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SMD Operations Procedures Manual

8.1.3.19 CRYOGENIC OPERATION OF CABLE TEST DEWAR #4

Text Pages 1 through 8

Hand Processed Changes

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8.1.3.19 Cryogenic Operation of Cable Test Dewar #4

1.0 Purpose and Scope

This procedure provides instruction on the following operations of the Cable Test Dewar #4.

- Pump & Purge Cable Test Dewar #4.
- Cooldown to 100 K for Cable Test Dewar #4.
- Cooldown to 4.5 K and 4.5 K Operation for Cable Test Dewar #4.
- Warmup for Cable Test Dewar #4.

2.0 Responsibilities

Operator is responsible for the cryogenic operations associated with testing cable sample in Cable Test Dewar #4.

- 2.1 After cable sample 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 100⁰K using the liquid nitrogen heat exchanger. Typically, it takes twelve (12) hours to reach 110⁰K and overnight operation is required.
- 2.3 After Cable Test Dewar #4 reaches 110⁰K, the operator is responsible to cool the Cable Sample and the measuring Magnet to 4.5⁰K using liquid helium. Throughout the test, the operator is responsible for maintaining proper liquid level in the dewar. Since Cable Test demands stable temperature, the operator shall control pressure accurately. Occasionally, the magnet quenches. This stored energy is absorbed by the liquid helium which causes pressure to rise as the liquid turns to gas. 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.

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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 warmup heaters.

3.3 Instruction shall include the computer display page of the Cable Sample Test.

4.0 Precautions

4.1 Transfer of liquid helium to magnet test dewar involves pressurizing the liquid storage dewar in use. The operator shall follow the operating procedure so as not to over-pressure the liquid storage dewar.

5.0 Procedure

5.1 Pump & Purge Cable Test Dewar #4

5.1.1 Make sure the supply, return, gauge, air line and all five lines for the current leads are properly connected for Cable Test Dewar #4.

5.1.2 Make sure the insulating vacuum is established.

5.1.3 Make sure the following valves in the supply header

MOV300D - liquid helium supply,
MOV304D – warmup supply,
MOV305D – transfer line cooldown valve, and
MOV308D – 100 K cooldown supply
are all closed.

5.1.4 Make sure the following valves in the return header

MOV302D – to SULLAIR compressor (subcool return),
MOV303D – to dirty gas bag,
MOV307D – to vacuum pump, and
AOV301D – to warm return
are all closed.

5.1.5 Open bottom fill valve AOV311D.

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- 5.1.6 Crack open vacuum pump valve MOV307D to pump on Dewar #4. The vacuum pump is on all the time. Avoid over-loading the vacuum pump.
- 5.1.7 After the pressure decreases somewhat, fully open MOV307D.
- 5.1.8 The dewar pressure, as shown on PI360D, should reach $-30''$ shortly.
- 5.1.9 When the pressure is less than 200 micron on the vacuum gauge VI370D, close MOV307D.
- 5.1.10 Open MOV302D (subcool) to fill Dewar #4 with clean helium.
- 5.1.11 After the 1st pump down, leak check shall be performed for all connections on the top hat of Dewar #4.
 - 5.1.11.1 Close MOV302D.
 - 5.1.11.2 Open MOV304D (warmup) to fill Dewar #4 to 7 psi on PI360D.
 - 5.1.11.3 Use Leak Teck to check all connections.
- 5.1.12 Repeat steps in Section 5.1.4 through 5.1.8 three more times.
- 5.1.13 The pump and purge is completed and Dewar #4 is connected to low pressure clean helium thru MOV302D.

5.2 Cooldown to 100⁰K for Cable Test Dewar #4

- 5.2.1 Make sure Cable Test Dewar #4 has been properly pumped and purged.
- 5.2.2 Make sure the following valves in the supply header
 - MOV300D - liquid helium supply,
 - MOV304D – warmup supply,
 - MOV305D – transfer line cooldown valve, and
 - MOV308D – 100⁰K cooldown supplyare all closed.

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5.2.3 Make sure the following valves in the return header

MOV303D – to dirty gas bag,
MOV307D – to vacuum pump, and
AOV301D – to warm return
are all closed.

5.2.4 Open liquid nitrogen supply valve AOV301N for the LN₂ heat exchanger.

NOTE: Check that MOV222 & MOV223 warm helium supply are open.

5.2.5 Wait approximately twenty minutes until the vent line in the LN₂ heat exchanger becomes cold. This ensures liquid nitrogen in the heat exchanger.

5.2.6 Open AOV301D on low pressure return line.

5.2.7 Fully open MOV308D for the helium flow. Use the throttling valve in front of the flow meter for additional flow adjustment. The flow meters should be kept at 25 psi and 8 SCFM.

5.2.8 Watch temperature on the computer for Cable Tests. The temperature will decrease with time. It takes about 12 hours for the magnet assembly in Dewar #4 to reach 100 – 125⁰K.

