SMD Operations Procedures Manual

8.1.3.18 CRYOGENIC OPERATION OF TEST DEWAR #3

Text Pages 1 through 9

Hand Processed Changes

HPC No.	Date	Page Nos.	Initials

Revision 03 Approved

Signature on File 1/25/16
Division Head Date

Preparer(s): P. Ribaudo

8.1.3.18 Cryogenic Operation of Test Dewar #3

1.0 Purpose and Scope

This procedure provides instruction on the following operations of the Test Dewar #3.

- Pump & Purge Test Dewar #3.
- Cooldown to 100 K for Test Dewar #3.
- Cooldown to 4.5 K and 4.5 K Operation for Test Dewar #3.
- Warmup for Test Dewar #3.

2.0 Responsibilities

Operator is responsible for the cryogenic operations associated with testing a magnet in Dewar #3.

2.1 After a 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 magnet to 100 K using the liquid nitrogen heat exchanger. Typically, it takes fifteen (15) hours to reach 100 K and overnight operation is required.

2.3 After the magnet reaches 100 K, the operator is responsible to cool the magnet to 4.5 K using liquid helium. Throughout the test, the operator is responsible for maintaining proper liquid level and pressure in the dewar. Majority of the tests involve magnet quenching which dumps the stored energy to liquid helium and creates a rapid pressure rise in the dewar. The operator is responsible to prevent overpressure by venting the helium gas to the recovery tank or outside.

2.4 At the conclusion of the test, the operator is responsible for warming up the magnet to room temperature using helium flow through the electric heater.

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 heat exchangers, 10,000 Liter liquid helium storage dewar and warmup heaters/Helium compressors, LN^2 40,000 liter 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 rise after a quench is in 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 twelve months.

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 the 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. For this 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 of liquid helium to test dewar involves pressurizing the liquid storage dewar in use. The operator shall follow the operating procedure not to over-pressurize the liquid storage dewar.

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

5.0 Procedure

5.1 Pump & Purge Test Dewar #3

5.1.1 Make sure the supply, return, gauge, air line and all current leads are properly connected for Magnet Test Dewar 3.

5.1.2 Make sure that Test Dewar 3 Whitey valves are in the open position located behind the control panel near the distribution header. And Test Dewar 2 is in the close position.

5.1.3 Switch liquid level select, trickle valve controller on control panel to Test Dewar 3.

5.1.4 Make sure valves in the supply header

AHE11 - liquid helium supply,
MOV3 – warm up supply, and
MOV1 – 100 K cool down supply
are closed.

5.1.5 Open AHE9 and AHE13.

5.1.6 Make sure valves in the return header

AOV25 – to SULLAIR compressor (subcool return),
HE15 – to dirty gas bag/or warm return,
V5 – to vacuum pump, and
AOV23 and AOV21 – to warm return
are closed.

5.1.7 Open bottom fill valve AHE13 and Trickle valve.

5.1.8 Open AOV19.

5.1.9 Crack open vacuum pump valve V5 to pump on Test Dewar 3. The vacuum pump is on. Avoid overloading the vacuum pump.

5.1.10 After the pressure decreases somewhat, fully open V5.

5.1.11 The dewar pressure, as shown on PI0189, should reach –30”in about 10 minutes.

5.1.12 When the pressure is less than 200 micron, on the vacuum gauge VI0175, close V5.

5.1.13 Open HE15 to fill Dewar 3 with clean helium from warm return.

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

5.1.15 Close HE15

5.1.15.1 Open MOV3 (warm up) to fill Dewar 3 to 7 psi on PI0189.

5.1.15.2 Use Leak Teck fluid to check all connections.

5.1.16 Repeat steps 8 through 12 three more times.

5.1.17 The pump and purge is completed and Dewar 3 is connected to low pressure clean helium.

5.2 Cooldown to 100 K for Test Dewar #3

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

5.2.2 Make sure valves in the supply header

AHE11 - liquid helium supply,
MOV3 – warm up supply, and
MOV1 – 100 K cool down supply
are closed.

5.2.3 Make sure valves in the return header
HE15 – to dirty gas bag/or warm return,
AOV23 - return to Lab Veiw CONTROL VALVE,
V5 – to vacuum pump, and
AOV21 – to quench return
are closed.

5.2.4 Make sure valves in the return header
AOV19 and AOV25 are open.

5.2.5 Use the throttling valve MV219
located on top of PAT, to provide 40 psi helium to the nitrogen heat exchanger.

5.2.6 Open liquid nitrogen supply valve HE6 for the LN_2 heat exchanger.

5.2.7 Wait until the level in the LN_2 heat exchanger becomes full.

5.2.8 Fully open MOV2 for the helium flow. Use the throttling valve MV219 located on top of PAT, to provide 40 psi helium to the nitrogen heat exchanger.

