D-ZERO CRYOGENIC OPERATING SYSTEMS

LOAD SUMMARY

AND

TIME PERIODS DURING TROUBLE SUMMARY

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PPD/MSD/D0 Operations

D-Zero Cryogenic Operations Load Summary

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LN2 consumption
Calorimeter system components:

LN2 Dewar 42	6.5 gph
LAr storage dewar	6.5 gph (full or empty)
3 calorimeters	31 gph (all full), 14 gph (all empty)
S.S. Op. Total =	**44 gph Liquid nitrogen**

LN2 consumption
Helium system components:

LN2 Dewar 39	6 gph
Fixed Purifier	4 gph
LN2 subcooler	3 gph
GHe HX (used for cooldowns)	*3 to 35 gph (for 0 to 5 g/s He cooled)*
STAR HX	15 to 20 gph
East & West VLPC cryostats	50 gph
S.S. Op. Total =	**80 gph Liquid nitrogen**

Helium Heat Loads

Refrig. Lhe dewar, jumpers	20 Watts			
Solenoid box, x-fer lines off detector	40 Watts			
Solenoid on detector	20 Watts			
Solenoid lead flow, liquefaction load	20 L/hr = 0.7 g/s	at 4750 amps		
Solenoid charging (transient)	*20 Watts*			
Solenoid Subtotal =	**80 Watts + 0.7 g/s**			
EAST VLPC cryostat	200 Watts, (225 Liters of LHe/hr) C.B. = 5.7 K	full load, S.S.	100 K intercept	Coll. Hall
[includes x-fer lines,box]	*120 Watts, cold block = 7.5 K*	*No cassettes*	*92 K intercept*	*Ass'y Hall*
WEST VLPC cryostat				
[includes x-fer lines,box]	172 Watts, (175 Liters of Lhe/hr) C.B. = 6.4 K	full load, S.S.	100 K intercept	Coll. Hall
	115 Watts, cold block = 7.5 K	*No cassettes*	*95 K intercept*	*Ass'y Hall*
VLPC System subtotal =	**372 Watts**			

TOTAL Steady State Helium Load = 452 Watts + 0.7 g/s
Remaining Refrigerator Margin = 75 Watts

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Time Periods during Trouble – An aid for evaluating bad situations

South End Calorimeter:

Loss of vacuum pumping:

Vacuum vessel rate of rise with no pumping = 1.9 microns/hr

Worry about condensing on vacuum shell & heat loads at 80 microns.

Therefore if you lose pumping at 5 microns, you'll reach 80 microns in 39 hours.

Loss of LN2 cooling:

Pressure vessel rate of rise with no LN2 cooling = 1.9 psi/hr (for a vessel full of LAr)

Pressure vessel rate of rise with no LN2 cooling = 0.22 psi/hr (for an empty but cold SEC)

Pressure goes back to the Lar Storage dewar at 23.0 psia through PV-314-A

Therefore from 20.0 psia to 23.0 psia will take 95 minutes. (vessel full of LAr)

Relief valve goes at 13 psig = 27.3 psia. We don't ever want to pop the relief because it may not re-seal, and will contaminate the very pure liquid argon.

It would take just under 4 hours for this to occur if you lost cooling and PV-314-A did not work.

Normal SEC coolant flow is 5 gal/hr (cold but empty) and 10 gallons/hr (full of LAr)

Center Calorimeter:

Loss of vacuum pumping:

Vacuum vessel rate of rise with no pumping = 0 microns/hr. Fine without pumping

Loss of LN2 cooling:

Pressure vessel rate of rise with no LN2 cooling = 1.9 psi/hr (for a vessel full of LAr)

Pressure vessel rate of rise with no LN2 cooling = 0.1 psi/hr (for an empty but cold SEC)

Pressure goes back to the Lar Storage dewar at 23.0 psia through PV-314-A

Therefore from 20.0 psia to 23.0 psia will take 95 minutes. (vessel full of LAr)

Relief valve goes at 13 psig = 27.3 psia. We don't ever want to pop the relief because it may not re-seal, and will contaminate the very pure liquid argon.

It would take just under 4 hours for this to occur if you lost cooling and PV-214-A did not work.

Normal CC coolant flow is 5 gal/hr (cold but empty) and 10 gallons/hr (full of LAr)

North End Calorimeter:

Loss of vacuum pumping:

Vacuum vessel rate of rise with no pumping = 0.8 microns/hr

Worry about condensing on vacuum shell & heat loads at 80 microns.

Therefore if you lose pumping at 5 microns, you'll reach 80 microns in 94 hours.

