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Byrns, R

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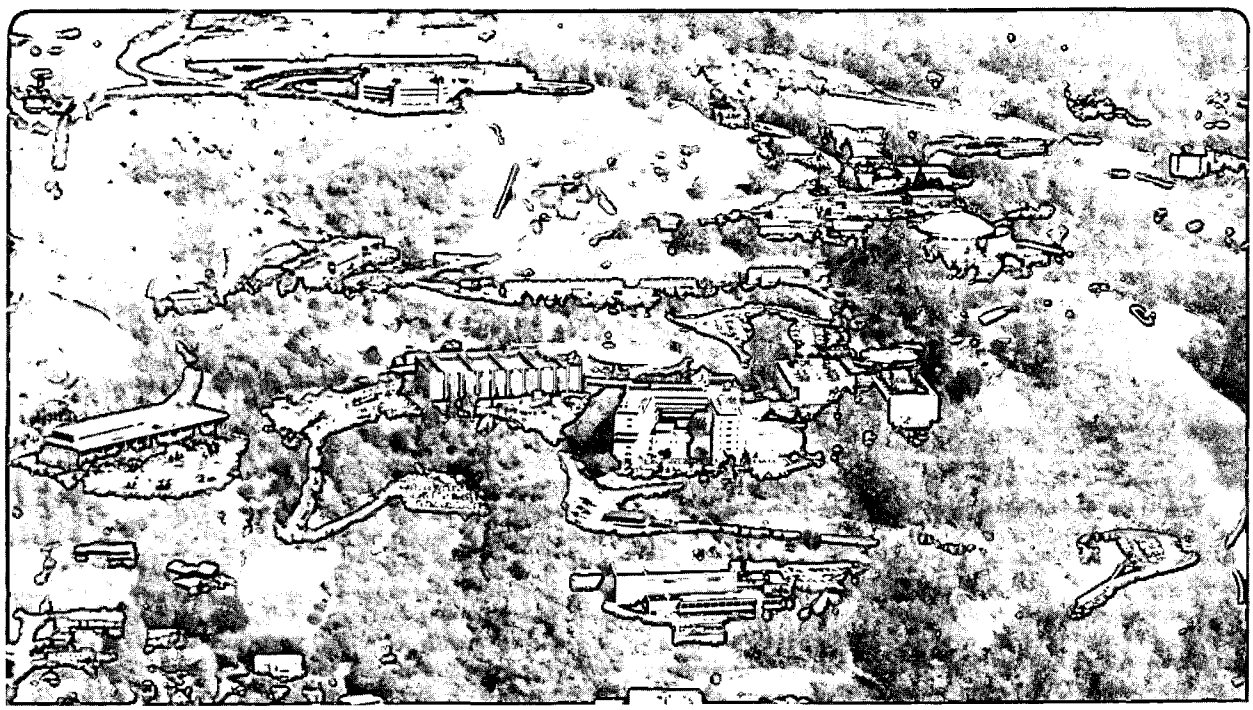

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LBID 079 CO# 0029

LAWRENCE BERKELEY LABORATORY - UNIVERSITY OF CALIFORNIA

ENGINEERING NOTE

CODE	SERIAL	PAGE
TF0200	M5378B	1 OF 25

AUTHOR	DEPARTMENT	LOCATION	DATE
R. BYRNS	MECHANICAL	BERKELEY	JULY 19, 1979

PROGRAM — PROJECT — JOB
NBTF-TFTR

GRYOGENICS

TITLE
OPERATIONS 1979 - 1980

A REVISION 6/10/80
B REVISION 10/2/80

INDEX

DISTRIBUTION
G. Newell (3)
R. Byrns (2)

AUTHOR R. BYRNS RB | DEPARTMENT MECHANICAL | LOCATION BERKELEY | DATE JULY 19, 1979

PROGRAM — PROJECT — JOB
NBSTF-TFTR

CRYOGENICS

TITLE
FIRST COOLDOWN - JULY 9, 1979

Operations Synopsis

Monday 7-9-79

22:30 Start LN cooldown

Tuesday 7-10-79

01:50 LN leak indicated maybe?

07:30 Remove all orifices in LN line; replace with plugs.

12:00 Cooldown very slow. Remove all plugs; line left wide open. Strain gages behaving fairly.

LN truckers on strike, but TFTR getting sufficient delivery.

15:30 LN Bayonet (2R) leak very badly; much trouble to fix (45 minutes, 4 men, Newell, Ellis, Curtis, Gachis). 4 end panels seem cold, 4 middle panels not cooling? Some anomaly?

Wednesday 7-11-79

09:30 Discovered Computer Room TV display CGR'S all read 77°K, LHe panels 150°K.

Discovered Datalogger (T.C.) all fouled up, at least 40 out of 100 channels. "The beauty of redundant, independent sensors:"

10:30 R. Nemetz took rate-of-rise on main tank. N_2 leak is very small or non-existant.

Start LN flow thru LHe dewar shield and main tank guard circuits.

Reading TV monitor for temperatures, must punch and wait 27 seconds for update.

11:00 LHe Refer start up.

Discovered Grove dome regulator AFU, must put He gas into propane tanks manually.

12:30 Flow started from "C" Box thru "D" Box to panels via diverter valve in cooldown mode; return flow exits via Bayonet 11 to 9Kw heater and compressor suction.

14:15 START DRY ENGINE.

16:00 Found 500 micron pressure in XSFR lines. High Δp on JT and LHe dewar phase separator (maladjusted JT?)

17:20 START WET ENGINE

Panel cooling inlet/outlet ΔT= 6°K.

TIME	17:20	19:00	20:00	21:00	22:00	23:00
inlet temp	158°K	37°	36°	33°	28°	22.8°K
outlet temp	164°K	134°	121°	95°	62°	33.7°K
ΔT	6°K	97°	85°	62°	34°	10.9°K

23:00 Closed bypass valve at Bayonet 11.

23:45 Approaching 9°K at inlet.

Thursday 7-12-79

00:03 Making liquid!! Suction make-up from trailer went negative. Manual filling from tube trailer.

01:30 Switch diverter valve to circulating mode.

02:30 Close Turbo Pump, V-21 main tank vacuum holds at 4×10^{-8} Torr.

03:20 Gas make-up shut off, 10 tubes used. Estimate ∿250 liters LHe (±20%). Liquid level gage works! Reads 10% full.

03:30 Close off wet engine, go to J.T. mode.

Open Bypass MV-26 and balance with heater.

06:00 Stable operations for last few hours.

10:30 Measured LN decay 1" in 30 minutes (5.8" to 4.8") ≃120 $^{\text{liter}}/_{\text{hour}}$? Measured LHe heat load at 75 watts ±20% = 60/90 watts?

13:00 Pulse in H_2 gas to main tank for vacuum pumping speed tests.

H_2 pump speed tests, R.G.A., etc.

15:00 Start warm-up, cut off LN.

23:00 Put diverter valve into cooldown mode.

Return flow overboard at Bayonet 11.

Friday 7-13-79

09:00 Warm gas into "D" Box and panels, out RB valves thru 9Kw heater.

