Investigating Oil Contamination and Scrubbing Line to Bay C in MAGCOOL

K. C. Wu, 4/14/03

- Introduction
- Summary
- Absorber and Helium Line at Discharge of Warmup Compressor
- Circulating Helium through Coalesor and Filter and Cold Trap

Introduction

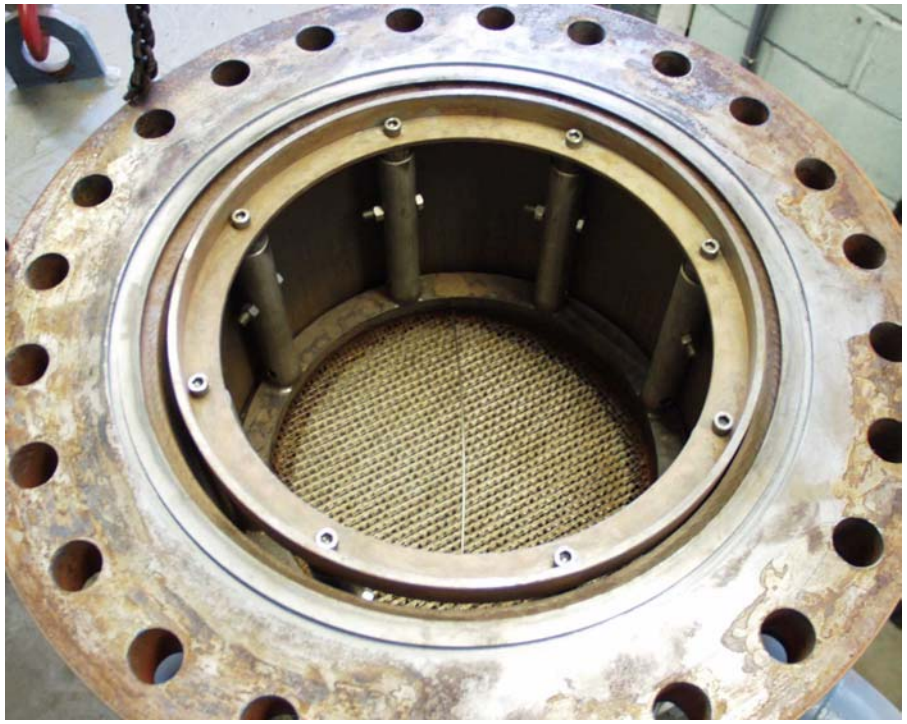
- A small amount of oil ~100 cc was found in D2L104 after tested in MAGCOOL.
- From the operating history of D2L104 and inspection results on the pipe, the source of oil was identified as one time operation error of flowing helium through a pipe contaminated with oil.
- To prevent oil from entering the magnet in the future,
  relevant piping in the helium system is inspected,
  a clean up mechanism is exercised to remove left over oil in the pipe, and
  condition of the piping system is evaluated.
- A description of work performed is given.

Summary

- No oil was found in the absorbers of the warmup and the cooldown compressors. As we remove the cover of the absorbers, the housing is clean and dry.
- Oil is believed to come from discharge line of Sullair 350.
- A coalescer, a filter and a LN2 cold trap is installed in series for scrubbing contaminated lines.
- Lines for warmup and cooldown have been scrubbed.
- After 8 days of scrubbing, only a trace of oil at most was vented out of the coalescer. Lines associated with filter and cold trap are dry and clean.
- With a flow of ~ 35 g/s over 8 days, oil concentration is estimated below ~ 50 ppb (part per billion by weight).
- To ensure oil from not entering the next D2, filters will be installed in front of inlet nozzles on the magnet.

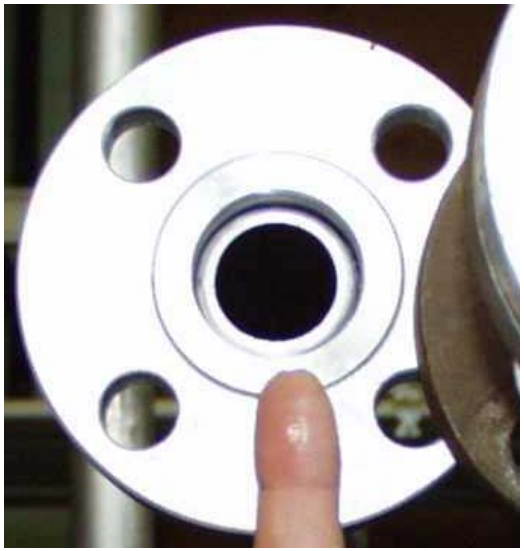
Coalesor & Absorber of Warmup Compressor

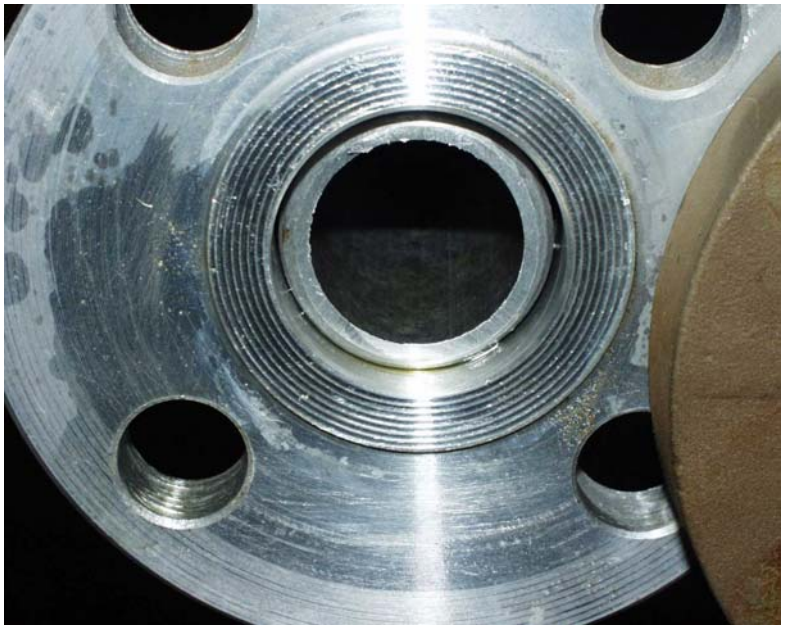
Absorber with Top Flange Removed (Left)
No Trace of Oil in CS6 Discharge Line (Right)



There are 3 stages of coalescing and an absorber installed at the compressor discharge for removing oil droplet and vapor from the warmup compressor CS6. The last stage absorber is opened for inspection. No trace of oil is found at the discharge port of the absorber. Condition for cooldown compressor CS5 (no photo) is the same.

