Cryogenic Summary - Testing D2L108 in MAGCOOL

10/20/03

- Description
- Operating Summary
- Tests Performed
- Detail Operation
- Test Conditions
- Summary

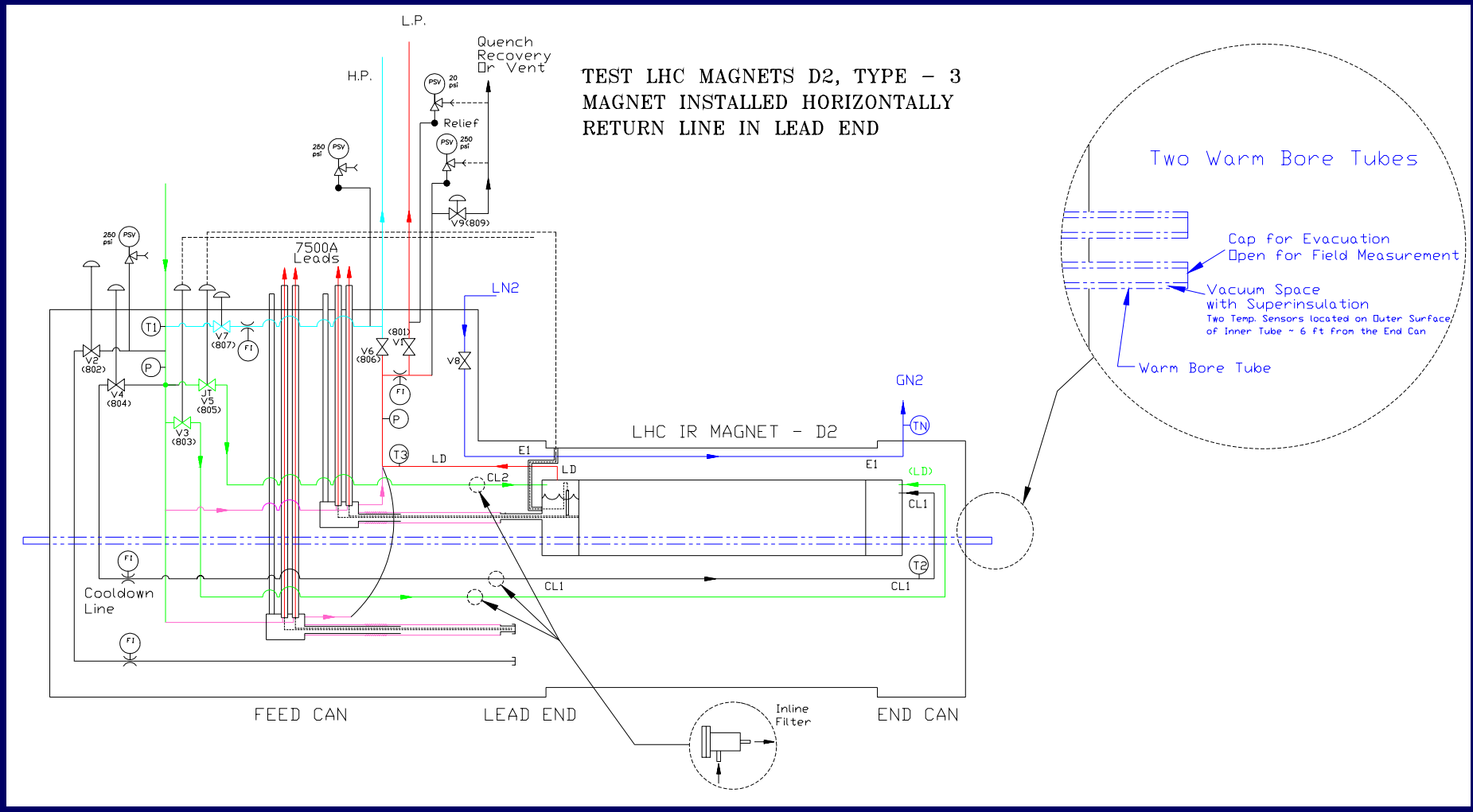
Specific of D2L108 Test

- Filters are installed downstream of the cooldown and two JT supply lines to prevent any chance of oil contamination - similar to testing D2L105, 106 and 107.
- During 100 K cooldown of D2L108, we have not experienced flow restriction (sign of contamination) as D2L107. It appears oil has been removed.

General Description - D2L108

- The magnet is installed horizontally on test bay – 0% slope.
- Cooldown/warmup supply in non-lead end, helium return from lead-end.
- In liquid cool mode, JT flows are fed from both ends.
- Warm bore tubes inserted and evacuated during quench tests.
- Warm bore tubes are open for field measurements.
- Information on the Warm Bore Tube and measuring device can be obtained from
    - A. Marone - andym@bnl.gov
    - G. Ganetis – ganetis1@bnl.gov
    - D. Sullivan – dans@bnl.gov

Flow diagram of D2L108 with Warm Bore Tubes, Three Filters, 0% Slope and Return Line from the Lead End.



