PROCESS SYSTEMS INTERNATIONAL, INC.					ENGINEERING	NO:V049-1-078
WESTBOROUGH, MA					CALCULATIONS	PAGE 1 OF 44
REV	DEO#	DATE	BY:	CHECK	TITLE:	
0	133	04/22/96	R. Than	D. Mick	STATIONS	
					PUMPDOWN & ULTIMATE PRESSURES	
					BY: R. THAN	DEPT: 744
PROJECT: LIGO					PROJECT NO: V59049	

PURPOSE:
Pumpdown of the End Station
Pumpdown of the Mid Station
Pumpdown of Vertex & Beam manifold isolatable section WA Corner station
Pumpdown of Vertex isolatable section WA Corner station with only 1 roughing and 1 main turbo system.
Pumpdown of Vertex & Beam manifold isolatable section LA Corner station
with selected vacuum system.

METHOD:
Computer simulation
Standard calcs

ASSUMPTIONS:
See calculations

INPUTS:

REFERENCE: See page 9

CALCULATIONS: see Attachments

CONCLUSIONS: Pumpdown of stations isolatable sections to a total pressure of less than $2X10^{-8}$ Torr

NOTES:

PRESSURE MEASUREMENT

Partial pressure of gasses will vary depending where the pressure gauge / RGA is located relative to the pumps. Partial pressures will be measured at the ion pumps. Because the attainable partial pressure of water is based on the pumping speed of water at the cryopump, the partial pressure of water at other locations will be higher. Thus measurement of the partial pressure of water at the ion pumps may not be representative of the outgassing rates for water. Rather measurements at two locations one at the ion pumps and one at the cryopump is recommended.

OUTGASSING RATES

Outgassing from Viton O-rings

The available data on outgassing of unbaked and baked O-ring material is limited.

The following table contains selected outgassing data for Viton-A from W.G. Perkins' "Permeation and Outgassing of Vacuum Materials," *Journal of Vacuum Science & Technology*, Vol. 10, No.4, 1973. Outgassing experiments were also done by L. de Csernatony with o-rings in their grooves and outside their grooves, see article: L. de Csernatony, "The properties of Viton "A" elastomers III", *Vacuum* , Vol. 16, No.5, 1967.

	Pumpdown time hours	Outgassing Rate Torr-L/s-cm^2	Dominant Species
Unbaked samples			
Unbaked Pumpdown Viton-A	51	1×10^{-7}	H_2O, H_2, O_2, N_2
Baked Pumpdown (200 °C) Viton-A	24	20×10^{-10}	H_2O

	Pumpdown time hours	Outgassing Rate Torr-L/s-cm^2	Dominant Species
Pre-baked samples air-exposed for 0.5 hr			
Unbaked pumpdown Viton-A	5	1.5×10^{-8}	H_2O
Baked Pumpdown (200 °C) Viton-A	12	1×10^{-10}	H_2O

PROJECT: LIGO BY: R.THAN DEPT: 744

PROJECT NO: V59049 DATE:

TITLE: PUMPDOWN & ULTIMATE PRESSURES

The total outgassing rate of a Viton o-ring can be reduced to 1 X 10^{-10} Torr-L/s-cm^2 through baking under vacuum. Since the vacuum system needs to be re-opened, the total outgassing rate will vary depending on the amount of time the o-ring is re-exposed to air. The outgassing of a baked Viton o-ring which has been re-exposed to normal air will be dominated by water. Since the vacuum system is purged with dry air when open for service, the re-adsorption of moisture can be minimized; however the readsorption of other gasses will be dictated by exposure time. For short exposure times to air, the amount of gases other than water that are readsorbed is minimal. Water outgassing dominates for short exposure times, such as 0.5 hour. However, since in practice the O-rings are re-exposed to air for a longer period than 0.5 hour, the actual amount of gasses readsorbed can only be determined from further experiments.

If re-exposure is limited to a short time the outgassing rate of a baked O-ring will be about 1.5 X 10^{-8} Torr-L/s-cm^2, mostly water, after 5 hours. Assuming the outgassing is dictated by diffusion, i.e. the decay behaves as function of time to the -0.5 power, the outgassing rate for water will be about 3 X 10^{-9} Torr-L/s-cm^2 after 100 hours of pumping. Since the outgassing rate for short term re-exposure is dominated by water, assuming that the total outgassing rate for the other gasses is no more than 10% of that of water, the outgassing rate of the other gasses will be approximately 3 X 10^{-10} Torr-L/s-cm^2.