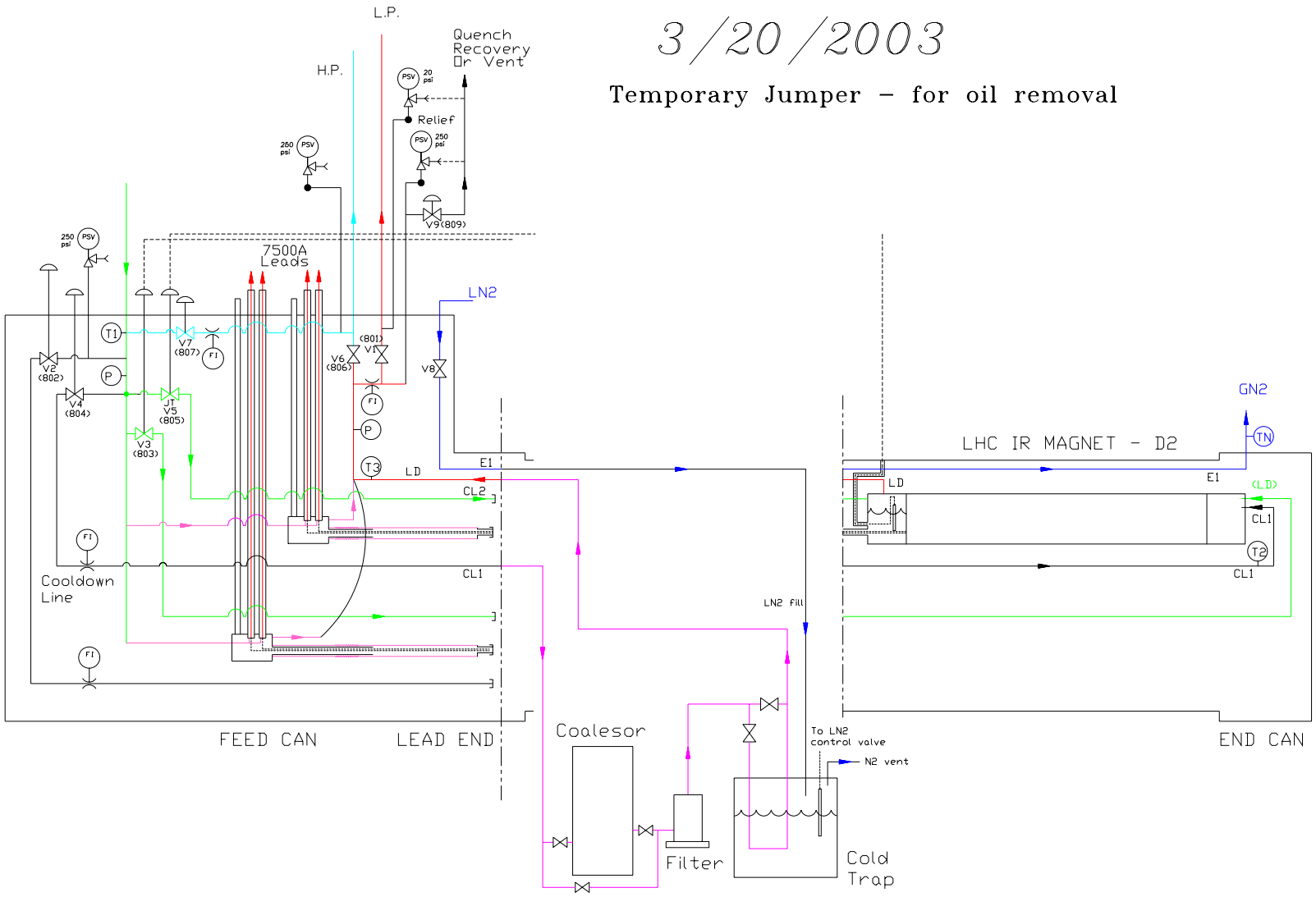
Oil Trace in Pipe Connected to Sullair 350





We inspect a helium line used to warmup D2L104 when CS6 was out of service. Some oil as shown was found in the line from SULLAIR 350. Oil is believed to have left from previous operation of the SULLAIR 400 compressor.

Flow Diagram for Scrubbing Oil in Supply Pipe Using Coalesor, Filter and Cold Trap



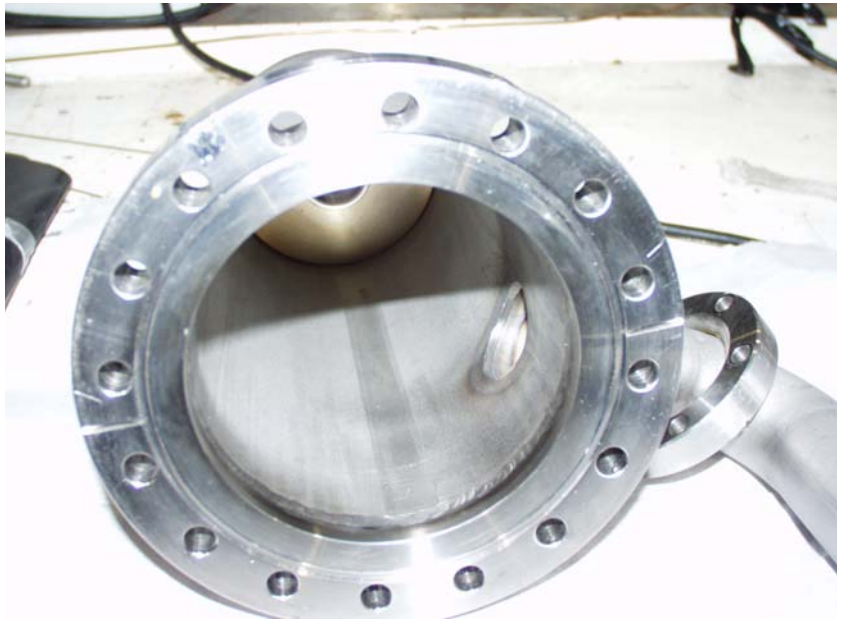
Coalesor, Filter and Cold Trap

- Balston KCF Coalesor
  - four AQ coalescing filters, capable of retaining 99.9999+ % of 0.6 micron liquid droplets
- Filter
  - same as installed in front of Air Liquide Turbine and Creare Circulating Compressor
  - the filter is made by SOFRANCE and consists of fine stainless steel screen, paper filtration component and possibly charcoal, rated at 3 micron
- Cold Trap
  - A cold trap consists of coil inside a LN2 bath is constructed for removing oil vapor

