**SMD Operations Procedures Manual**

# 8.1.3.17 CRYOGENIC OPERATION OF TEST DEWAR #2

Text Pages 1 through 9

## Hand Processed Changes

| HPC No. | Date | Page Nos. | Initials |
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# 8.1.3.17 Cryogenic Operation of Test Dewar #2

## 1.0 Purpose & Scope

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

- 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. Typically, it takes twelve (12) 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 is capable of providing 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. Once in a while, the magnet will quench. The stored energy is dumped to liquid helium and pressure rises 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 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, 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

5.1.1 Make sure the supply, return, gauge, air line and all current leads are properly connected for Test Dewar 2. 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, |
| MOV4 | Warm up supply, and |
| MOV2 | 100K cool down supply |
| SV3003 | Aux 4.5K Fill |

5.1.3 Open the following:

| | |
|---|---|
| AHE8 | |
| 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) |

5.1.4 Make sure valves in the return header are as follows:

| | |
|---|---|
| AOV24 | To SULLAIR compressor (subcool return), |
| HE16 | To dirty gas bag/or warm return, |
| V4 | To vacuum pump, and |
| AOV22 and AOV20 | To warm return are closed. |

5.1.5 Open AOV 18.

5.1.6 Crack open vacuum pump valve V4 to pump on Test Dewar 2. The vacuum pump is on. Avoid overloading the vacuum pump.

5.1.7 After the pressure decreases somewhat, fully open V4.

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

5.1.9 When the pressure is less than 200 micron, on the vacuum gauge VI0175, close V4.

5.1.10 Open HE16 to fill Dewar 2 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.

5.1.11 Close HE16.

5.1.11.1 Open MOV4 (warm up) to fill Dewar 2 to 7 psi on PI0189.

5.1.15.2 Use Leak Teck fluid to check all connections.

5.1.13 Repeat steps 5 through 9 three more times.

5.1.14 The pump and purge is completed and Dewar 2 is connected to low pressure clean helium.

5.2 Cooldown to 100 K for Test Dewar #2

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

5.2.2 Make sure valves in the supply header

AHE10 - liquid helium supply,
MOV4 – warmup supply, and
MOV2 – 100 K cooldown supply
are closed.

5.2.3 Make sure valves in the return header
HE16 – to dirty gas bag/or warm return,
V4 – to vacuum pump, and
AOV20 – to quench return
are closed.

5.2.4 Make sure valves in the return header
AOV18 and AOV24 are open.

5.2.5 Use the Fisher Regulator on throttling valve MV219 (when using MYCOM or SULLAIR compressor) located on top of PAT, to provide 40 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 MOV2 and HE-1A for the helium flow. Use the throttling valve MV219 (when using MYCOM or SULLAIR compressor), located on top of PAT, to provide 40 psi helium to the nitrogen heat exchanger.

5.2.8.1 Use PI0189 to read pressure in Dewar 2. This can be as high as 7 psi.

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 2 to reach 100 – 125 K.

5.2.10 Close 100 K cool down valve MOV2.

5.2.11 Close liquid nitrogen supply valve NI6. After all liquid is out of heat exchanger by the use of level monitor turn off power supply to monitor and close valve HE-1A.

5.3 Cool down to 4.5K and 4.5 K 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 Make sure valves in the supply header

AHE10 - liquid helium supply,
MOV4 – warm up supply, and
MOV2 – 100 K cool down supply
are closed.

5.3.3 Make sure valves in the return header

HE16 – to dirty gas bag/or warm return,
HE12 - small return, and
V4 – to vacuum pump
are closed.

5.3.4 Open AOV22 Return to CONTROL VALVE low pressure return.

5.3.4.1 Close AOV24

5.3.5 Select either Storage Dewar SD 1, 2 or 3 to provide liquid helium.

5.3.5.1 For SD 1 and PAT is running, close return valve HE34 slightly to increase pressure in SD 1 to 7 psi.

5.3.5.2 For SD 1 and PAT is not running, use warm helium to pressure SD 1 to 7 psi by opening H0245M and pressure regulator PR0261. Close HE34 all the way.

5.3.5.3 For SD 2 and HEUB is running, close return valve X1154M slightly to increase pressure in SD 2 to 7 psi.

5.3.5.4 For SD 2 and HEUB is not running, use warm helium to pressure SD 2 to 7 psi by opening H0279M and pressure regulator PR0296. Close X1154M all the way.

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

5.3.5.6 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.

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

5.3.6.1 For Liquid SD 1, open AHE32.

5.3.6.2 For Liquid SD 2, open AHE43.

5.3.6.3 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 AHE10 to cool Test Dewar 2.

5.3.9 Open bottom fill valve SV3004.

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 MOV10 and MOV11 for lead flow.

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

5.3.11 It takes about one and half hours for the temperature inside Dewar 2 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 SV3002 to automatic for maintaining constant liquid level in the upper gauge. Dewar 2 is filled and ready for 1.9K pumping.

5.3.15 1.9K Pumping for Test Dewar #2

*After filling of liquid helium into Dewar 2.*

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

5.3.15.2 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.

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

5.3.15.4 Start program to run 1.9K pump. The initial setting, from the control room is set at 200mm mercury. It will control all necessary valve positions.

5.3.15.5 Hit 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

5.3.15.6 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 three to four hours for the lower chamber to reach 1.9K

5.3.15.7 To shut down the 1.9K pump, using control program increase the set pressure to 200 mm. Wait for the return line pressure to reach 200 mm. Press OFF to shut down the 1.9K pump.

5.3.15.8 Go to the 1.9K pump room. Turn off the electrical power. Change back signage.

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

5.3.16 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.

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

5.3.16.2 The operator shall open vent valve AOV20 when the dewar pressure reaches 30 psi and H1002A when the pressure reaches 45 psi.

5.3.16.3 After the dewar pressure pass the peak value and begins to decrease, close H1002A and AOV20.

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

5.3.17.1 Close valves for lead flow MOV10 and MOV11.

5.3.18 Vent helium in the cold transfer line. Open HE32 and close the cold helium supply valve AHE10 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 #2

5.4.1 Make sure valves in the supply header

AHE10 - liquid helium supply,
MOV4 – warm up supply, and
MOV2 – 100 K cool down supply
are closed.

5.4.2 Make sure valves in the return header

HE16 – to dirty gas bag/or warm return, and
V4 – to vacuum pump
are closed.

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

5.4.4 Slowly open warm up valve MOV4. 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 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 15 hours for the Dewar to reach room temperature.

5.4.7 Turn off electrical power to the warm up heater.

5.4.8 Close warm up supply valve MOV4.

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*