11:00 All "C" Box at + 300°K. Isolate "C" Box.

11:45 Close LN solenoid to warm up LN panels with force flow.

14:00 Both LN and LHe panels about 200°K ± 15%.

Summary and Conclusions

1. LN use 2" decay in manifold in one (1) hour ≃ 120 liter/hour.

   On 7-12 with both panels and refer on and including trailer losses, use from 07:00 to 14:15 was 1030 gallons per 7.25 hours equals 140 gallons per hour ≃ 560 l/hr = $33.00/hr. ≃ $21,000/month.

2. 4.5°K heatload approximately 75-100 watts.

3. Pumping speed on H_2 gas is: 15,000 to 5,000,000 liters/sec. {R. Smith, R. Nemetz}

4. Calorimeter went to -27°C on TV CGR'S after a few hours of cryosystem operation.

   Frozen water burst copper pipes on calorimeter.

   Water flow Needs redesign for icing protection.
   Needs series circuits.
   Isolation valves and non vapor-lock circuit design.

5. The Divertor valve works OK in cool-down and circulation mode (also warm-up). It seems to work partially for reactivation and panel de-rime mode. The seal for the foot valve needs improvement.

6. Real Time Systems monitor of cryopanel temperatures and redundant instrumentation is great convenience and mandatory for operations.

7. Excess refrigeration capacity provides speedy cool-down and liquefaction for filling cryopanels and dewar, especially important for:

   a. Short cycle operations.

   b. Overcoming excess heat leaks from poor vacuum or assembly.

   c. Minimizing time required for preparatory operations.

APPENDIX I LIQUID NITROGEN ESTIMATED LOSS

LN level: (If inlet valve leaks data N.G.) goes from 5.8" to 4.8" in 1/2 hour.

Dewar is - 6" dia. pipe , length is 50 ft. approx.

Approx. Volume = 6" x 1" x (50' x 12"/ft). = $\frac{3600\ in^3}{1/2\ hour}$

LN loss is: $\frac{7200\ in^3/hr}{60\ in^3/liter} = 120\ liter/hour$

LN cryopanel loss -	120 ℓ/hr
LHe refer use -	60 ℓ/hr
Dewar and guard lines	20 ℓ/hr
XSFR line loss	10 ℓ/hr
Trailer 1%/day (4000 Gal) $\frac{40\ gal\ (4)}{24\ hr} = 7$ ℓ/hr (+50%) ≃	10 ℓ/hr
	220 ℓ/hr ....(est.)
Est. XSFR Losses.....	100 ℓ/hr
	320 ℓ/hr ....(est.)

As measured on trailer:

1000 gal in 7 hours ≃.....560 ℓ/ hour..(est.)

(Possibly some error in trailer gage readings, see item 1, page 3.)

With LN at 6¢ per liter, operating costs are approx. $15.00 to $30.00 per hour or at 700 hrs/month ≃ $10,000 to $21,000 per month.

APPENDIX II LIQUID HELIUM PRODUCTION RATE

10 Bottles (2500 psi - 600 psi) = 3/4 (10) used = 7.5 bottles

3.5 to fill system, 4 for liquid x 50 ℓ/B = 200ℓ. (Each bottle holds 1300 ft^3≃50ℓ)

8 panels @ 20ℓ each = 160 ℓ
level gage = 10% (750) = 75 ℓ
235 ℓ

or

10 Bottles total.
4 to fill system
6 for liquid @ 50ℓ each ≃ 300ℓ/

So time to produce*from :00/0 to $\begin{matrix}0350\\0400\end{matrix}$ ≃ $\begin{matrix}3.5\\4\text{ hours}\end{matrix}$

between $\begin{matrix}240\\300\end{matrix}$ ℓ = $\begin{matrix}60\ell\\80\end{matrix}$/hr.; production rate 70$\ell$/hr ± 12%

---

*At operating conditions; dry engine @ 275 RPM, wet engine @ 290 RPM,

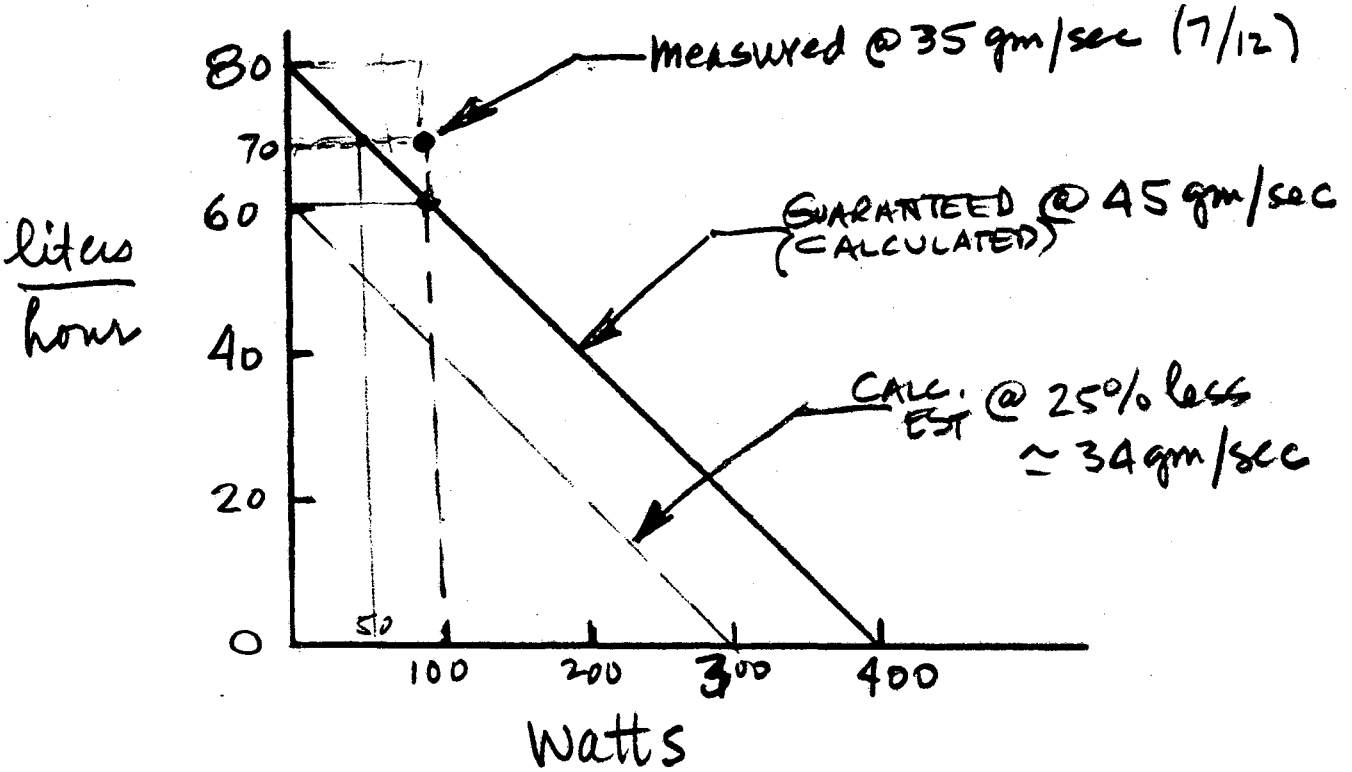
mass flow ≃ 35" ≃ 36 gm/sec., p ≃ 235 psi

Helium Refer Estimated Performance

The above liquefaction rate of 60/80ℓ/hr. was maintained while simultaneously holding the 75/100 watts static panel heat leak at 80% mass flow (35/45).