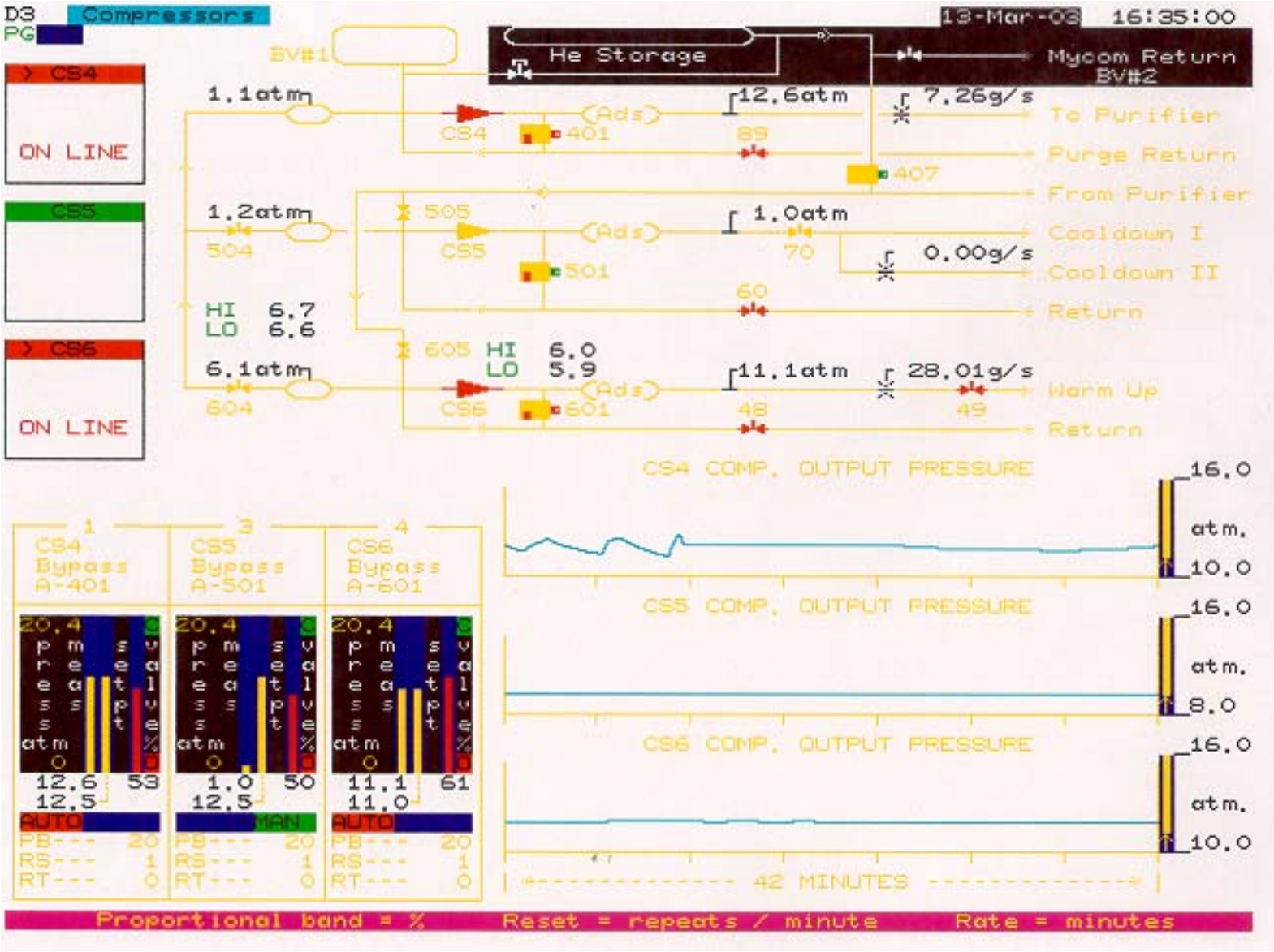
Coalesor and Filter (Left), and Cold Trap (Right) are Connected in Series for Scrubbing Oil

No Sign of Oil on Coalescer After 8 Days Scrubbing

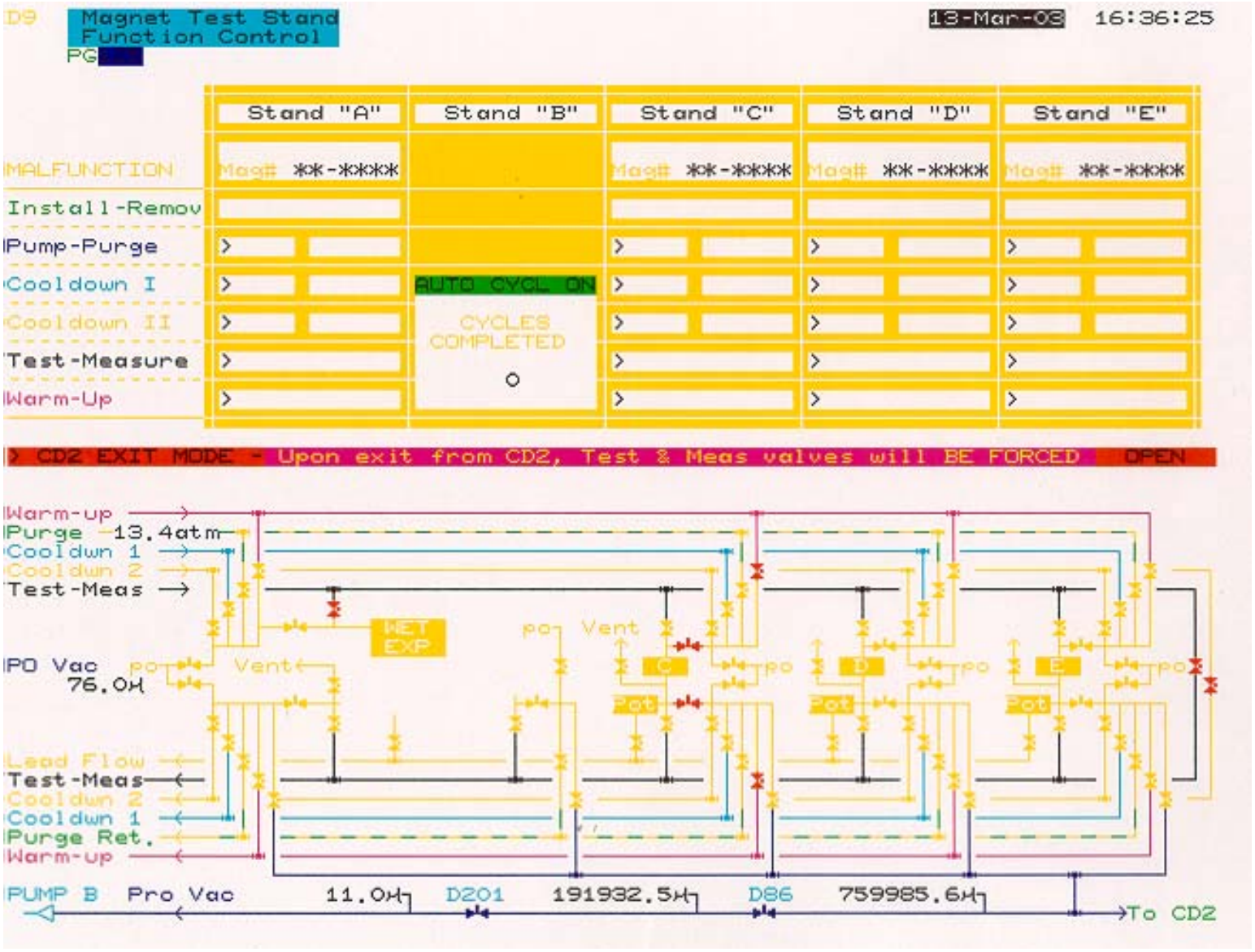
No Oil on the Filter After 8 Days Scrubbing