5.2.9 Close 100⁰K cooldown valve MOV308D.

5.2.10 Close liquid nitrogen supply valve AOV301N.

5.3 Cooldown to 4.5⁰K and 4.5⁰K Operation for Cable Test Dewar #4

5.3.1 After Dewar #4 is cooled to about 100⁰K, one can proceed 4.5⁰K cooldown.

5.3.2 Make sure the following valves in the supply header

MOV300D - liquid helium supply,
MOV304D – warmup supply,

MOV305D – transfer line cooldown valve, and
MOV308D – 100 K cooldown supply

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are all closed.

5.3.3 Make sure the following valves in the return header

MOV303D – to dirty gas bag,
MOV307D – to vacuum pump, and
MOV302D – to subcool return
are all closed.

5.3.4 Set AOV301D (on low pressure return) to 18 psi and AUTO.

5.3.5 Select Storage Dewar SD #3 to provide liquid helium.

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

5.3.5.2 For SD #3 with HEUB not running, use warm helium to pressurize 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 of liquid helium to Cable Test Dewar #4, open the helium supply valve on liquid helium storage.

5.3.6.1 For Liquid SD #3, open X580A and H329A.

5.3.7 Open MOV305D to cool the liquid helium line. When liquid air drips from the line, close MOV305D.

5.3.8 Open liquid helium supply valve MOV300D to cool Cable Test Dewar #4.

5.3.9 Open bottom fill valve AOV311D.

5.3.9.1 Adjust storage dewar supply valve MOV300D to control the cool-down from 100⁰K to 4.5⁰K. Watch the return pressure and pump back.

5.3.9.2 Open valves for lead flow MOV321D, MOV322D, MOV323D, MOV324D and MOV325D.

5.3.10 On the cable test computer display page, observe temperature readings inside the dewar.

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5.3.11 It takes about one hour for the temperature inside Dewar #4 to reach 4.5⁰K and liquid level in the lower gauge to occur.

5.3.12 Liquid level in the upper gauges will follow afterward.

5.3.13 Labview computer control system will maintain constant liquid level in the upper gauge.

5.3.13.1 Close Labview controlled valve for bottom fill. Dewar #4 is ready for 4.5⁰K test.

5.3.14 At the end of the 4.5⁰K test.

5.3.14.1 Close liquid helium supply valve AOV312D.

5.3.14.2 Close valves for lead flow MOV321D, MOV322D, MOV323D, MOV324D and MOV325D.

5.3.15 Vent helium in the cold transfer line and close the cold helium supply valve on selected storage dewar and distribution line.

5.3.15.1 For liquid SD #2 and SD #3, leave MOV300D open for 30 minutes before closing.

Alternatively if storage dewar is not in use, MOV300D can be closed right away by opening H326M and HE37.

NOTE: In either case, the vent valves shall be opened for about 20 minutes.

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

5.4 Warmup for Cable Test Dewar #4

5.4.1 Make sure the following valves in the supply header

MOV300D - liquid helium supply,
MOV304D – warmup supply,
MOV305D – transfer line cooldown valve, and
MOV308D – 100 K cooldown supply
are all closed.

5.4.2 Make sure the following valves in the return header

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MOV303D – to dirty gas bag,
MOV302D – to subcool return, and
MOV307D – to vacuum pump
are all closed.

- 5.4.3 Set AOV301D (to low pressure return) to 18 psi and AUTO.
- 5.4.4 Slowly open warm-up valve MOV304D. The upstream valve MOV306D is preset for normal warm-up flow rate. Excessive opening of MOV306D may over-pressurize the dewar. If adjustment of MOV306D is required, it must be performed with great care.
 - 5.4.4.1 When setting the warm-up flow, use the Nullmatic Controller for valve AOV301D to help with adjustment of MOV306D.
- 5.4.5 Watch the display page on the computer for Cable Tests. 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 40⁰C.
 - 5.4.6.1 Open valve MOV302D.
- 5.4.7 Watch temperature on the computer for Cable Tests. The temperature increases with time. It takes about 12 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 MOV304D.
- 5.4.10 The purpose of warm-up is to remove the cable sample. Therefore all supply and return valves must be closed.
- 5.4.11 Close MOV302D and AOV301D.
- 5.4.12 Make sure all supply valves and return valves are closed. Vent residual helium from the dewar.
- 5.4.13 The Cable Sample in Dewar #4 is ready for removal.

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6.0 Documentation

- 6.1 A logbook, in spread sheet form, shall be maintained by the operator and kept on the PC in 902 Cryogenic Control Room.

7.0 References

- 7.1 BNL Drawing, P&I D 902A, Cable Test Dewars, RD 12155434.
- 7.2 BNL Drawing, P&I D 902A, Liquid Helium Storage Area, RD 12155451.

8.0 Attachments

None