Minimum performance specified by the vendor (CCi) was 400 watts or 80ℓ/hr at 44 gm/sec. LN use 30ℓ/hr (Refer), 60ℓ/hr (liq.). Actual performance expected; 95ℓ/hr and 475 watts.

Therfore we can conclude the refer meets LBL specification 300 watts/80ℓ/hr. (100 watts + 70ℓ/hr. = 90ℓ/hr.)



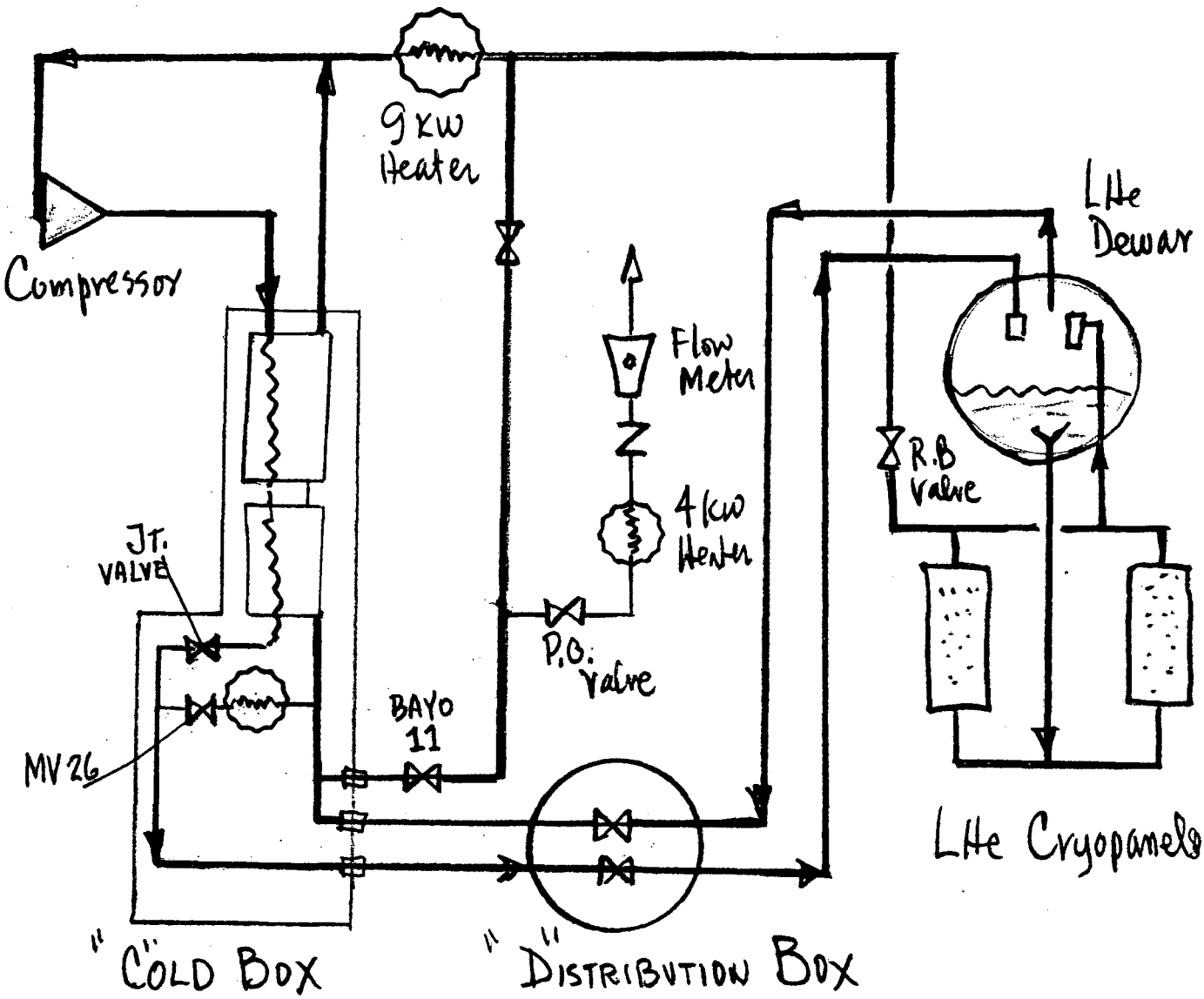
APPENDIX III MEASURE OF 4.5°K HEAT LOAD

How to measure LHe heat leak

1. Close "D" Box supply valve.
2. Open Bayonet 11 valve to vent dewar.
3. Rebalance LHe refer with bypass MV-26 and increase of heater watts; no mass flow or JT valve change. Difference in heater watts is panel watts. (Δw)

Another Method

1. Close "D: Box supply valve to cryopanel.
2. Open Bayonet 11 valve, close 9 Kw heater valve, open pumpout valve.
3. Attach 4 Kw heater and flowmeter to pumpout valve and measure boil off (air calib on flowmeter to He is $\simeq$ 2.75.)



APPENDIX IV OIL REMOVAL NOTES

July 11, 1979

11:00 Start compressor

19:00 Oil out of coalescers ∿ 105 mℓ.

1900-1100 ≃ 8 hours don't know when last drained? Data N. G.

22:00 Oil out $250^{m\ell}$/3 hours. = 83.3 $^{m\ell}$/hr.

July 12, 1979

02:00 Oil out $140^{m\ell}$/4 hrs. = $35^{m\ell}$/hr.

70" on FM. Dwyer p=220 psi Q=56 gm/sec Flowmeter Calib.

Helium flow = 32"/34" $\frac{X}{56} = \sqrt{\frac{35}{70}} = \frac{1}{\sqrt{2}}$ x = (1.414) (56) = 35 gm/sec (He)

PPM = $\frac{35\ m\ell\ (0.9\ ^{gm}/_{m\ell})}{35\ gm/sec\ \ 3600\ sec/hr.}$ = 250 ppm_w

09:30 Oil out 165 $^{m\ell}$/7.5 hrs = 22 $^{m\ell}$/hr = 157 ppm

15:45 Oil out 125 $^{m\ell}$/6.25 hrs = 20 $^{m\ell}$/hr = 142 ppm

July 13, 1979

09:55 Oil out 225 $^{m\ell}$/18 hrs = 12.5 $^{m\ell}$/hr (1/2)*

*compressor at 50-60% capacity ≃20 - 25 $^{m\ell}$/ hr 150 ppm_w

The above data is total oil blown down from both coalescers. The amount from the second coalescer is guessed at approx. 1/10 of the total for an amount equal to about 15 ppm. If a true 15 ppm at the entrance to the No. 2 coalescer then the system is OK (assumes the charcoal stops the remainder of oil vapor).