Loss of LN2 cooling:

Pressure vessel rate of rise with no LN2 cooling = 2.9 psi/hr (for a vessel full of LAr)

Pressure vessel rate of rise with no LN2 cooling = 0.22 psi/hr (for an empty but cold NEC)

Pressure goes back to the Lar Storage dewar at 23.0 psia through PV-314-A

Therefore from 20.0 psia to 23.0 psia will take 62 minutes. (vessel full of LAr)

Relief valve goes at 13 psig = 27.3 psia. We don't ever want to pop the relief because it may not re-seal, and will contaminate the very pure liquid argon.

It would take just 2.5 hours for this to occur if you lost cooling and PV-114-A did not work.

Normal NEC coolant flow is 5 gal/hr (cold but empty) and 10 gallons/hr (full of LAr)

Liquid Argon Storage Dewar:

Loss of LN2 cooling:

Pressure vessel rate of rise with no LN2 cooling = 0.3 psi/hr (for a vessel full of 15,000 gallons LAr)

Pressure vessel rate of rise with no LN2 cooling = 0.2 psi/hr (for vessel with 3000 gallons of LAr)

Relief valve goes at 20 psig = 34.3 psia. It would take over 70 hours to get to that point. We don't ever want to pop the relief for contamination concerns. Switch diverter to higher pressure 65 psig relief instead.

Normal LN2 coolant flow is about 7 gal/hr.

Instrument Air Systems:

Loss of North & South Air compressor:

Consumption rate of system: 60 scfm

Will consume backup air trailer at a rate of 162 psi/hr

Backup trailer will go from 2000 psi to 60 psi in 12 hours.

Loss of East & West Air compressor (tracker purge):

Consumption rate of system: 60 scfm

Will consume backup air trailer at a rate of 162 psi/hr

Backup trailer will go from 2000 psi to 60 psi in 12 hours.

Uninterruptable Power Supplies:

Control System UPS on catwalk: 1.5 hrs without commercial power or Emergency Generator backing

Loss of this UPS is critical, will loose calorimeter system, silicon controls, PLC's.

Conserve battery life by switching off all non-critical items like SCADA nodes.

DMACS NT server UPS in cryo control room: 10 min. without being backed by Control System UPS

Detector platform UPS: 1.5 hr with loss of commercial platform power (not backed by generator)

Loss of this UPS yields loss of Solenoid, VLPC instrumentation, it is not critical.

HVAC UPS in tape room by main control room: 5 hrs without being backed by Emergency Generator

Loss of this UPS is not critical, will loose some HVAC set points

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STAR Helium refrigerator:
Loss of dry engine: 6 hours until 2700 Liters of useable inventory is used. (If VLPC + Solenoid kept cold)
Loss of a dry engine: > 12 hours running if VLPC cyostats are valved off, and Solenoid is kept cold.
Loss of a wet engine: > 6 hours, use EVXJT to continue to make liquid at a lesser rate.
Loss of LN2: As long as the STAR system is cold, can continue to run the refrigerator without LN2.
Loss of a Mycom: Immediately impacts refrigerator, suction relief pops, engines trip off. Solenoid & VLPC will slowly warm due to less flow because of high suction pressure. If suction pressure is kept low, normal flow to cold VLPC and Solenoid will use the Lhe dewar up at 450 L/hr.

VLPC cryostats:
Loss of lid heaters (or power to platform): < 5 minutes before lid temp interlocks trip cooling off
Loss of Lhe (valve interlocked closed): Cold block temp rises 70 K in 4 hrs.
Loss of LN2 (valve interlocked closed): LN2 intercept rises to 225 K in 4 hrs.

Solenoid:
Loss of Lhe: Power permit lost after 1 minute. Stays cold a very long time with good vacuum.
Loss of LN2: Heat load and use of helium will increase, estimate > 1 hr before impact.

Silicon:
Loss of chiller refrigeration (due to interlock or compressor failure): Coolant temps rise 6.3 °C/hr
Emergency warm up: Coolant stops, Silicon warms in about 30 minutes.
Use of GN2 cylinders: 16 Cylinders hold 3100 scf of useable GN2, lasts 50 min.at 60scfm nom. purge

Interesting dates and events that some data was gleaned from:

Dec. 15, 2001 – Loss of platform power, caused VLPC cryostat loss of lid heaters
Dec. 19, 2001 – Liquid nitrogen shut off to full calorimeters and Lar dewar during LN2 repair efforts
Jan. 21, 2001 – Mycom shut off due to loss of DA water cooling pump
Jan. 22, 2001 – East & West I/A compressors shut off during maintenance problem, consumed backup trailer, interlock shut off chiller refrigeration