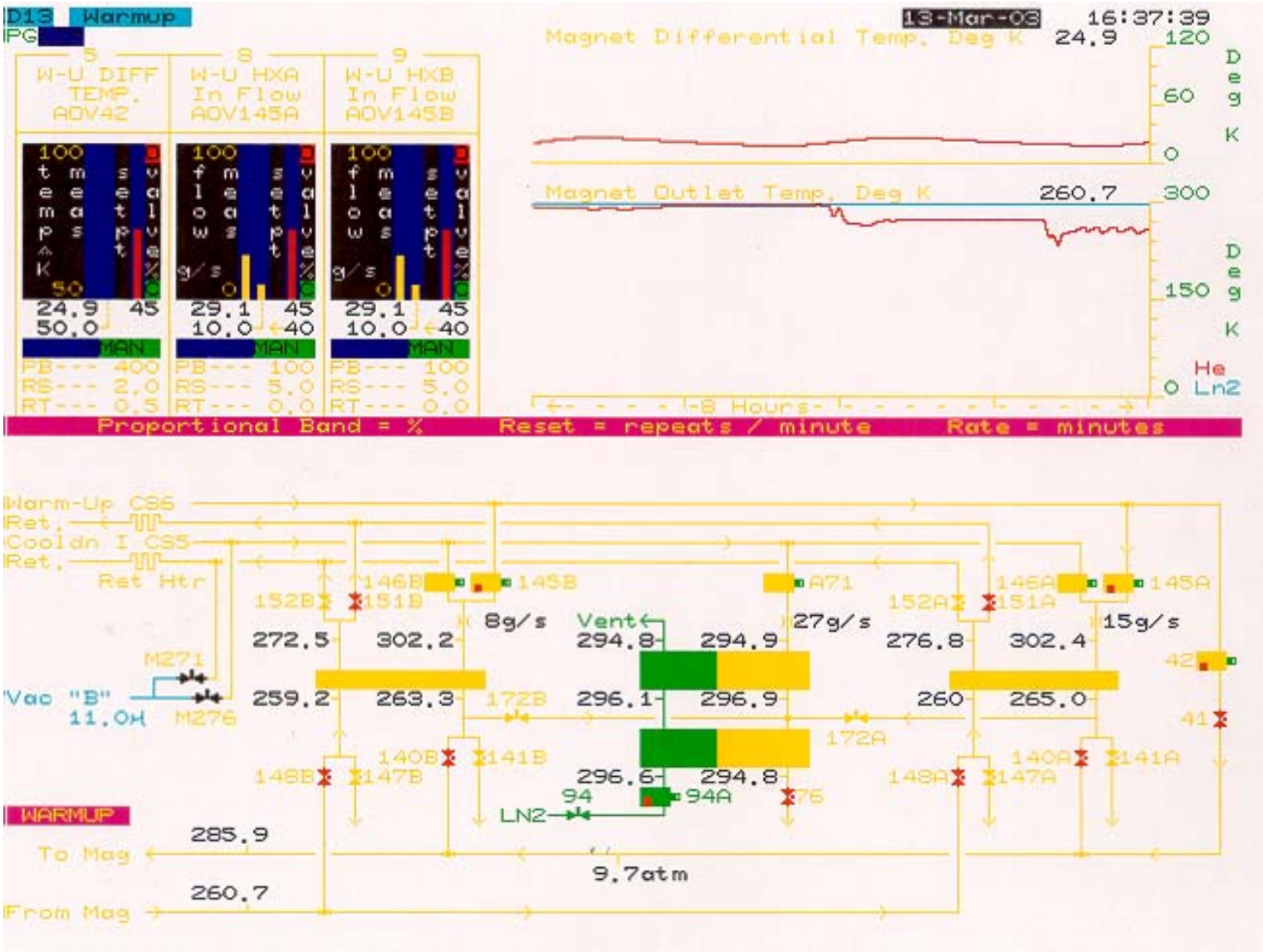
Warmup compressor CS6 for Scrubbing Oil



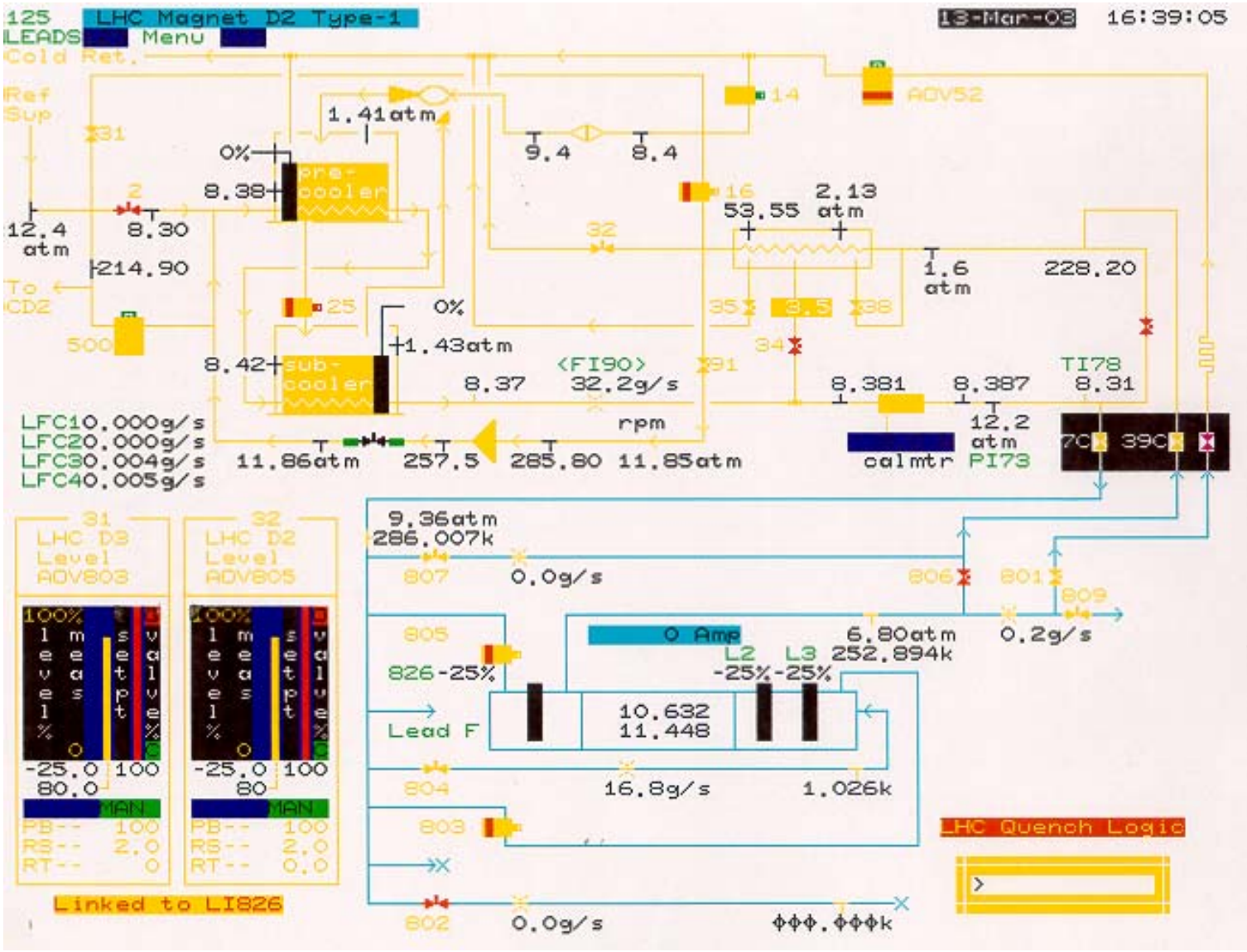
Valve Status for Scrubbing Warmup Line to Bay C