However, the amount of oil, 250 to 140 ppm at the first coalescer is 4 to 7 time higher than that (35 ppm) in Bldg. 56 (1500 watt refer) and leads me to suspect that the coalescer cartridge in the big (800 HP) Sullair compressor is doing a better job than the unit in Bldg. 6 (400 HP).

System in Bldg 6, piping and internals should be inspected with ultra violet black light, and monitored further.

Consider set-up compressor to bypass flow ahead of charcoal filter and extend life of charcoal.

APPENDIX V

WORK LIST

1. Inspect/fix all leaky bayonets XSFR-LN line 2 bayonets vert run - LN line.
2. Install blowdown valve on feed line from LN trailer.
3. Horizontal bayonets on shroud and ground no darn good.
4. Grove, Hubbell regulators AFU install compressor bypass line suction control.
5. Need gage on RB valve line from LHe panel.
6. Need seals in RB valves for liquid O_2 maybe cracked?
7. Need overbound flow from panels at "D" Box.
8. Need Cu-Co Tc's for cool/warm modes.
9. Put manual 3 way air valve for JT/wet engine - ? (JT creeps open) and kicks off engine.
10. Need charger H_2 and regulator for T1-4.
11. Grease fittings on engine rollers!
12. Check out oil system, coalescers, and blowdown returns.
13. 100°F switch on 4.5Kw heater.
14. Procedures - shutdown/warm up and schematics.
15. Need bypass valve at Bayonets 11 substitute for MV26?
16. Does heater have enough heat xsfr area?
17. Replace JT valve, open up MV26.

LBID-079

LAWRENCE BERKELEY LABORATORY · UNIVERSITY OF CALIFORNIA. ENGINEERING NOTE	CODE	SERIAL	PAGE
	TFO·200	M5378	10 OF 25

AUTHOR	DEPARTMENT	LOCATION	DATE
R. Byrns	Mech Engr.	B.	9 June 80

Flow Rate Calculations from CCI 12/18/78

DANIEL Industries ORIFICE PLATE } FI-3
316 S.S. – 3" ϕ pipe – Inlet 0.792"

CALC. FLOW AS FOLLOWS –

$$Q = \frac{C_1 \sqrt{H \cdot PF \cdot 520/FT}}{FTF}$$

Q = FLOW – SCFM
C_1 = CONST = 5.56391
H = Δp, inch H_2O
PF = Line press. when (195 / 200 psig) FLOW – PSIA
FT = Flow temp, °R (60°F)
FTF = " " FACTOR = .98076

SUBSTITUTING –

$$Q_1 = \frac{5.5639}{.98076} \sqrt{35" \cdot 215 \cdot \frac{520}{520}}$$

$$Q_1 = 5.673(86.747) = 492.12 \text{ SCFM} = 38.60 \frac{gm}{sec}$$
$$(12.75 \text{ SCFM/GM/sec})$$

Flow meter Δ

$$Q_2 = Q_1 \sqrt{\frac{20"}{35}} = Q_1(.7559) = 372.01^{SCFM} = 29.18 \, g/s$$

$$Q_3 = Q_1 \sqrt{\frac{70"}{35}} = Q_1(1.414) = {}^{*}695.97^{SCFM} = 54.59 \, g/s$$
(FULL FLOW)

Pressure Δ. Assume pressure @ 180 psig = 195 psia.