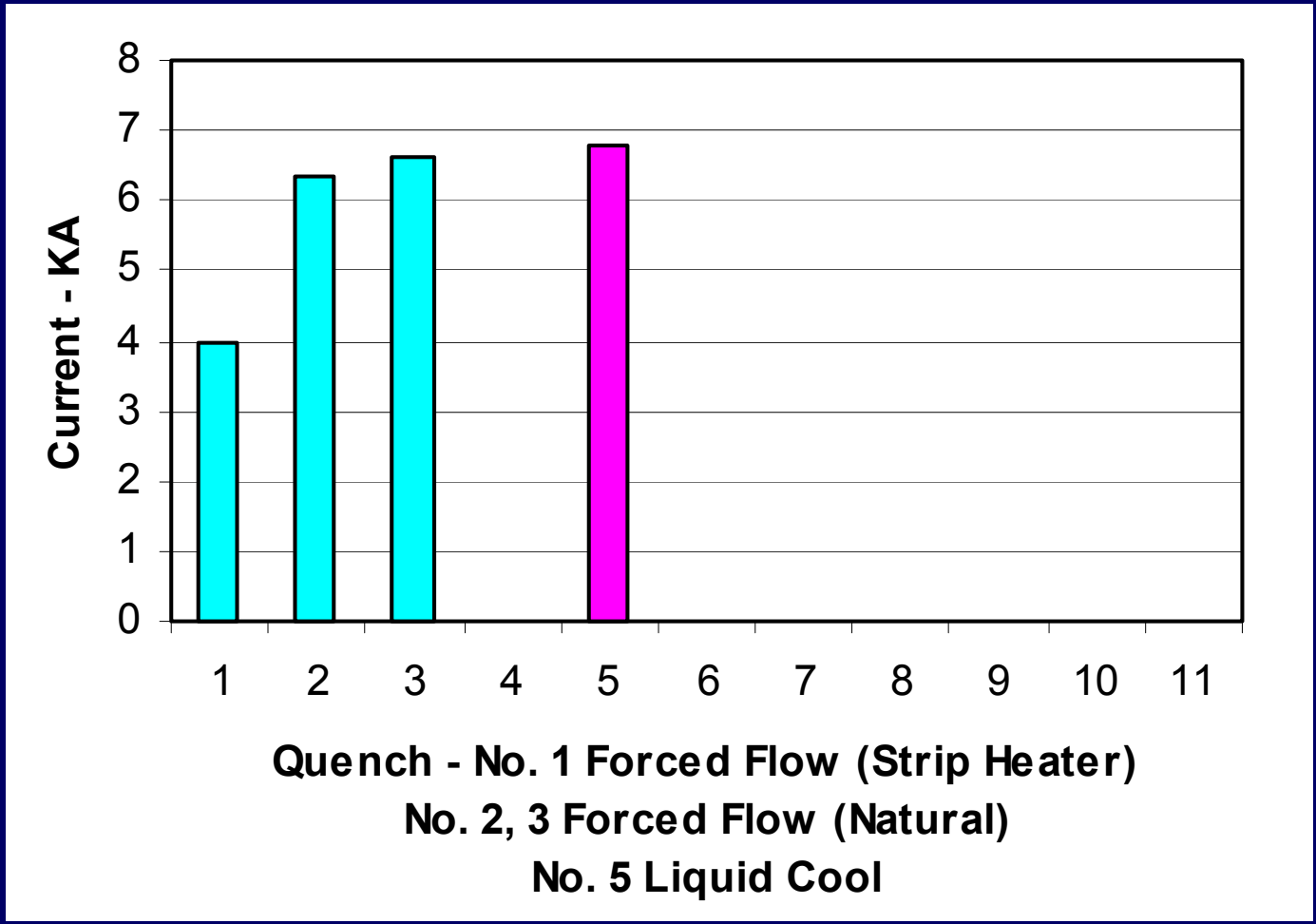
Tests Performed for D2L108

- 1st test group (forced flow cooling ~ 4.6 K),
  - Shut off (10/14)
  - Strip heater – 4000 A (10/14)
  - 1st quench – 6355 A (10/14)
  - 2nd quench – 6619 A (10/14)
- 2nd test group (liquid cool ~ 4.6 K),
  - 1st quench - 6781 A (10/20)

Quench Performance of D2L108

(Warm Bore Tubes Evacuated for Forced Flow Cooling)

(Warm Bore Tubes Have Some Vacuum for Liquid Cool)



Operation (10/10 – 13)

- 10/10 Start Cooldown at 4 pm
- 10/11 Cooldown I
- 10/12 D2 ~ 125 K. Manually terminate CD I
  Start 5 K cooldown at 1:30 pm using E19 & E20
- 10/13 Reach 10 K in the morning
  Reach 6 K in the afternoon for cold check.

Operation (10/14 - 15)

- 10/14 Reach cold condition with liquid in Subcooler. Found a small amount of cold helium leaked to the cooldown supply line. Tighten valve seat and correct problems. Ready for test.
  Perform shutoff and strip heater quench.
  Quench Test in forced flow cooling.
  1st quench – 6355 A.
  2nd quench - 6619 A.
- 10/15 Field measurement – 1 AC cycle and 7 DC loops.