Valve Status in Warmup Control for Scrubbing Oil



Process Condition for Oil Scrubbing – Magnet is Replaced by Oil Removal Equipment



Scrubbing Oil in the Supply Line - 1

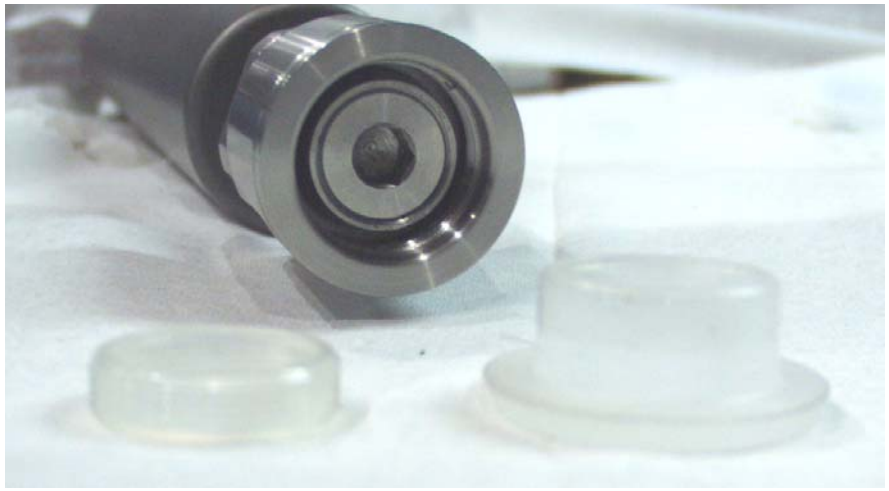
- 3/7 - Remove valve stem of DOV806 & 804 on Feed Can for inspection.
  DOV806 is fairly clean since it is installed at the line exiting the magnet.
  Found Kel-F seat on DOV804 lost. The valve plug also has tiny trace oil.

Scrubbing Oil in the Supply Line - 2

- 3/10 - Remove valve stem of DOV807, 802 and two JT valves 803 & 805 for inspection. Nitrogen valve and DOV801 was not inspected since it is rather difficult to remove and is in the return side. All valves show tiny amount of oil. DOV802 has slightly more.
  Install DOV804 without valve plug.
  Connect Coaleser and Filter to the supply and return lines on Bay C Feed Can.
  Pump & Purge the system.
  Pressure test to 13.5 atm.
  At 3PM, use warmup compressor CS6 to circulate helium through warmup heat exchangers to the coaleser & filter system.

Scrubbing Oil in the Supply Line - 3

- 3/11 - Construct LN2 cold trap.
  Kel-F seat for DOV804 arrives without installation tool.
  Inspect broken seat. The Kel-F seat appears to have split along the bottom of the thread.
  Pass information to PHPK for investigation and request to borrow installation tool.



Kel-F seat and the retainer lock nut assembly. The broken seat in the left is shown together with a new seat in the right for comparison.

Scrubbing Oil in the Supply Line - 4

- 3/12 - CS6 tripped at ~ 17:00 3/11, after ~ 26 hours of continuous running. Restart CS6.
  The coalesor was open for inspection after 30 hours of helium flow. The AQ coalescing filters are essentially as clean as they were installed and have no oil trace.
  The housing in the discharge side is very dry.
  Install cold trap. Pump & purge.
  Pressure test piping. Leak check new joints.
  Start CS6 to circulate helium. Shutdown CS6 after ~ 1 hour due to unstable voltage of the power supply for the I/O rack.

Scrubbing Oil in the Supply Line - 5

- 3/13 - Start LN2 feed to cold trap. Verify LN2 fill and level control by opening by-pass valve and closing inlet to cold trap.
  11:30, portion of helium flow is introduced into cold trap by crack opening inlet valve while keeping by-pass fully open.
  Observe decreasing temperature in return.
  Increase valve opening to 45 % on Warmup HX for more flow. Adjust opening of inlet valve to cold trap so that return is no less than 250 K.
  Construct a header to accept all four supply lines (2 Cooldown and 2 JT).
  Seat installation tool from PHPK arrives.
  4PM, shutdown LN2 and inlet valve. Use CS6 to keep helium flow through coalescer for the night.

Scrubbing Oil in the Supply Line - 6

- 3/14 - Install common header for all four supply lines.
  Found small amount of oil at the conflate joint of supply line but no oil in the coalescer.
  Duration is 24 hours since previous inspection or total of 54 hours from initial circulation.
  Install Kel-F seat on DOV804.
  Pump & purge. Pressure test. Leak check.
  Start circulating flow using CS6. Found pipe resistance decreases and more flow from CS6.

  Start LN2 to cold trap.
  Total running time using cold trap ~ 5hours.
  Shutdown cold trap but leave CS6 running through weekend.

Scrubbing Oil in the Supply Line - 7

- 3/17 - Scrubbing time is 65 hours over the weekend. Helium flow from CS6 is 36 g/s and is divided into four parallel supply lines in the Feed Can. Inspect drain valve and blown down valve on the coalescer. Tiny amount of oil, a circle of oil trace of ~ 2 cm diameter on the testing tissue is found. Start flow through coalescer, filter and cold trap. Fill LN2. Crack open inlet valve to cold trap. Based on the return temperature of ~ 245 K after mixing, 25% of total flow or 9 g/s flow through cold trap. 75% or 27 g/s flow through by-pass. Leave LN2 on over night.

Scrubbing Oil in the Supply Line - 8

- 3/18 - Inspect drain valve and blow down valve on the coalescer. Tiny amount of oil, a circle of oil trace of ~ 2 cm diameter on the testing tissue is found – similar to 3/17.
  Stop LN2 fill to cold trap for coil to warmup.
  Start cooldown compressor CS5.

  Open valves on Test Stand and Cooldown I page Scrubbing the cooldown header and supply lines.