$$Q_2 = Q_1 \sqrt{\frac{195}{215}} = 54.59(.952) = 51.99 \text{ gm/sec}$$

$$Q_1 = Q_4 \sqrt{\frac{165}{215}} = 54.59(.876)$$
$$= 47.82 \, g/s$$

* 80% vol. eff. (DISPLACMNT 880 SCFM) = 704 SCFM

DANIEL INDUSTRIES

ORIFICE PLATE

3" I.P.S 0.792" ϕ

$$Q = \frac{C_1 \sqrt{H \cdot PF \cdot 520/FT}}{FTF}$$

Q = FLOW - SCFM

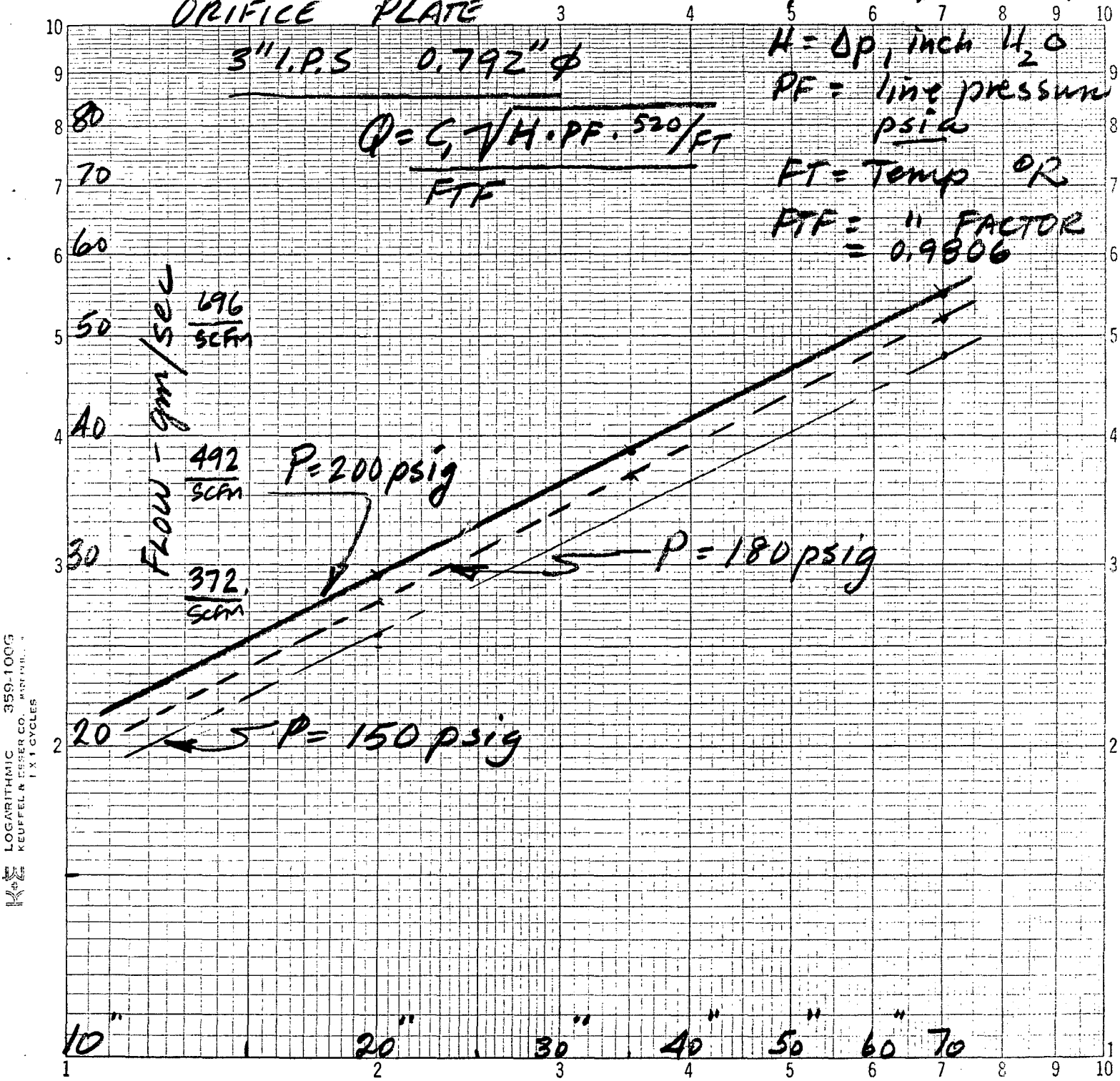
C_1 = CONST. 5.5639

H = ΔP, inch H_2O

PF = line pressure psia

FT = Temp °R

FTF = " FACTOR = 0.9806



LOGARITHMIC 359-1005
KEUFFEL & ESSER CO.
1 X 1 CYCLES

6-9-80
R. Byrns

POSSIBLE AUTO CONTROLS

1. Transducers on suction:
   — controlling slide valve
2. — controlling boot pressure on discharge
3. — controlling MV-26
4. — controlling internal heaters on dewars (Target and source tank) (or cold box?)
5. — controlling J.T.
6. Add small amount warm gas via solenoid valve and needle to cold end.
7. Add suction press bypass - hi side to low — hold suction up unload high side — (use grove valve?)
8. Pilot valve pressure control to high side boot valve.

Fault Mode Safety

1. Engine off — close J.T.
2. " " , Heater off

SUBJECT: AUTOMATIC CONTROL OF SUCTION PRESSURE

NAME Jim Cox

DATE 7-15-80

THE BARBER-COLMAN PROPORTIONAL CAPACITY CONTROLLER CAN BE USED TO AUTOMATICALLY CONTROL THE SUCTION PRESSURE OF THE COMPRESSOR IN BUILDING 6.

THE CONTROL SYSTEM IS OF THE ON-OFF TYPE. I.E., IT WILL TURN RELAYS ON AND OFF FOR FIXED PERIODS OF TIME, ADJUSTING THE CONTROLLED PARAMETER (E.G. SUCTION PRESSURE) IN A STEPWISE MANNER. THE BARBER-COLMAN INSTRUMENT CONTROLS TWO SWITCH CONTACTS WHOSE CONDITION IS MONITORED BY ONE AMBER LIGHT AND ONE GREEN LIGHT. THE INPUTS TO THE CONTROLLER ARE A DIALED REFERENCE AND THE TRANSDUCER READING (0-100 MV. FULL SCALE). THERE ARE FOUR CONTROL BANDS; THE PROPORTIONAL BAND, THE DEAD BAND, BELOW THE PROPORTIONAL BAND, AND ABOVE THE PROPORTIONAL BAND. THE PROPORTIONAL BAND CAN BE SET TO ± 3% OR ± 10% OF FULL SCALE BY MOVING A WIRE INTERNAL TO THE DEVICE. THE PROPORTIONAL AND DEAD BANDS ARE CENTERED ABOUT THE REFERENCE SETTING, THE DEAD BAND BEING

RL-888 1000-42887 (Rev. 8/78)

SMALLER THAN THE PROPORTIONAL BAND. IF THE TRANSDUCER SIGNAL IS WITHIN THE DEAD BAND THE TWO SWITCH CONTACTS ARE OPEN; IF ABOVE THE PROPORTIONAL BAND, THE LOAD SWITCH IS CLOSED AND GREEN LIGHT IS ON; IF BELOW THE PROPORTIONAL BAND THE UNLOAD SWITCH IS CLOSED AND THE AMBER LIGHT IS ON. WITHIN THE PROPORTIONAL BAND THE CONTACTS WILL BE INTERMITTENTLY CLOSED IN AN EFFORT TO DRIVE THE TRANSDUCER SIGNAL INSIDE THE DEAD BAND.

FOR A TRANSDUCER WHICH OUTPUTS 0-100 mV. FOR 0-5 PSI., THE 10% CONTROL RANGE PRODUCES A ± 0.5 PSI. PROPORTIONAL BAND. THE FIGURE BELOW SHOWS A TYPICAL CONTROL SYSTEM.

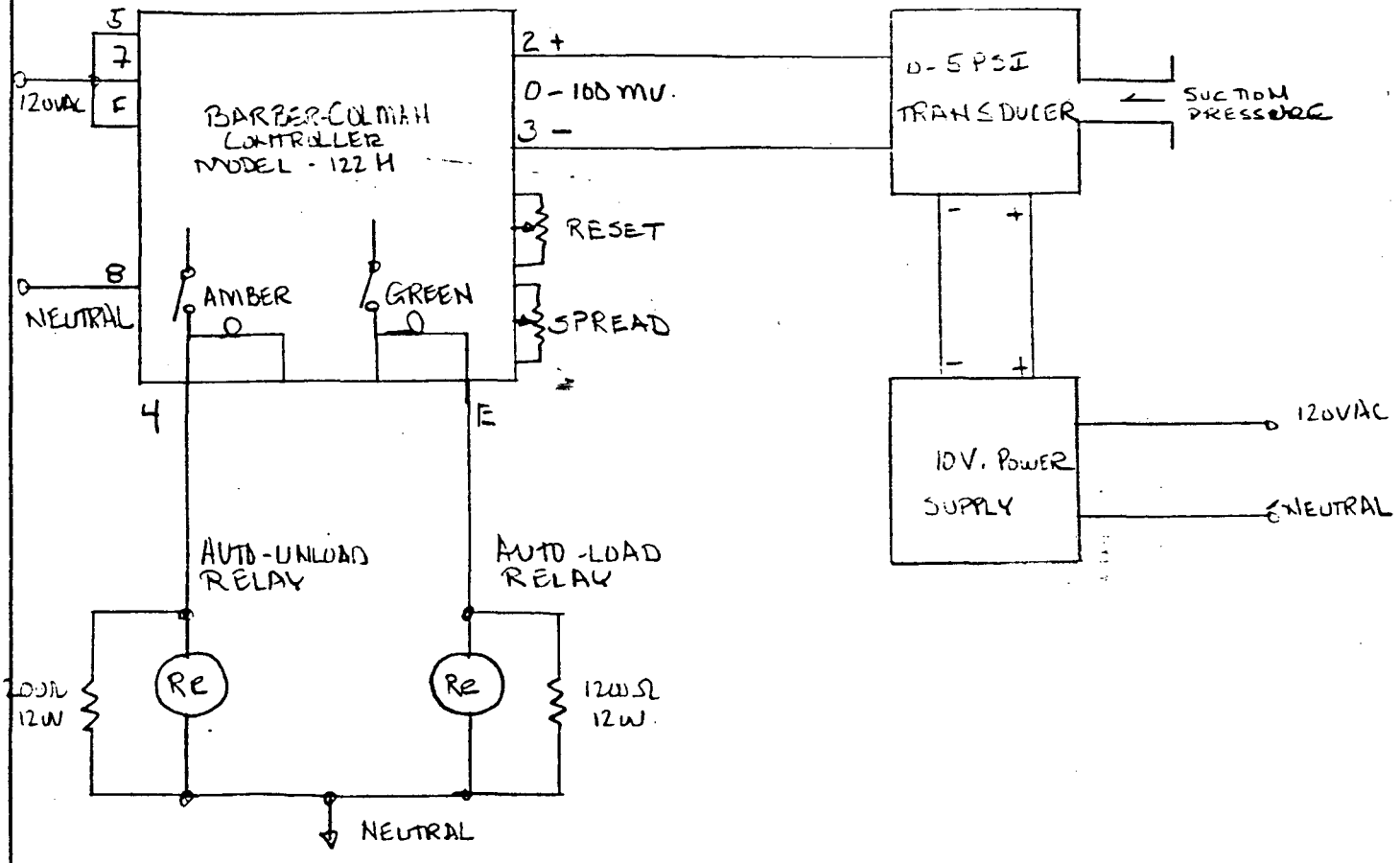
RL-388 1000-4/81 (Rev. 8/81)