Operation (10/16 – 20)

- 10/16 Field measurement –
  Finish left bore 1 AC cycle and 3 DC loop.
  1 AC cycle for right bore.
- 10/17 Field measurement – 1 AC cycle and 6 DC loops.
- 10/18 Field measurement – 1 AC cycle and 4 DC loops. Finish right bore.
- 10/19 Keep at test condition for weekend.
- 10/20 Switch to liquid cool.
  Quench – 6781 A.

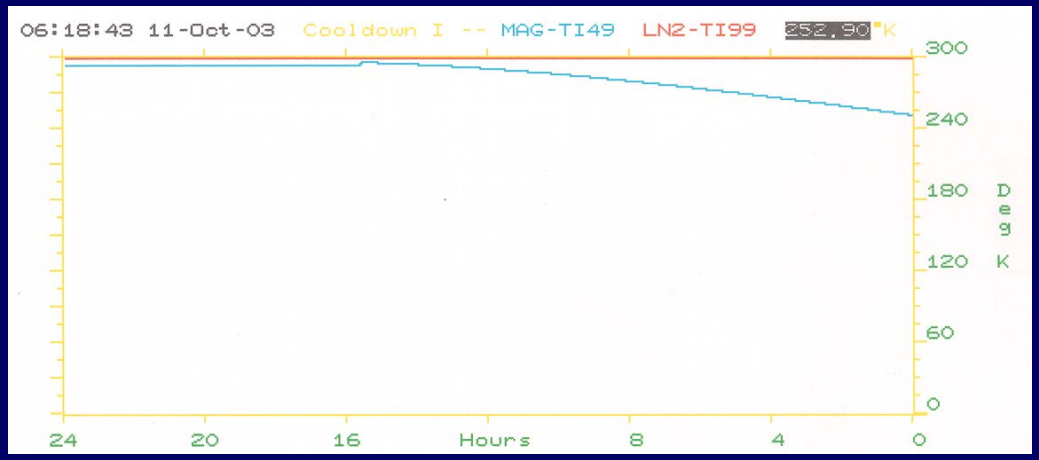
Test Conditions

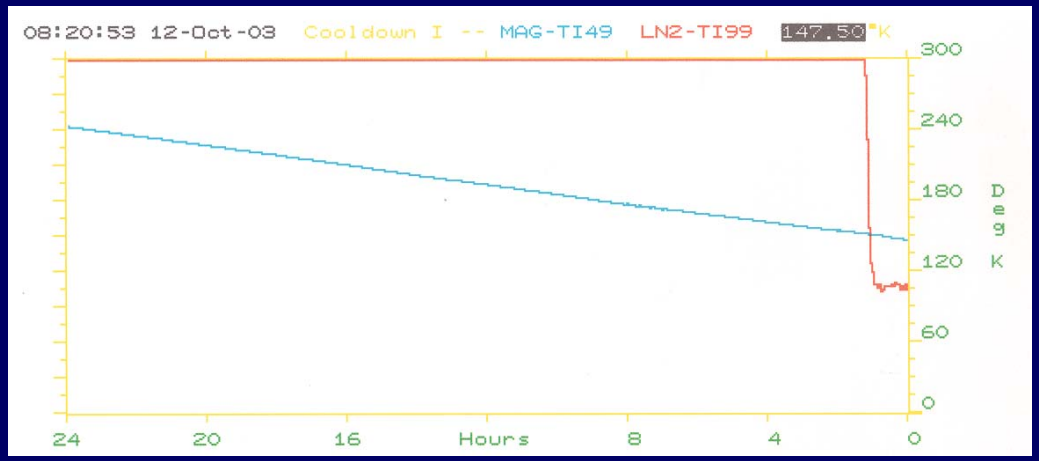
- Forced flow cooling - 12 atm, 4.6 K & ~ 60 g/s
  (Warm bore tube evacuated)

- Liquid helium cooling – 1.43 atm, ~ 4.6 K
  Liquid level ~ 87% (~ 14 cm above coil,
  ~ 1 cm below vent)
  in both lead end and non-lead end
  (Warm bore tubes partially evacuated -
  pump was turned on for less than 2 hours)

Cooldown from 300 – 100 K for D2L108

(10/10 – 10/13/03, Time on display needs to add 1 hour and 30 min)