Scrubbing Oil in the Supply Line - 9

- 3/19 - Open DOV807 to scrub by-pass line. Open valve downstream of flow controller to scrub lead. Inspect coaleser and filter. Both are dry and clean. We put alcohol into the coil of cold trap and are unable to find oil after the alcohol is pour out. Total scrubbing is about 180 hours as given below:

Warmup system	150 hours
Cold Trap	35 hours
Cooldown system	28 hours
By-pass & leads	3 hours

Complete scrubbing. Ready to install D2L105 with in cooldown and JT supply lines.

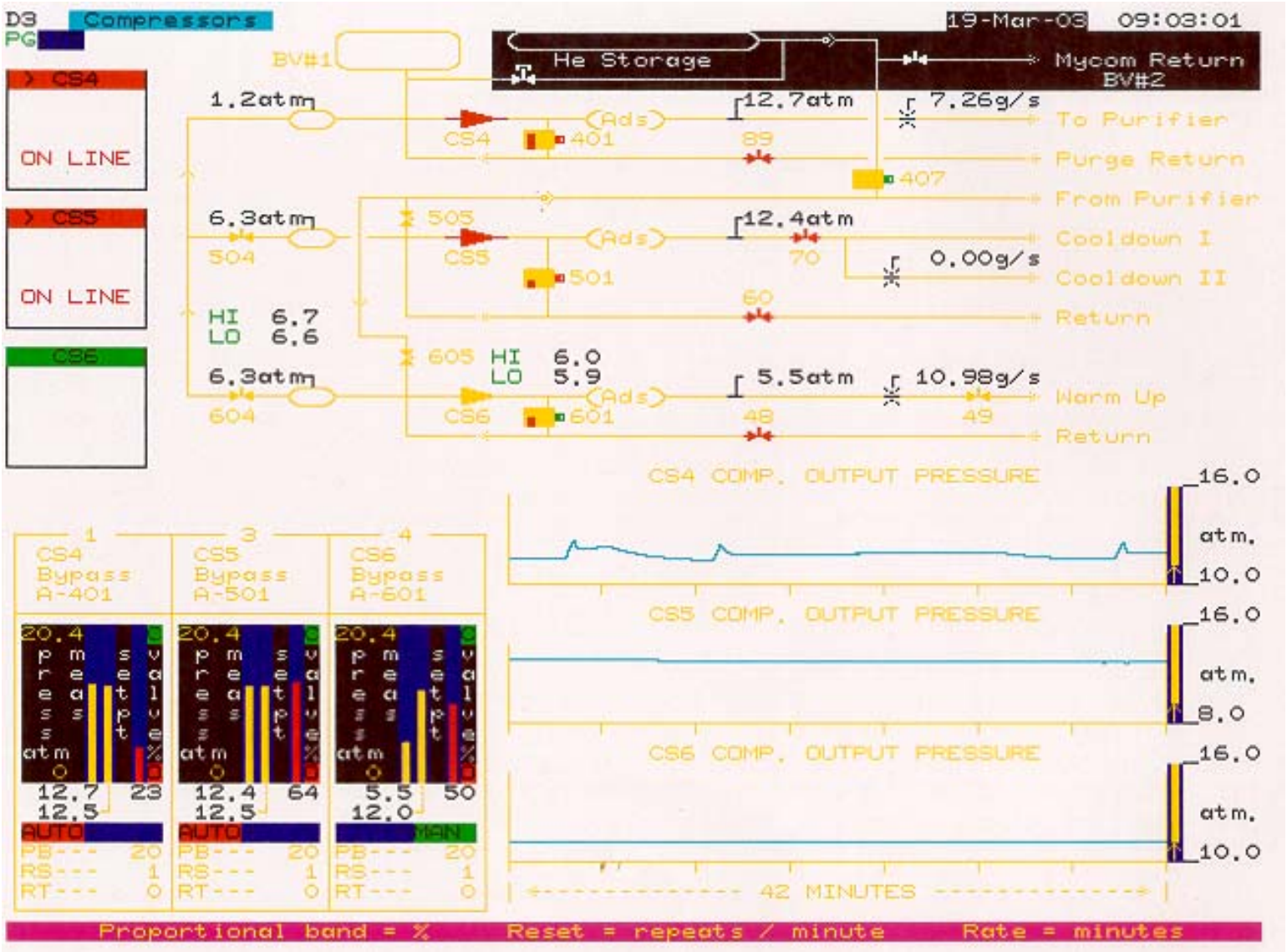
Questions:

- What are the possible explanations of founding tiny amount of oil through circulation of helium?
  - Probably majority of oil already deposited in D2L104 and only a small amount is left in MAGCOOL piping.
  - Can oil enter the system from sources other than Sullair 350? Most likely not, because we scrub all warm piping including warmup and cooldown I heat exchangers.