SUBJECT: AUTOMATIC CONTROL OF SUCTION PRESSURE

NAME: Jim Cox

DATE: 9-15-80

CONTROL SYSTEM



NOTES.

1. RELAYS KRP11AG (LBL STOCK)
2. RESET POTENTIOMETER CENTERS THE PROPORTIONAL BAND ABOUT THE REFERENCE SETTING
3. SPREAD POTENTIOMETER SETS THE SIZE OF THE DEAD BAND. IT SHOULD BE SET TO MINIMUM DEAD BAND WHEN SETTING UP. IF THE DEAD BAND IS TOO LARGE IT INTERFERS WITH THE TIMING IN THE PROPORTIONAL CONTROL BAND
4. POWER SUPPLY: ANY REGULATED 10V D.C. POWER SUPPLY

KL-888 7800-43817 (Rev. 8/78)

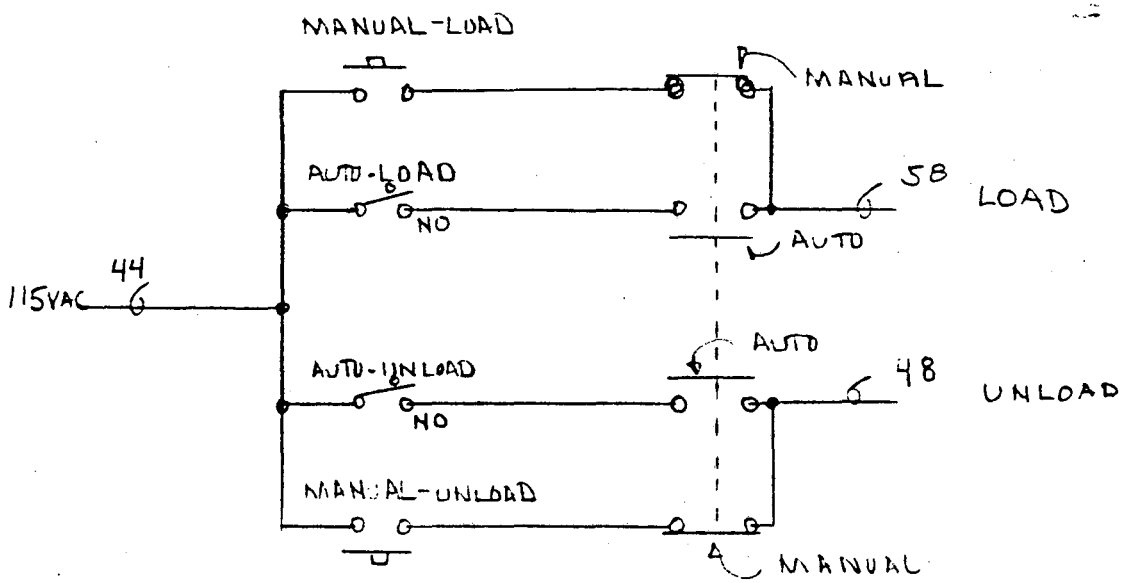
SUBJECT: AUTOMATIC CONTROL OF SUCTION PRESSURE

NAME: Jim Cox

DATE: 9-15-80

CONNECTION TO COMPRESSOR CIRCUIT

THE CONTACTS OF THE AUTO-UNLOAD AND AUTO-LOAD RELAYS IN THE ABOVE FIGURE MUST BE CONNECTED INTO THE COMPRESSOR CIRCUIT, SPECIFICALLY THE AUTO-MANUAL / LOAD-UNLOAD SWITCH. THE SWITCH AND THE CONTACTS SHOULD BE WIRED AS IN THE FIGURE BELOW.



REMOVE P1-LO, P2-HI, & 3 TR. AS. THEY ARE NO LONGER NECESSARY.

REFERENCE: 8T1144; PAGE 8 OF OPERATORS MANUAL, SULLAIR

BL-888 7800-4888 (Rev. 8/78)

SUBJECT

AUTOMATIC CONTROL OF SUCTION PRESSURE

NAME Jim Cox

DATE 9-15-80

PARTS:

1. BARBER-COLMAN CONTROLLER - 122M
   SHOULD GET MANUAL FROM MANUFACTURER
2. TRANSDUCER - 0-100mV. OUTPUT.
   MECHANICAL ENGINEERING
3. 0-10V. POWER SUPPLY LBL STOCK OR OUT OF BLDG. 56 COMPRESSORS (NOT USED.)
4. RELAYS KRP 11AG. LBL-STOCK
   " SOCKETS " "
5. LOAD-UNLOAD SWITCH : PARTS ~~AT~~ COMPRESSOR.

RECOMMENDATIONS

1. START WITH ±10% PROPORTIONAL BAND ON CONTROLLER
2. START WITH MINIMUM DEAD-BAND
3. TEST CIRCUIT WITHOUT RUNNING COMPESSOR

METHOD:

a. LIFT LEAD TO MOTOR CONTACTOR
b. MAKE UP CHAIN
c. BUGGER LO-OIL PRESSURE
d. PUT FALSE SIGNAL INTO CONTROLLER AND CHECK FOR CORRECT MOTOR CONTROL IN THE AUTO / LOAD-UNLOAD CONDITION

RL-888 7000-4557 (Rev. 8/7

SHUTDOWN PROCEDURE

R. Curtis
6-80

1. Crack 2 R.B. valves (4L, 4R) thru 9 kw heater to suction.

2. Kill warm engine, but not J.T.

3. Open MV-14 (80°K bypass) and isolate adsorber with 44/45, then bleed thru 46 to suction until at 30-40 lbs.

4. Cut LN supply to cold box

   A. Watch suction all the while. If it goes towards 4 1/2-5 get to the kickback pilot to adjust back down. Hold at 2 1/2-3 lbs.

5. Close diverter valve to "cooldown"...

   B. This should have a drastic effect on suction, i.e. should rise fast. As it climbs you can increase lst: compressor discharge... Not faster than 2 lbs. boot pressure per second or two. This will adsorb excess suction gas temporarily.