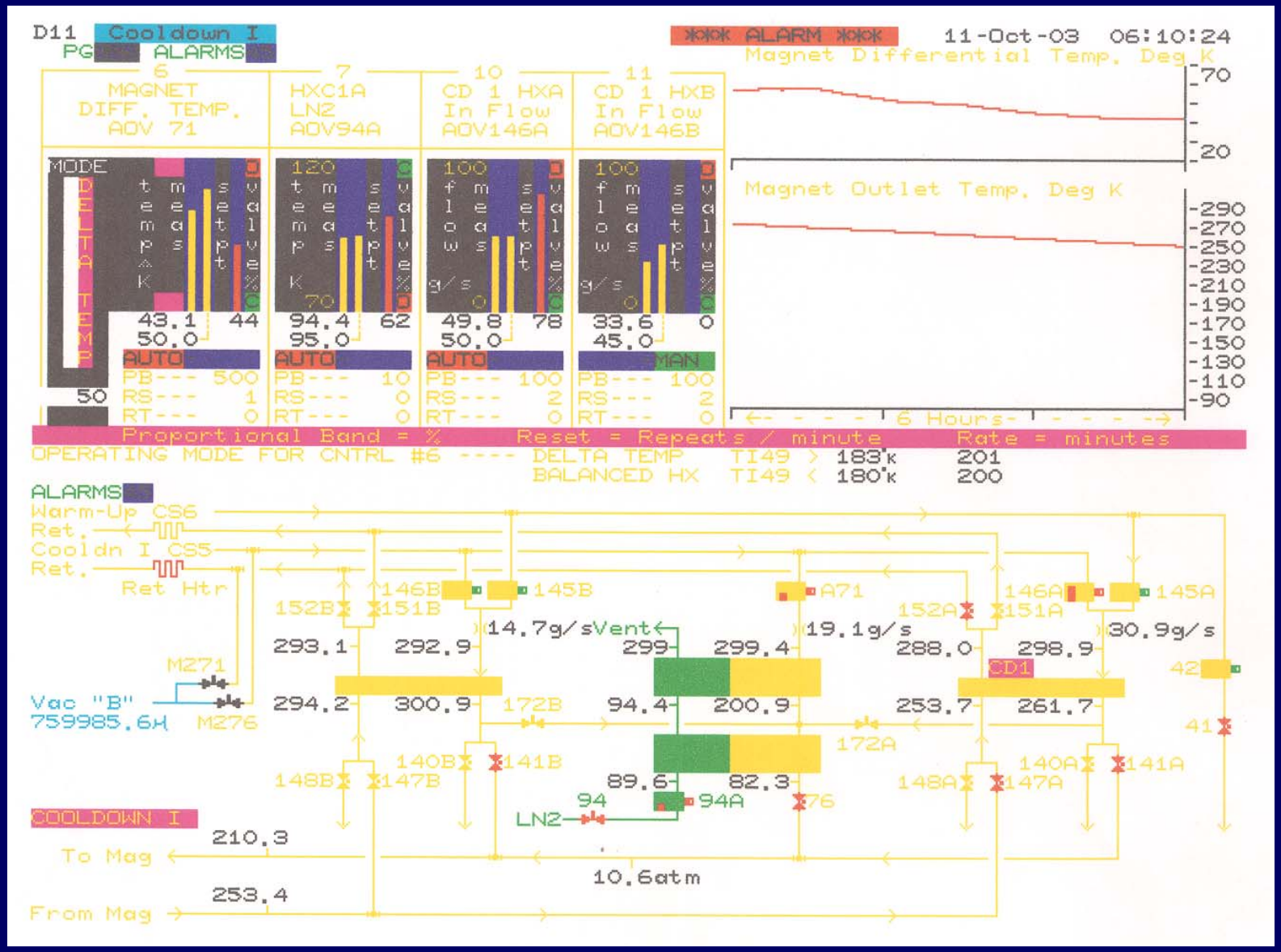




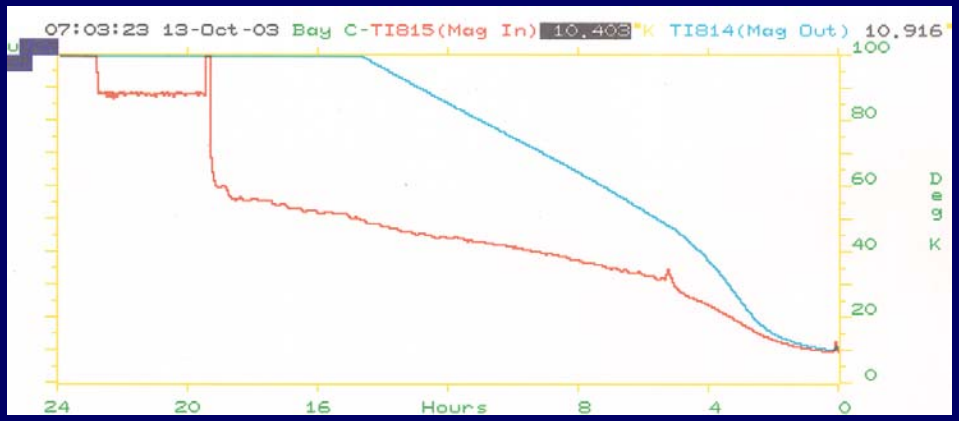
- Total cooldown time to 130 K is ~ 45 hours
- Cooldown time:

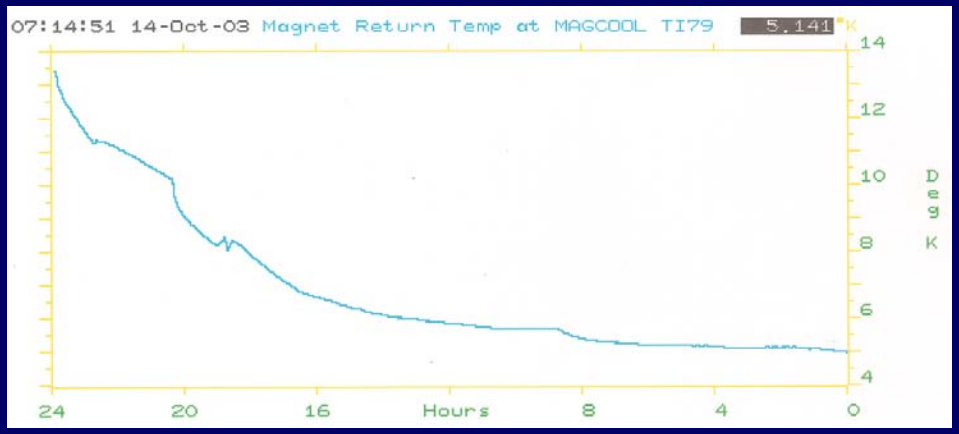
300 – 240 K ~ 24 hours
240 – 130 K ~ 21 hours