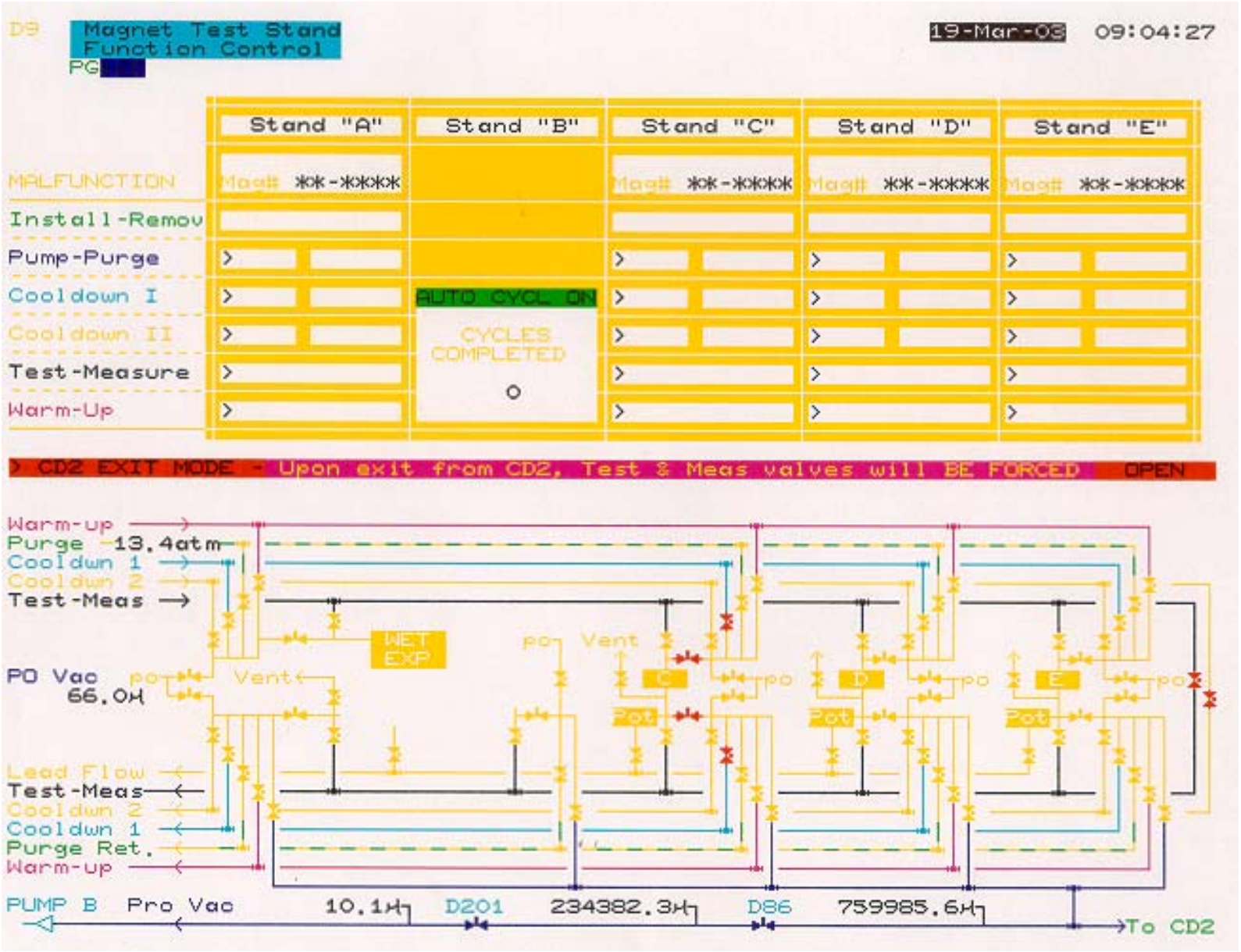
Remarks

- What happen to oil vapor during scrubbing? The oil vapor should condense in the cold trap or flow back to compressor. Since no observable oil is found in the trap sing alcohol rinse, oil is below measurable amount. Once oil vapor returns to the compressor, it will be removed by the absorber.
- Can 35 g/s of helium flow insufficient to remove oil compared to 60 g/s during warmup or cooldown? Don't think so. There should have some visible sign of oil.
- Does it take a very long time (months or years) to move oil though flow circulation? Not true because we found oil in D2L104.
- By installing filter in front of nozzle to the magnet, one should be able to prevent oil from entering the magnet. The filter should be good for several days. Oil trapped in the filter (if any) should remain inside the housing during warmup.
- The magnet is able to tolerate small quantity of oil based on RHIC experience.

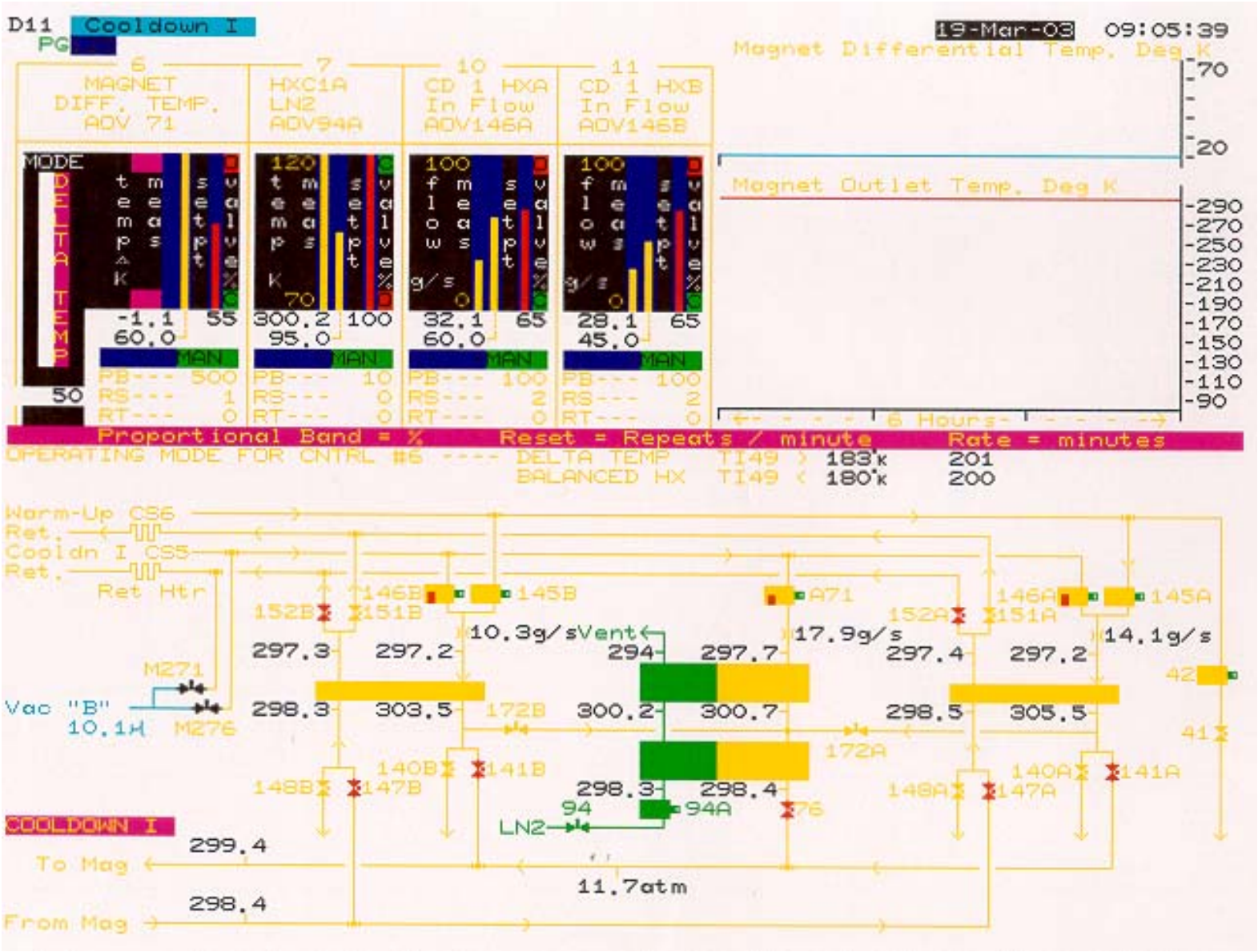
Cooldown compressor CS5 for Scrubbing CD Lines