   C. Increase capacity to 80%-95%. Boot pressure should be no more than 230. If you are kicking back boot pressure and comp. disch. will read low. To see real boot pressure turn off kick back for 1/2 minute or so and you, should see a slight rise on boot and disch. pressures.

   D. Thing will happen quickly so at 220-230 lbs. shut coldbox is MV-13, 11 and pinch 12 alowly while watching suction. i.e. The faster you shut it off the faster suction rsies. If you don't have 250 lbs after bleed down leave compressor going and it'll catch boiloff... tank. You may unload compressor capacity at that point but discharge pressure above desired propane tank pressure...

Monday 5-5-80

Ran compressor while waiting for data logger to arrive

Tuesday 5-6-80

18:00 Began LN cooldown. Data logger not reading degrees kelvin yet.

21:00 Started compressor.

23:00 Data logger not working yet called RTSG.

23:30 RTSG got data logger working and programmed.

Wednesday 5-7-80

02:30 Have been trying to control LN_2 with wrong knob, level fell. Opened main valve to 6.0. Recycling liquid helium thru wall heater.

04:00 Thermocouples not showing drop below approx. 125°K, assume they're calibrated wrong.

07:00 Virtually no oil out of coalescers.

08:00 All thermocouples read 120°K except LN frame tops

10:00 Only 3L frame top not down to 77°K, cracked guard and shroud valves.

13:00 Sending cold helium to panels, return thru R.B. set up

16:30 Power supply for data logger burned up. Opened D box return valve closed R.B. belw all relief valves

22:00 Sending liquid He to panels

Thursday 5/8/80

00:00 Rod Byrns calculated 200 Liquid liters of He produced so far.

02:00 Valved out turbo source I.G. went up from 5.5. x 10^{-6} to 5.7 and held.

03:00 Al Lietzke did pumping speed calculation and found 2.7 million torr liters/sec, valved turbo back in

06:00 Source tank pressure seems dependent on compressor suction pressures as Lietzke states. Dewar full? No diverter valve in cooldown mode want accept liquid to dewar. 2 phase gas bubbling around panels and dewar.

08:30 Balancing out cold box with MV 26 and internal heater.

11:30 Closed J.T. somewhat, coldbox demanding gas.

13:00 Discovered diverter valve motor is broken. Manually set it to circulating mode.

14:30 Filled in compressor motor wiring caused it to trip out.

15:35 Got compressor back on. 870 ml oil total in 31 hours = 28 ml/hr.

17:15 Used up all gas from storage tanks, switched to trailers. 28 tubes open @ 250 psig.

18:10 He dewar at 12% .125 psi in 28 tubes went to J.T. mode with MV-26 and internal heater @ 50 watts.

19:00 65 watts

19:15 Heater off. Bob Gray and crew suspected a leak in Helium circuit to source tank based on R.G.S. and Annie readings. Took rate of rise $>.2 \times 10^{-5}$. Dropped suction pressure to 10" causing ion gage to fall to 4.7×10^{-7}.

23:00 Coalescers blew out 380 mL = 1250 mL/39hrs = 32 mL/hr.

Friday 5-9-80

00:30 Reset suction to 1 1/2 lbs.

03:00 Turned off LN_2 supply at trailer to check consumption - 100ℓ/hr for source tank 57ℓ/hr for cold box.

Put Annie on source tank and got no helium response. R.G.A. showed virtually no He peak.

05:30 Running unattended (almost) since midnite on J.T.

07:00 Raised J.T. setting, compressor to 85%. Did various calculations. Average oil consumption to date @ 25 mL/hr. Average LN consumption 160L/hr.

09:45 Still running steady, He dewar @1% raised J.T.; compressor capacity to 90%, He dewar to 3%.

12:00 Still running steady, He dewar from 1% - 5%.

13:00 Begin warmup

16:00 Secured compressor and refer 235 psig in storage

SUGGESTIONS - THINGS TO DO

Compressor/Cold Box

1. Better pilot (circle seal) for PRV-2-(make-up)
2. Storage tank pressure gage mounted on cold box control panel
3. Coalescer blow down line - Coalescers to suction side of compressor. Mounted with a pot and a sight glass.
4. Kickback pilot (PRV-3) put upstream and downstream sensor lines farther from regulator; i.e. high side line to 6" high pressure pipe near MV-9; downstream line to 1) suction? 2) intermediate line PRV-4 — PRV-2? 3) TEE'd into line for propane tanks pressure gage.
5. Lighter check-valve-spring at PRV-3 kickback.

Tuesday 5-27-80

7:30 Pumped transfer lines

13:00 Began LN_2 cooldown, trouble with shroud (seat had come loose) feed valve. Valve won't close off. LN overflowing.

21:00 Started compressor, pre-cooling adsorber

Wednesday 5-28-80

02:00 Adsorber cool, working on cold box temperature.

08:00 Began letting cold He gas into system

11:00 Repaired shroud valve

14:00 Increased compress or to max

19:15 Return gas @ 20°K

20:00 Panels @ 9°K

23:00 Panels @ 5°K bottom 10° 12 top, circulating now

Thursday 5-29-80

04:30 Dewar at 20%. Refer ran pretty smoothly all day. Suction pressure fluctuated from 0-5 psig. Controlled with by pass; internal heater, J.T. & compressor capacity valve.

Friday 5-30-80

OWL shift: Controlled refer suction with compressor slide valve. Ran very stably all night. Day shift controlled suction with warm expander internal bypass and heater; Slower response. Swing shift backed capacity to 70%, ran steadily

Saturday 5-31-80

OWL shift shut down refer. Boil off from dewar and top half of panels filled storage tanks. Panels warmed very slowly. 5 hours after shut down, temperatures varied from 6-12 degrees.

Source tank pressures varied from 3.5×10^{-6} at stary up, 4.3×10^{-7} with LN only. 3.0×10^{-8} with 20°K gas in system. 5.0×10^{-6} with big He but source operations 1×10^{-5} at start of warm up.

LN comsumption from May 27 to May 28 (24 hours) was approximately 2000 gallons or 83 gall/hr? Inaccurate gage. LN manifold use was 88ℓ/hr approx. Oil carryover was monitered at 4 hour intervals. Blowdown amounts varied from none to 110 mL from #1 coalescer.

#1 coalescer averaged 19 ml/hr over 39 hour period .
#2 coalescer averaged 10 ml/hr over 39 hour period.

Monday 6-2-80

LN_2 ran continuously since May 27. Little trouble with controller over weekend. Underfills or overfills pressure burst caused by valves opening cause transducer differential pressures to read negatively opening valves further. Helium panels at 85°K.

Tuesday 6-3-80

00:30 Temperature down to 8°K, 2% in dewar by 05:00, 9% by 6:30 or approximately 24 hours to ℓHe temperatures. Tank pressure @ 1.8×10^{-8} very smooth running all day, no internal heater, no adjustments. Swing shift had suction pressure going up and down. Controlled with comp. capacity, J.T., M.V. 26-int. bypass. LN_2 controller very uncontrollable.