Operating Condition for 100 K Cooldown of D2L108



Cooldown from 100 – 5 K for D2L108 (10/12 – 10/13/03)

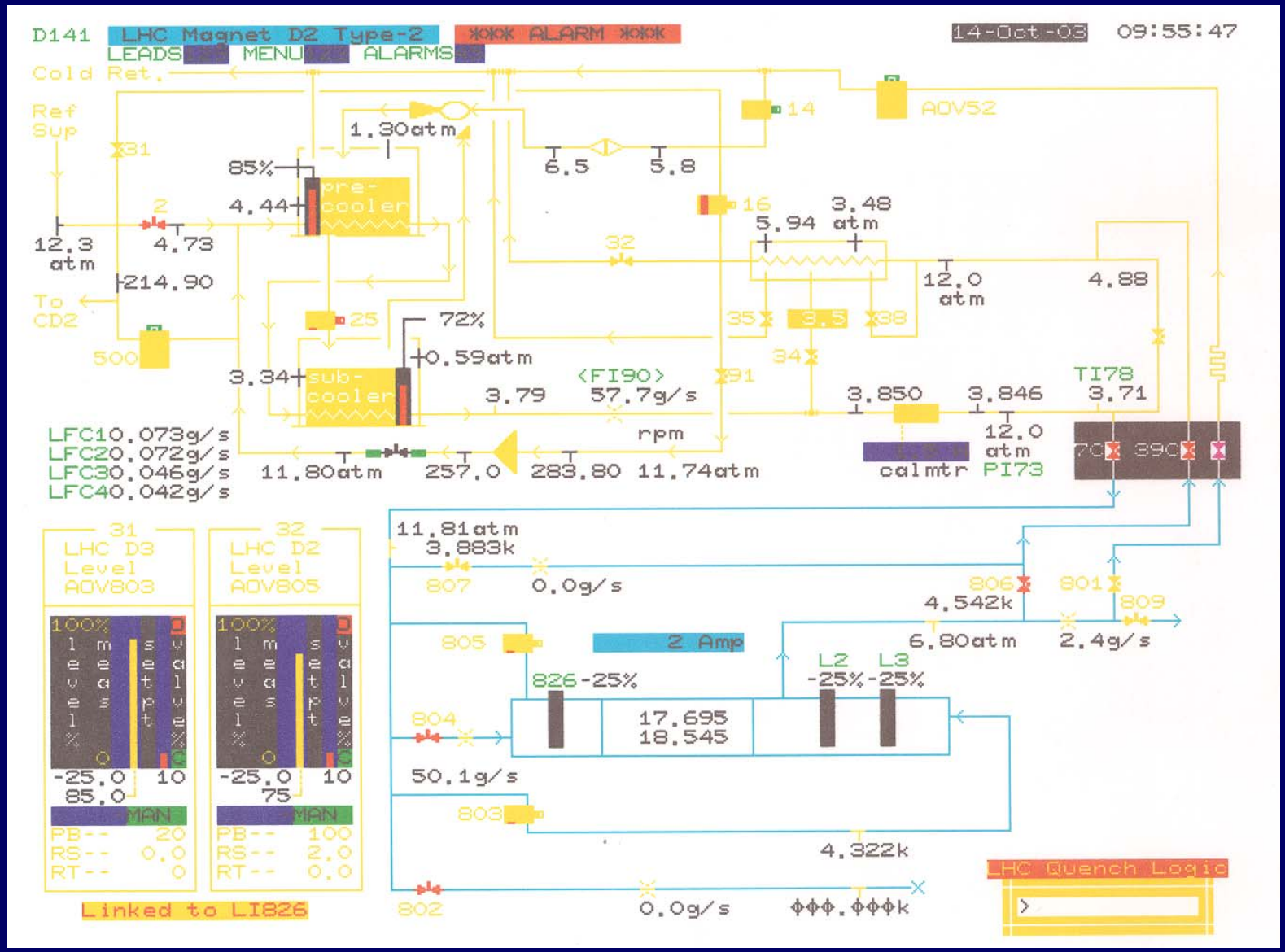




- Cooldown time (125 to 100 K) is ~ 5 hours, using E19 & E20 (~150 rpm).
- Cooldown time (100 to 10 K) is ~ 12 hours, using E19 & E20 (~ 150 rpm).
- Cooldown time (10 to 5 K, liquid fill and subcooler pump down) is ~ 24 hours (leak small amount of cold helium to cooldown supply line, valve repaired)
- Total cooldown time from 125 K to test condition is ~ 41 Hours

Forced Flow Cooling of D2L108 Prior to 6619 A Ramping

(Warm Bore Tube Evacuated)

