquid helium into Dewar 2.

5.3.18.1 On the Top Hat Dewar 2, close manual quench valve on lambda plate

5.3.18.2 Go to the 1.9K pump rooms to check electrical power and to switch signage to ODH zero using proper PPE. Bleed water and oil out of the air supply header.

5.3.18.3 The interface controls for the 1.9K pump are in cryo control room and use LabVIEW 2014.

5.3.18.4 Start Sullair 100 and loaded using the Crisp system inside the cryo control room, make sure that purifier A or B is online.

5.3.18.5 Start Lab-View program to run 1.9K pumping station The initial setting, from the control room is by-pass valve set to 100% open. It will be necessary to make adjustments to valve positions during cool down

5.3.18.6 Hit NASH run on the program which initiates control. Change set point as needed. Watch pressure in the 1.9K suction line. PI363. PI363 reads about 10 mm when the controller is set at 20 mm

5.3.18.7 Watch temperature readings from the computer. Observe the rate at which temperature decreases. Typically, the temperature decreases at 0.015 Degree Kelvin per minute or approximately 1 K per hour.

NOTE: Normally, it takes two and half to three hours for the lower chamber to reach 1.9K

5.3.18.8 To shut down the 1.9K pump, using control program increase the set pressure by adjusting by-pass valve. Wait for the return line pressure to reach 300 mTorr. Press OFF to shut down the 1.9K pump.

5.3.18.9 Shut down Sullair 100hp

5.3.18.10 Open manual quench valve on the lambda plate located on top of Top Hat Dewar 2.

5.3.19 Majority of the tests involves magnet quenching during the first day of test. In our operation, the magnet test operator informs the cryogenic operator prior to a magnet quench. When the magnet quenches, the pressure inside Dewar #2 will increase.

5.3.19.1 Get ready for venting helium through H1001A

5.3.19.2 The operator shall arm valve H1001 prior of powering up magnet. When the program receives a quench signal valve will open automatically operator shall close AOV 23 quickly insuring not to over pressurizing return

5.3.19.3 After the dewar pressure pass the peak value and begins to decrease, (around 33psia at cryostat) close H1001A and raised cryostat pressure to 33psia open AOV23 and using the control valve reintroduce the remaining gas back to the warm return.

5.3.20 At the end of the 1.9K test, close liquid helium supply valve on the selected storage dewar.

5.3.21.1 Close valves for lead flow MOV10 and MOV11.

5.3.21 Vent helium in the cold transfer line. Open HE32 and close the cold helium supply valve AHE11 on distribution line in about 20 minutes.

5.3.22 Reduce pressure to active liquid helium storage Dewar to 5 psi if needed.

5.3 Warmup for Test Dewar #2&#3

5.4.1 Make sure valves in the supply header

AHE10& AHE11 - liquid helium supply or closed
MOV3– warm up supply, and
MOV1 – 100 K cool down supply are open

5.4.2 Make sure valves in the return header:

HE15– to dirty gas bag/or warm return, and
V3 – to vacuum pump are closed.

5.4.3 Set Lab-View to control at 18 psi to low pressure return.

5.4.4 Slowly open mixing valves to control no more than a 50 k differential from top to bottom of magnet

5.4.5 After liquid helium boiled off, turn on the electric heater. The temperature at the exit of the heater should be about 40 C.

5.4.6 The temperature increases with time. It takes about 72 hours for the Dewar to reach room temperature.

5.4.7 Turn off electrical power to the warmup heater.

5.4.8 Close valves MOV3.MOV1 and mixing valves on Lab-View Program

5.4.9 The purpose of warm up is to remove the magnet. Therefore, all supply and return valves must be closed.

5.4.10 Make sure all supply valves and return valves are closed. Vent residual helium from the dewar to the dirty bag thru He-16.

5.4.11 The magnet in Dewar 2 is ready for removal.

6.0 Documentation

6.1 A logbook, in spreadsheet form, shall be maintained by the operator and kept on the PC located in the Cryogenic Control Room.

7.0 References

7.1 BNL Drawing, P&I D 902A, Test Dewar 2 & 3, RD 1215549.

7.2 BNL Drawing, P&I D 902A, Liquid Helium Storage Area, RD 12155451.

8.0 Attachments

Acknowledgment Form

READING ACKNOWLEDGMENT FORM

MAGNET ASSEMBLY PROCEDURE (MAP)
OPERATIONS PROCEDURE MANUAL (OPM)

Procedure Number: _____

Title: _____

Revision: ____

Name: _____

Life No: _____

Date: _____

Signature: _____

Please fill out the above to indicate that you have read and understood the procedure. Return completed form to the MDC Office - H. Hocker