Wednesday 6-4-80

OWL shift had suction fluctuating half the night. Stabilized by morning. Installed artificial head pressure on LN transducer-Magnehelic Set gage to read 3". This we will have to improve, working.

Day shift reduced comp. capacity to 70% so as to control suction with the heater alone. (potential automatic feature)

Thursday 6-5-80

OWL shift let suction be at 2 1/2 lbs @ 70% comp. capacity. Bypass/internal heater off. By noon suction had slowly fallen and the bypass brought it back to 2 1/2 - 3 lbs and even 5 lbs by the afternoon.
Swing had a wter line break in the source arc. Refer ran smoothly.

Friday 6-6-80

OWL shift filled dewar from 2% to 28% for regeneration mode test. Used 3 1/2 tubes to make approximately 175ℓ He Liq., which read 28% full. Day shift just monitered things. Reset compressor to 70%, slow warm expander 75 r.p.m.

Swing shift regeneration of He panels was attempted. Set diverter valve to regen mode and dewar He indicator changed to 32%. Temperatures in the panels only came up average 1/2°K in 3 1/2 hours late in the shift the regen-mode was dropped and cool-down/warm-up was resumed/begun.

Saturday 6-7-80

OWL shift shut down. Mostly only enough storage room for He dewar - liquid Panel temperatures remained at 5.6°K to 10°K until 7 a.m.

Oil consumption - #1 21 ml/hr over 118 hours

#2 7 ml/hr over 118 hours

LN consumption for 2 days averaged 62 gal./hr.
Source tank pressures start 3.5×10^{-7}, @ ℓHe temp 1×10^{-8}
6/4 ∿ 1×10^{-7} to 6×10^{-8}, 6/5 ∿ 2×10^{-8} 6/6 2×10^{-8}
6/7 warmup 5×10^{-7}

Monday 6-9-80

Started system up, pre-cooled coldbox and 80°K adsorber. Split cold gas flow from panels at Bayonet 11 to 9 KW heater. After 7 hours.

Tuesday 6-10-80

Closed bayo 11 @ 02:30. (14 hrs on) discovered PV-37 on wet expander (pneumatic inlet valve) had crept closed @ 04:00.

10:00 Liquid showing up in dewar

Wednesday 6-12-80

System running smoothly on all shifts oil down below #2 window in Bulk Oil Seperator.

Thursday 6-12-80

Suction pressure varying from 1-3 pounds, otherwise smooth sailing all shifts

Friday 6-13-80

Suction pressure still eratic, 2" to 4 lbs. and difficult to control, but leveling out on day shift.

Saturday 6-14-80

'New' shutdown procedure. Cut coldbox pressure to 160 lbs. while @ 250 comp. discharge. Recovered gas while slowly lowering cold box pressure. Recovery time - 3 hours.

Monday 6-16-80

Calculated LN usage (for weekend) by cryopanels - only to be 200 ℓ/hr. Turbo had tripped out and source tank was @ 300μ for 8 to 10 hours. Restarted Helium system; cold gas thru Bayo - 11 after 5 hours

15:30 Supply temperature @ 28°K, Return temperature @ 70°K

Tuesday 6-17-80

01:00 Temperatures average 32°K, cut out Bayo 11 13 hours total; wet engine PV-37 crept closed again. Foot valve set wrong: reset

09:00 Liquid beginning to show in dewar.

Wednesday 6-18-80

running steady all night, dewar @ 8%... steady suction

08:00 Rebuilding LN supply valves. swing - steady running all nite, high suction.

Thursday 6-19-80

Suction pressure very erratic. LN system very erratic. Went from J.T. to expander often. Stabilized on day shift.

22:00 started overnite shutdown as per outline.

Friday 6-20-80

06:00 Restarted He system. Source tank pressure maintained 5×10^{-7} throughout the nite: Fell to 5×10^{-8} upon startup. Liquid shows up @ 15:00, steady operation thru swing.

Saturday 6-21-80

Shutdown for weekend according to quick procedure.

10:00 Bob Gray called in for vac-trip of turbo. Set points of 800μ for tank valve still not high enough.

Oil use 6/9 - 6/14 113 hours #1 14 mL/hr #2 5 mL/hr

Oil use 6/16 - 6/21 110 hours #1 10 mL/hr #2 5 mL/hr.

LAWRENCE BERKELEY LABORATORY - UNIVERSITY OF CALIFORNIA **ENGINEERING NOTE**	CODE TF0200	SERIAL M5378 B	PAGE 25 OF 25
AUTHOR F. Zucca	DEPARTMENT Mechanical Engineering	LOCATION Berkeley	DATE

Summary for week 6-23 to 6-27

We started the compressor in the usual procedure off of the propane tanks. Changed the #1 oil filter on compressor and circulated gas to the coldbox, opened supply valve to panels. Nine hours later capsuhelic went crazy and overfilled LN, we pressurized it, returned to normal. Switched to J.T. mode and set compressor capacity to 80%, valved off storage tanks, turned on trailer for nite running. Unattended operations midnite to 07:30.

Tuesday morning panels near liquid temperature switched to wet expander at 300 RPM and valved in propane tanks, by 2:00pm we had 4% He fill in the dewar. At 3:00p secured makeup gas and went to J.T. @ 11% in dewar. Refer ran good through Wednesday. (unattended for OWL shift).

Wednesday suction wanted to run high, the compressor discharge is at 180 to 190 and 75% cap. Had to switch to wet expander to recover, then back on J.T. Stayed erratic all day, negative on wet expander and too high on J.T. Tried to balanced it with comp. capacity and leveled out on swing shift. Until now have been running on four tubes from the trailer.

Refer contined running no problems on Thursday. Opened up three more tubes for trailer, the dome regulator wouldn't hold pressure, noticed propane tank valved open letting gas from trailer to tanks. 15% in dewar now, closed all empty tubes and opened one full one. "O" ring blew in high pressure union, replaced it.

Friday; suction was negative one tube was empty. The boot pressure was too high overnite (200 psi), and it J.T. the dewar to 21%. Boot should be at 170 lbs for overnite running; so we won't make liquid. Started shut down procedure as per Robin's instructions, determined that the Regen valve leaks. Ran diverter valve to 9/16 closed, blew gas into panels, after 1 minute return gas temperature went up but panels stayed same. Ran comp. at max to keep suction pressure down. Compressor tripped off on hi disc pressure. Started recovery of gas 4% in dewar. Recovered 250 psi and shutdown.

Recap:
1. Whole week refer ran unattended OWL shift.
2. High side pressure drifts up, 170 - 190 psi makes more refrigeration makes suction go negative if not enough supply gas.
3. Divertor valve leaks in Regen mode

RB

8-26, 27, 1980 - Geo. Nowell modified, fixed, installed Diverter Valve System cooled down and filled 8-26. On 8-27 (THUR) the valve rocker arm support on warm engine broke - But we had enough D_2 to continue a D.W. valve test.

Clock hours. Compressor 1379.
Warm engine 1300 dry engine 1079

Rocker arm support bracket remade, installed - Operations continue 9-15 week and 9-22 FOR PPPL visitors to see diverter valve

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