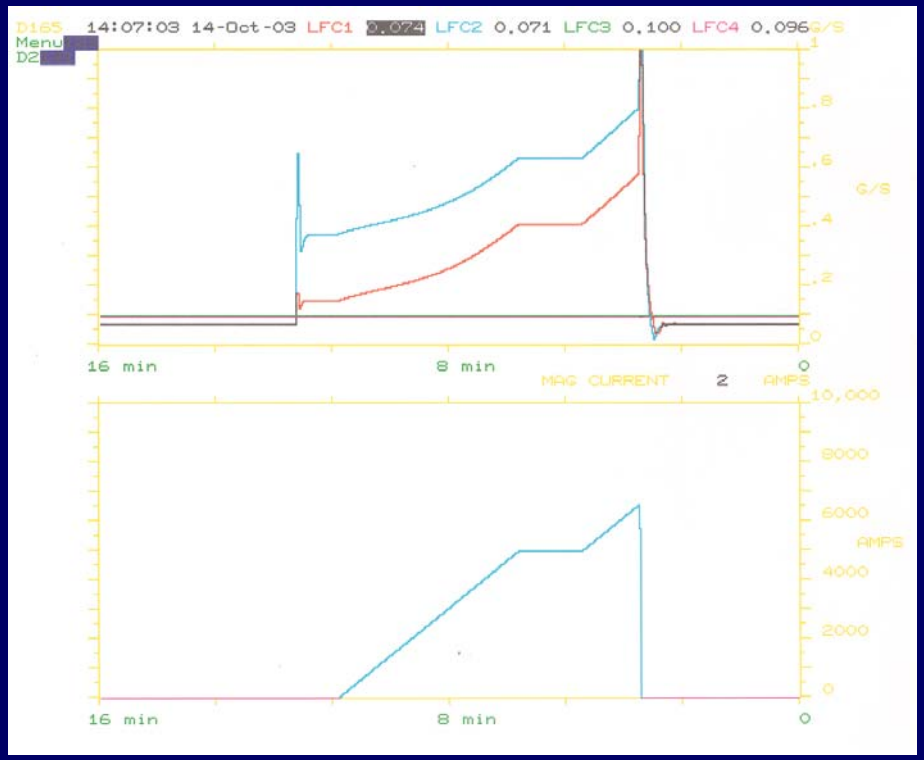


Lead Flow and Current During Ramping of D2L108

Ramp rate is 20 A/s. Below 10 A, Tare flow is 0.05 g/s. Above 10 A, Tare flow is 0.20 g/s for (+) lead & 0.35 g/s for (-) lead. Need to wait for voltage recovery of the (-) lead at 5000 A for ~ 2 min.

Upper Figure: Lead Flow – Blue for (-) Lead and Red for (+) Lead.

Lower Figure: Current as a Function of Time



Current Leads

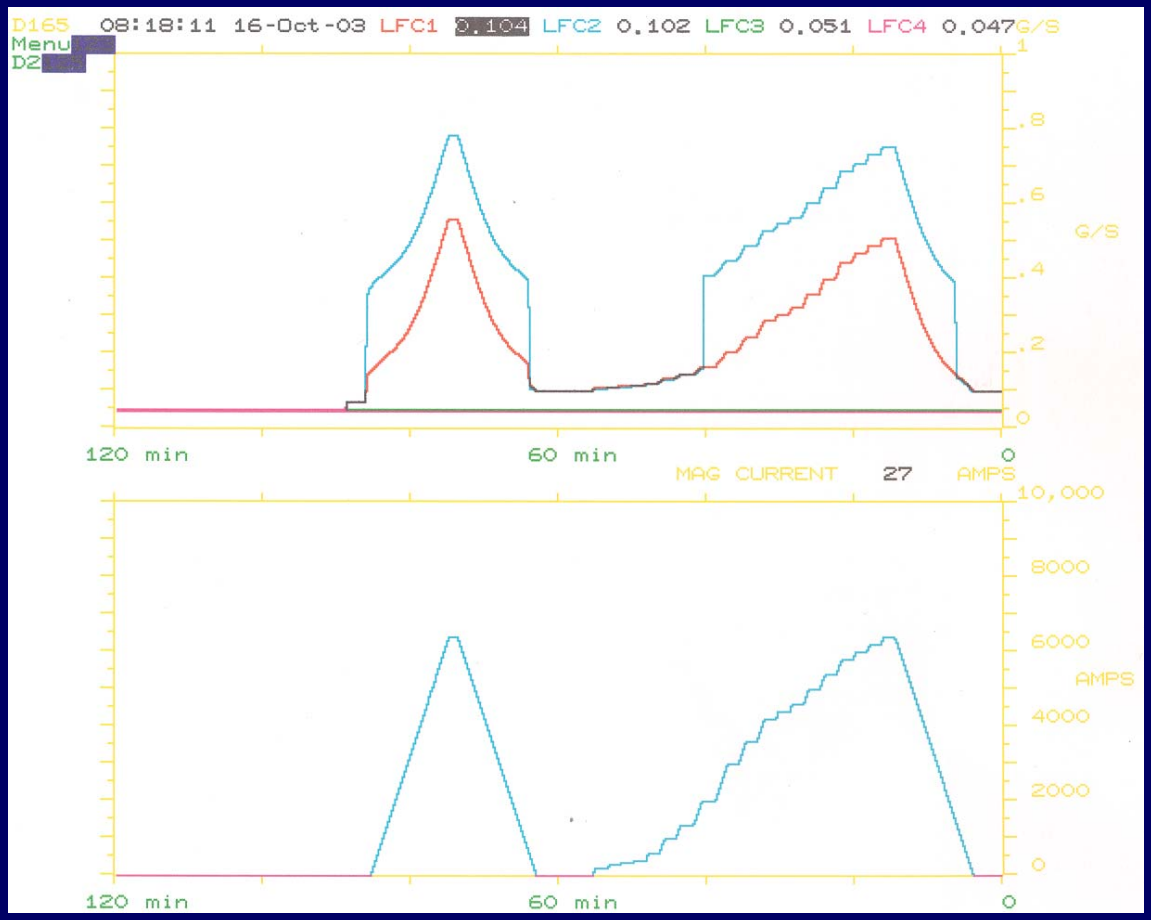
- Operate same way as previous D2 magnets.
- Separate flow controllers for the 7500 A leads. The (-) lead demands more flow than the (+) lead
  - For quench test at 20 A/s ramp rate,
    - The tare flow are 0.20 g/s for (+) lead and 0.35 g/s for (-) lead
    - Wait ~ 2 minutes at 5000 A for the (-) lead to recover the voltage developed before ramping current above 5000 A.
    - After reach the operating current, warm end of the leads could become cold. Small reduction in Tare flow is needed.
    - Unused leads are set at 0.050 g/s for forced cooling and are set at 0.100 g/s for liquid cool.

