

LN2 Usage Method for HALT/HASS Chambers

Description:

This procedure describes the method to determine LN2 consumption for a HALT/HASS chamber using a tank level digital meter.

Process Outline

- Test Equipment
- Test Setup
- Test Method – Method used to measure LN2 consumption and test profile to use.
- Sample Test Data – LN2 usage running a given test profile.
- Sample Test Error and Tolerance – Presentation of measurement accuracy.

Test Equipment

Bulk LN2 Storage Tank

Tank Pressure – 60 psi.

LN2 Level – Full tank

Digital Tank Meter - Barton Cryoscan LN2 tank level digital meter (Figure 4)

Resolution – 1 inH₂O or equivalent.

HALT Chamber Model XXXXXX

Work Volume -

Table size –

Voltage, current and phase requirement.-

Test Setup

Chamber Setup

- Control Thermocouple – The chamber air thermocouple is used as the control thermocouple.
- Thermocouple Placement (Figure 1)
 - Place the control thermocouple 2 to 3 inches above the surface of the vibration table at the following location. Note: bolt hole pattern 4inch apart starting 1inch from edges
 - 30inch x 30inch table: At table bolt hole position C4 (**Figure 1**)
 - 36inch x 36inch table: At table bolt hole position D4 (**Figure 2**)
 - 48inch x 48inch table: At table bolt hole position H7 (**Figure 3**)
- Consumption is based on an empty chamber (no load).
- Enter thermal profile shown in Figure 6 and Table 1 into chamber controller.