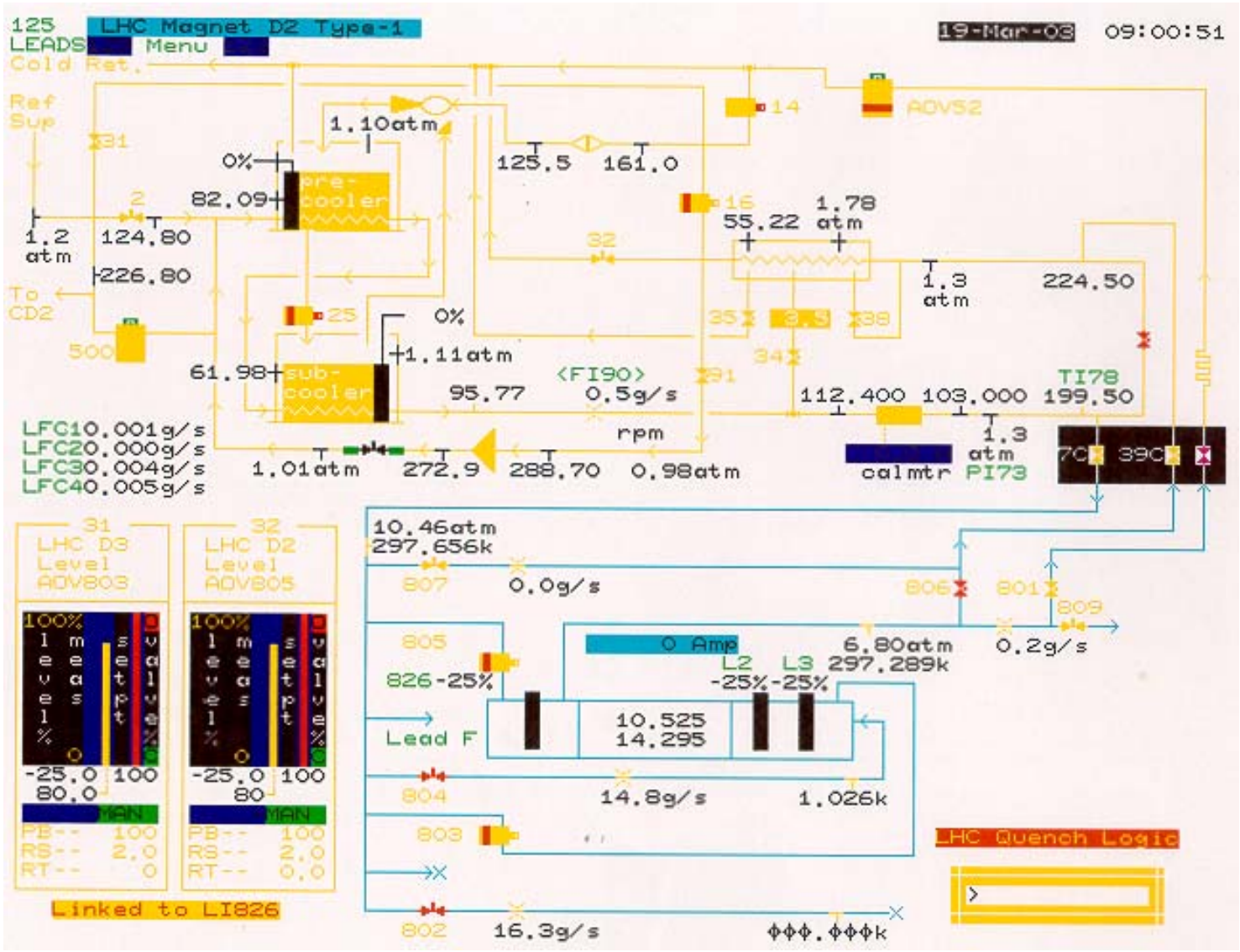
Valve Status for Scrubbing CDI Lines



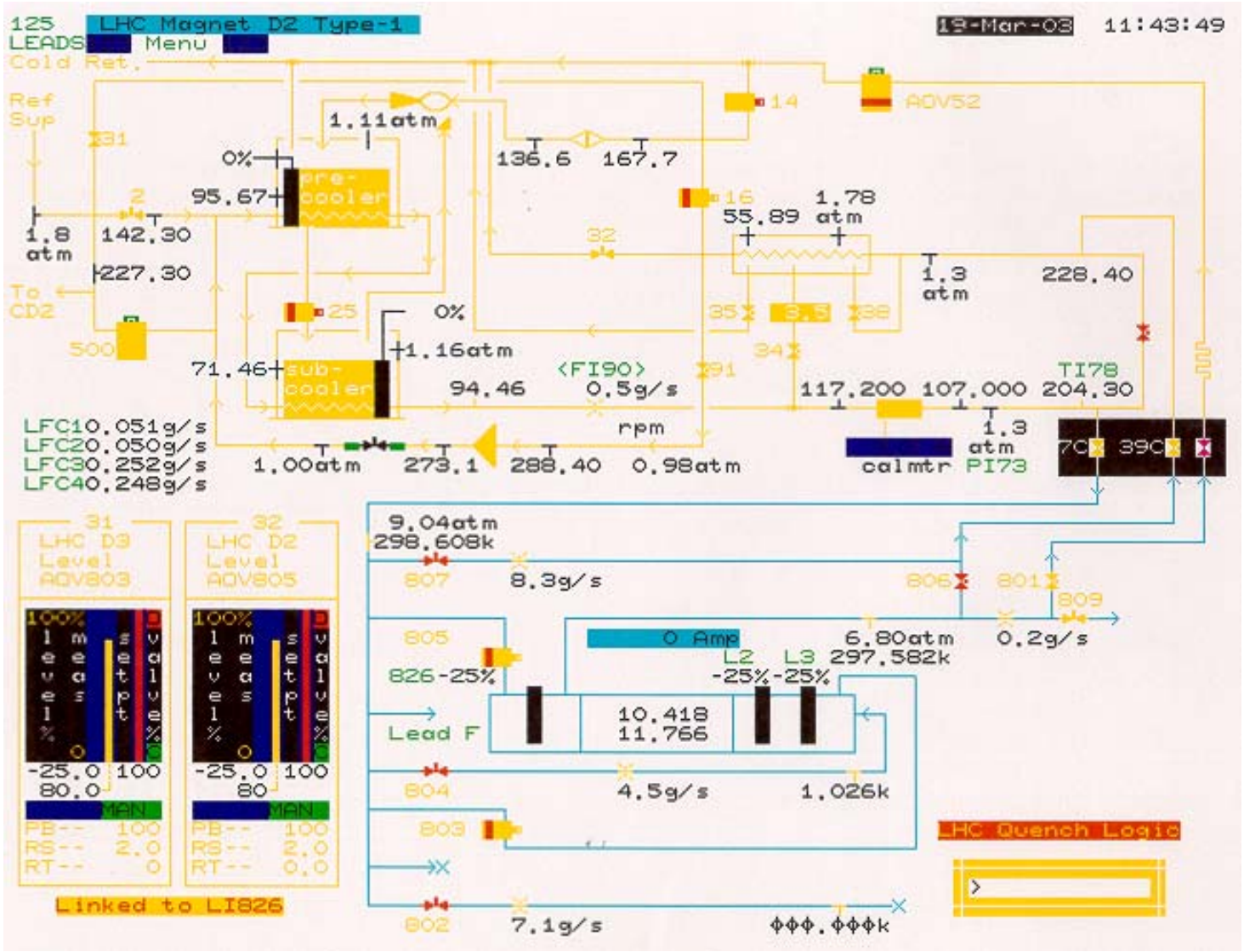
Valve Status in Cooldown I for Scrubbing Oil



Process Condition for Oil Scrubbing from CDI Magnet is Replaced by Oil Removal Equipment



Oil Scrubbing Including By-pass and Leads Magnet is Replaced by Oil Removal Equipment



Process Condition for Scrubbing Leads