5.2.8.1 Use Lab Veiw to read pressure in Dewar 3. This can be as high as 7 psig or 21 psia

5.2.9 Watch temperature on the computer for Magnet Test Page. The temperature will decrease with time. It takes about 15 hours for the magnet assembly in Dewar 3 to reach 100 – 125 K.

5.2.10 Close 100 K cooldown valve MOV1.

5.2.11 Close liquid nitrogen supply valve NI6.

5.3 Cooldown to 4.5K and 4.5 K Operation for Test Dewar #3

5.3.1 After Dewar 3 is cooled to about 100 K, one can proceed 4.5 K cool down.

5.3.2 Make sure valves in the supply header

AHE11 - liquid helium supply,
MOV3 – warm up supply, and
MOV1 – 100 K cool down supply
are closed.

5.3.3 Make sure valves in the return header

HE15 – to dirty gas bag/or warm return,
HE11 - small return, and
V5 – to vacuum pump
are closed.

5.3.4 Open AOV23 Return to Lab Veiw CONTROL VALVE low pressure return.

5.3.4.2 Set Lab Veiw CONTROLLER to 16.8 psi and AUTO.

5.3.4.3 Close AOV25

5.3.5 Using Storage Dewar SD 3 to provide liquid helium.

5.3.5.1 For SD 3 and HEUB are running, close return valve X581M slightly to increase pressure in SD 3 to 7 psi.

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

5.3.6. To get ready for transfer of liquid helium to Test Dewar 3, open the helium supply valve on the storage dewar.

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

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

5.3.8 Open liquid helium supply valve AHE11 to cool Test Dewar 3.

5.3.9 Open bottom fill valve AHE13.

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

5.3.9.2 Open valves MOV14 and MOV15 for lead flow.

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

5.3.11 It will take about one and a half hour for the temperature inside Dewar 3 to reach 4.5 K and liquid level in the lower gauge to occur.

5.3.12 Liquid level in the upper gauges will follow afterward.

5.3.13 Close the bottom fill valve.

5.3.14 Switch the controller of trickle valve to automatic for maintaining constant liquid level in the upper gauge. Dewar 3 is ready for 4.5 K test.

5.3.15 Majority of the tests involves magnet quench during the first day of test. For the operation, the magnet test operator informs the cryogenic operator prior to a magnet quench. When the magnet quenches, the pressure inside Dewar #3 will increase.

5.3.15.1 Get ready for venting helium through H1002A, open the isolation valve located immediately downstream of H1002A.

5.3.15.2 The operator shall open vent valve AOV21 when the dewar pressure reaches 30 psi and H1002A when the pressure reaches 45 psi.

5.3.15.3 After the dewar pressure pass the peak value and begins to decrease, close H1002A and AOV21.

5.3.16 At the end of the 4.5 K test, close liquid helium supply valve on the selected storage dewar.

5.3.16.1 Put the trickle valve in manual and close.

5.3.16.2 Close valves for lead flow MOV14 and MOV15.

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

5.3.18 Reduce pressure in liquid helium storage dewar to 5 psi.

5.4 Warmup for Test Dewar #3

5.4.1 Make sure valves in the supply header

AHE11 - liquid helium supply,
MOV3 – warm up supply, and
MOV1 – 100 K cool down supply
are closed.

5.4.2 Make sure valves in the return header

HE15 – to dirty gas bag/warm return, and
V5 – to vacuum pump
are closed.

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

5.4.4 Slowly open warm up valve MOV3. The upstream valve MOV219 or MV217 is preset for normal warm up flow rate. Excessive opening may over-pressurize the dewar. Adjustment is required, it must be performed with great care to 40 psi.

5.4.5 Watch the display page on the computer for Magnet Test Page. Liquid helium will boil off rapidly. Make sure the boil-off does not upset the compressor system for the refrigerators.

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

5.4.7 Watch temperature on the computer for Magnet Test Page. The temperature increases with time. It takes about 15 hours for the Dewar to reach room temperature.

5.4.8 Turn off electrical power to the warm up heater.

5.4.9 Close warm up supply valve MOV3.

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

5.4.11 Close AOV25 and Lab View CONTROL VALVE. Close AOV19, AOV23 and AOV21.

5.4.12 Make sure all supply valves and return valves are closed. Vent residual helium from the dewar to the dirty bag thru HE15.

5.4.13 The magnet in Dewar 3 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, Magnet Test Dewar 2 & 3, RD 1215549.

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

8.0 Attachments

None