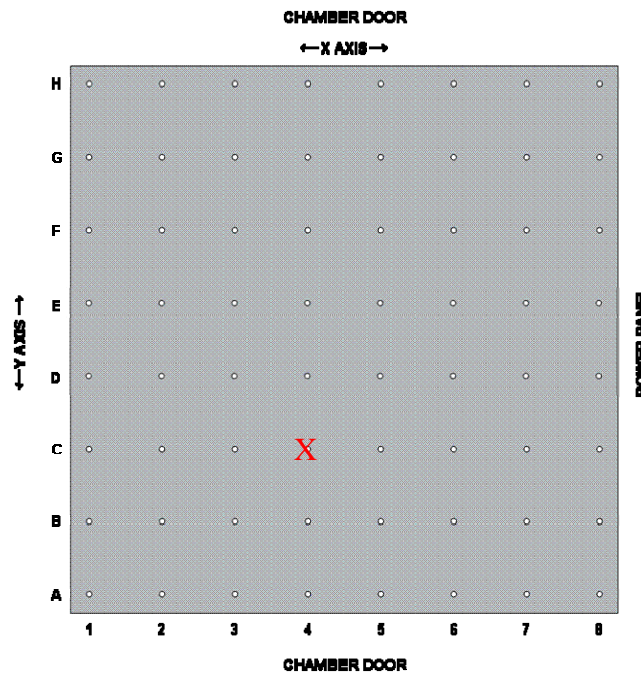


Figure 1 – 30inch x 30inch Table Layout- place thermocouple at position C4

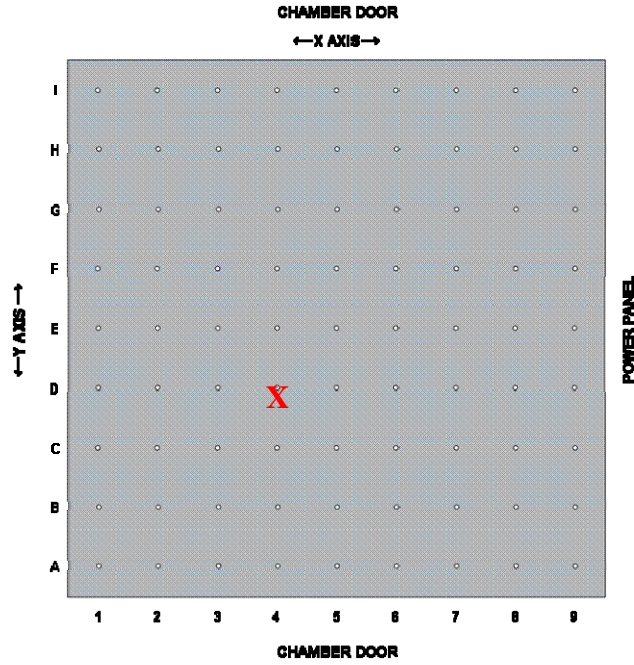


Figure 2 - 36inch x 36 inch Table layout- place thermocouple at position D4

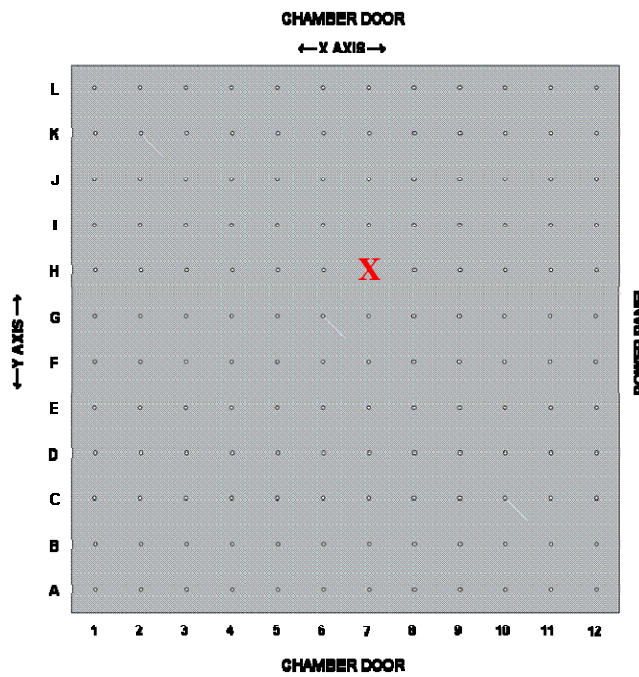


Figure 3 – 48inch x 48 inch Table layout- place thermocouple a position H7

Test Method

Measurements are taken on a digital tank level meter similar to that shown in Figure 4. The amount of LN2 consumed is expressed as the change in tank level using the meter and LN2 contents chart located on the tank (Figure 4 and Figure 5). The test profile to use is shown in Figure 6 and Table 1.



Figure 4 - LN2 Micro-bulk Tank with Barton Cryoscan LN2 tank level digital meter

INCHES OF WATER	GALLONS			CUBIC FEET (NPT)			WEIGHT (LBS)		
	ARGON	OXYGEN	NITROGEN	ARGON	OXYGEN	NITROGEN	ARGON	OXYGEN	NITROGEN
0	0	0	0	0	0	0	0	0	0
5	2	4	9	200	400	700	20	40	50
10	15	25	47	1600	2700	4000	160	220	290
15	37	55	91	3900	5800	7600	400	480	550
20	62	85	134	6400	9000	11300	660	740	820
25	86	115	177	8900	12100	14900	930	1000	1080
30	111	144	221	11500	15300	18600	1190	1270	1350
35	136	174	264	14000	18500	22200	1450	1530	1610
40	160	204	307	16600	21600	25900	1710	1790	1880
45	185	234	351	19100	24800	29600	1980	2050	2140
47	209	264	370*	21600	28000	31200*	2240	2320	2300*
55	234	294		24200	31100		2500	2580	
60	258	324		26700	34300		2760	2840	
65	283	354		29300	37500		3030	3100	
68	307	370*		31800	39200*		3290	3200*	
75	332			34300			3550		
80	356			36900			3810		
83	370*			38300*			3960*		

* FULL TRYCOCK

ALL VALUES ASSUME LIQUID SATURATED AT 50 PSIG.