Lead Flow and Current for AC Cycle (left) and DC loop (right) are the same as previous D2

Upper Figure: Lead Flow – Blue for (-) Lead and Red for (+) Lead.

Lower Figure: Current as a Function of Time

Ramp rate is 10 A/s and is ramped to 6400 A.

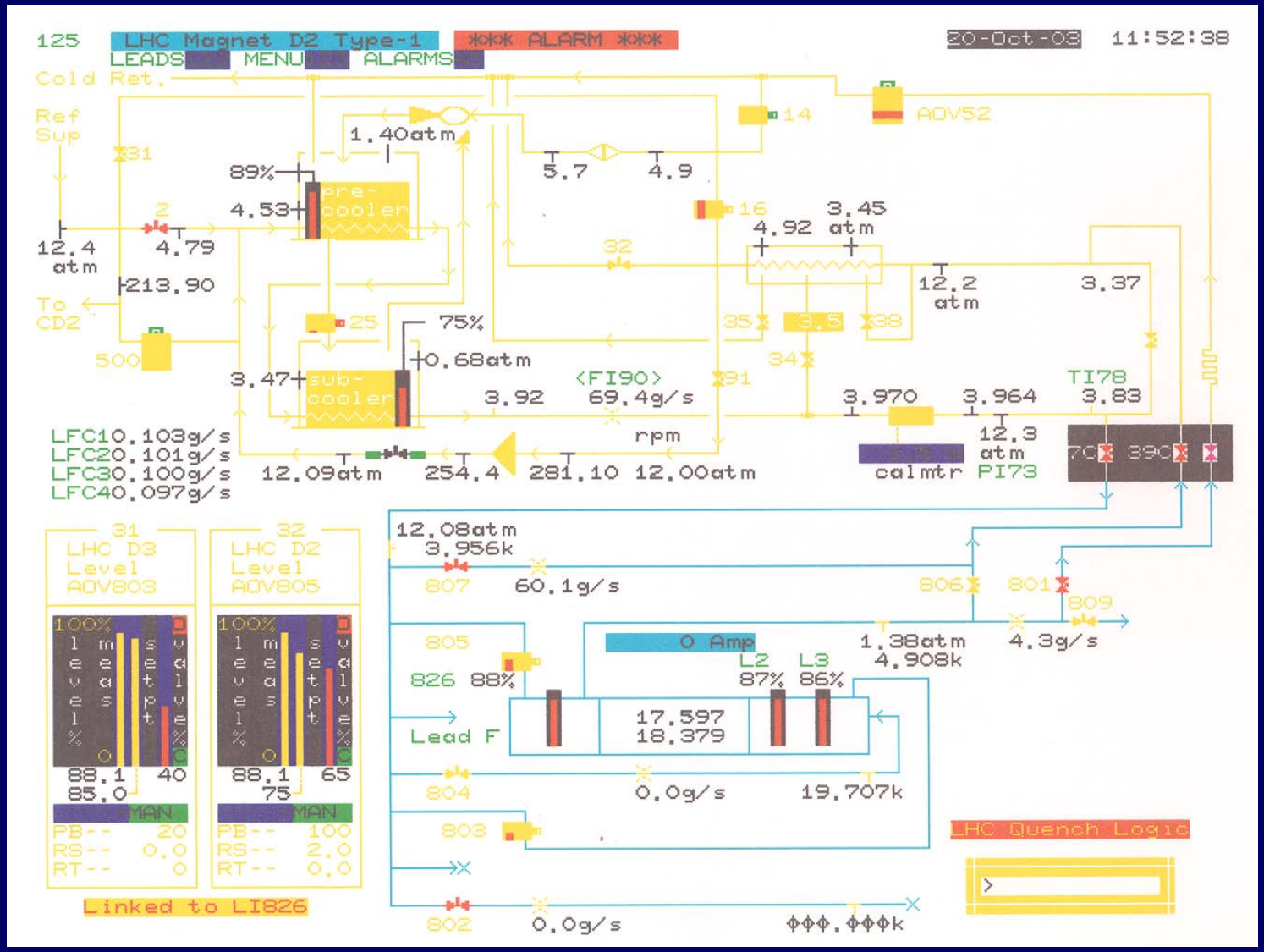


Current Leads

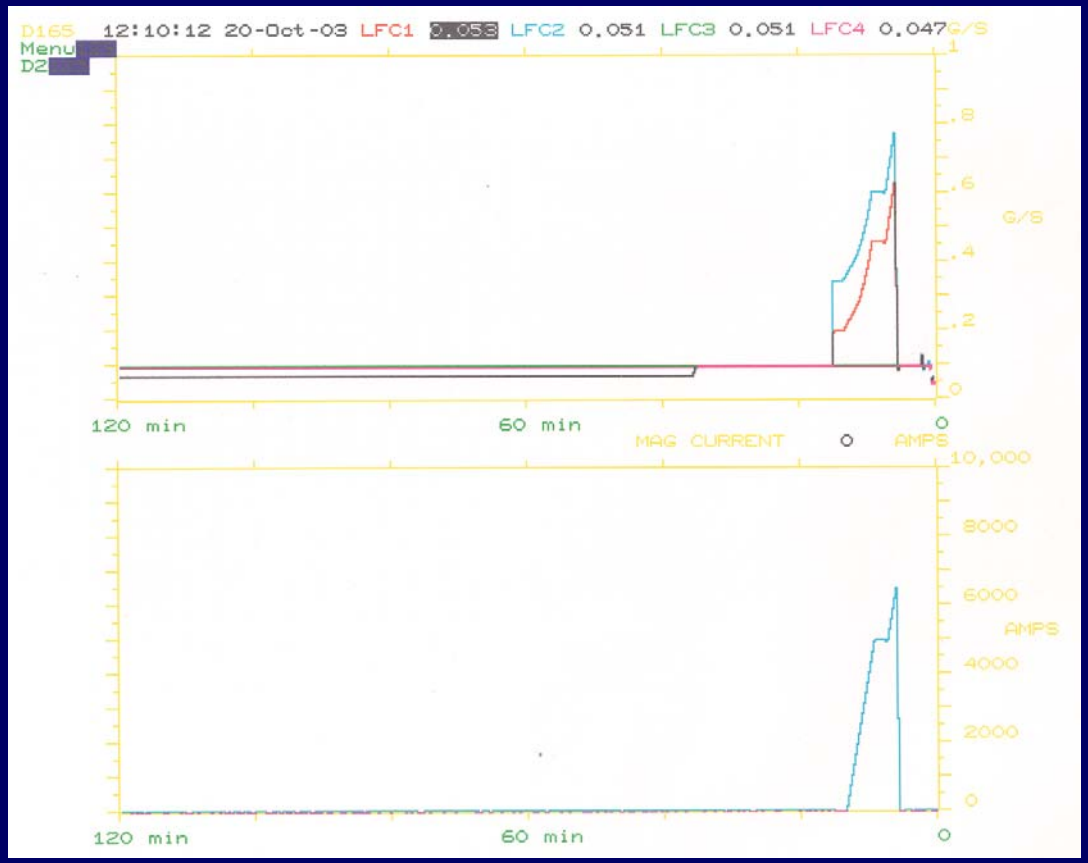
- Flow control for AC cycle and DC loop are the same as that for D2L104, 105, 106 & 107
  - For AC cycle at 10 A/s ramp up directly to 6400 A,
    - Tare flow is ~ 0.15 g/s for (+) lead
    - Tare flow is ~ 0.38 g/s for (-) lead
  - For DC loop at 10 A/s with 70 seconds stop at various pre-selected currents,
    - The tare flow is 0.10 g/s for (+) lead for all currents
    - The tare flow is 0.10 g/s for (-) lead below 2000 A and 0.35 g/s afterward, (or reduced back to 0.10 g/s below 2000 A with stop during ramp down)
- Unused leads are set at 0.100 g/s.

Liquid Cooling of D2L108 for ramping to 6781 A -

(Warm Bore Tubes Partially Evacuated)



Lead Flow and Current During Ramping of D2L108 – Liquid Cool
Ramp rate is 20 A/s. Below 10 A, Tare flow is 0.10 g/s. Above 10 A, Tare flow is 0.20 g/s for (+) lead & 0.35 g/s for (-) lead. Wait ~ 2min for voltage recovery at 5000 A. Curves appear to be different from previous tests because the time scale is 120 min. as field measurement (not for quench test).
Upper Figure: Lead Flow – Blue for (-) Lead and Red for (+) Lead. Lower Figure: Current as a Function of Time



Summary

- Complete quench test and field measurement for D2L108 with two warm bore tubes.