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Figure 5 – Example contents chart

Test Profile

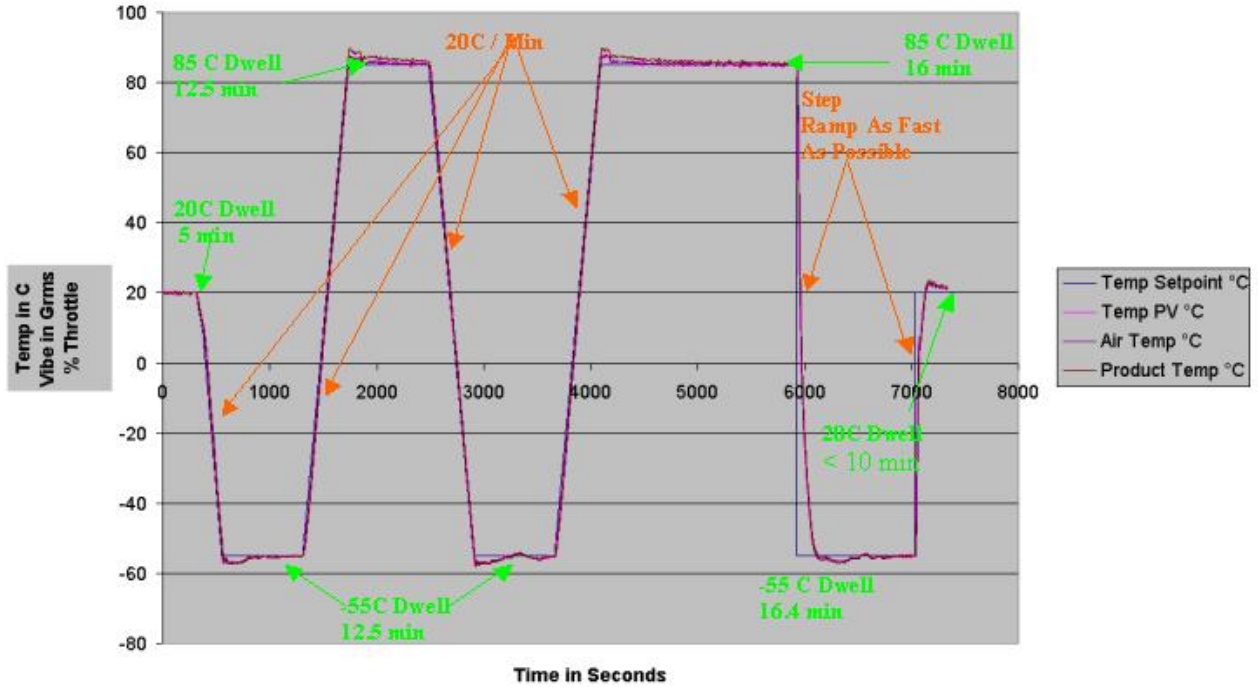


Figure 6 – LN2 Usage Test Profile

Sequence #	Thermal Sequence Type	Thermal Time Hr:Min:Sec	Previous Temp	Next Temp
1	Starting	Starting	NA	20 °C
2	Dwell	5:00	20 °C	20 °C
3	Ramp	1:00 (10 °C /min)	20 °C	10 °C
4	Ramp	3:00 (21.7 °C /min)	10 °C	-55 °C
5	Dwell	12:30	-55 °C	-55 °C
6	Ramp	7:00 (20 °C /min)	-55 °C	85 °C
7	Dwell	12:30	85 °C	85 °C
9	Ramp	7:00 (20 °C /min)	85 °C	-55 °C
10	Dwell	12:30	-55 °C	-55 °C
11	Ramp	7:00 (20 °C /min)	-55 °C	85 °C
12	Dwell	27:00	85 °C	85 °C
13	Step	As fast as Possible	85 °C	-55 °C
14	Dwell	18:00	-55 °C	-55 °C
15	Step	As fast as Possible	-55 °C	85 °C

Table 1 - LN2 Usage Test Profile Listing

Sample Test Data

Table 2 presents the amount of LN2 used to run the test profile in a Qualmark chamber.

Chamber Type	PSI	Start Tank Level	End Tank Level	Level Difference taken from tank chart	LN2 Consumed
Model#					

Table 2: LN2 usage running test profile listed above

Error and Tolerance

1. The precision of the meter used is XX unit of H₂O height. This means for any given test the starting or ending tank level could be ready to change XX unit lower. This can cause the total LN2 consumption to be high by around XXgal of LN2. Thus the LN2 consumed is represented as a range.
2. Pressure of the micro-bulk tank can affect the quality of the LN2.
3. Ln2 tank levels below 10 inches have a different molar volume compared to a full tank. This means as the tank continues to drain, the density of the nitrogen (amount of nitrogen per tank volume) in the tank decreases.