L. de Csernatony (Ref.13,14) experiments with baked o-ring without re-exposure gives a rate of 2 X 10^{-10} Torr-L/s-cm^2 after 25 hours for an o-ring in the chamber and 8 X 10^{-9} Torr-L/s-cm^2 after 25 hours with the o-ring in the groove.

The o-ring grooves are designed with vents to vent the trap volume in the o-ring groove. This will prevent the outgassing of the o-ring to retard and allow the outgassing rate to approach that of an o-ring inside a chamber.

Outgassing from Stainless Steel.

Various sources provide data on outgassing of hydrogen from stainless steel for unbaked and baked specimens.

G.Moraw and R. Dobrozemsky report a total outgassing rate of about 8×10^{-12} Torr-L/s-cm^2 after a 20-hour vacuum bakeout at 100 °C, with H_2 dominating at a rate of 7×10^{-12} Torr-L/s-cm^2 ,and CO outgassing at a rate of less than 4×10^{-13} Torr-L/s-cm^2 , and CO_2, CH_4, and water each at less than 1×10^{-13} Torr-L/s-cm^2.

Calder and Lewin report a total outgassing rate of 1.4×10^{-11} Torr-L/s-cm^2 after 40 hours of pumping for a specimen bake in vacuum at 350 °C for 2 days and re-expose to air for 3 hours.

Barton and Govier report a total outgassing of 7×10^{-12} Torr-L/s-cm^2 after a 100 hours of pumping for a specimen that has been prebaked in vacuum at 400°C and re-exposed to air for 24 hours with water being the predominant outgassing specie.
For an unbaked vapor degreased specimen the total outgassing rate was about 1×10^{-11} Torr-L/s-cm^2 after 100 hours of pumping, with water being the predominant outgassing specie. Partial pressure measurements after 70 hours indicated that about 60% was water and about 30% CO and CO_2.

Dylla et al. report outgassing rates of between 6×10^{-11} to 1×10^{-11} Torr-L/s-cm^2 after 100 hours of pumping for specimens baked at 150 °C for 48 hours and re-exposed to air. The predicted decay and outgassing rates at the end of 100 hours vary depending on exposure time to air, and dew point of the air. Analysis of species after 100 minutes into pumpdown indicates that the outgassing rate is dominated by water, with CO, CO_2, and CH_4 contributing less than 10% to the outgassing rate (5%,3%, and 2% respectively).

S. Rezaie-Serej and R.A. Outlaw report for a baked stainless steel specimen the amount of hydrogen desorbed is about 38 times the amount of CO desorbed. No outgassing rates were given.

Okamura, Miyauchi, and Hisatsugu report a total outgassing rate approaching 5×10^{-13} Torr-L/s-cm^2 for finely polished stainless steel surface and a 1×10^{-12} Torr-L/s-cm^2 for a standard electropolished surface after 100 hours of pumping preceded by an 80-hour vacuum bake-out at 250 °C. H_2 dominates with water being the next dominant specie, and with CO and CO_2 contributing less than 20% to the outgassing rate.
(2×10^{-13} Torr-L/s-cm^2).

Santeler predicts an outgassing rate of stainless steel based on a diffusion model of about 2×10^{-11} Torr-L/s-cm^2, with a 200 hour, 150 °C bake, and 6×10^{-12} Torr-L/s-cm^2, with a 20 hour, 250 °C bake.

PROJECT: LIGO BY: R.THAN DEPT: 744

PROJECT NO: V59049 DATE:

TITLE: PUMPDOWN & ULTIMATE PRESSURES

Outgassing rates:

Stainless steel

H2: $1.0X\ 10^{-11}$ Torr-L/s-cm^2

H2O:

Re-exposure to air	
Time	Q
min.	Torr-L/s-cm^2
10	$7X\ 10^{-8}$
100	$5X\ 10^{-9}$
1000	$3.5X\ 10^{-10}$
1440	$2.4X\ 10^{-10}$
6000	$5X\ 10^{-11}$

No Re-exposure	
Time	Q
min.	Torr-L/s-cm^2
10	$2.8X\ 10^{-9}$
100	$5.6X\ 10^{-10}$
1000	$1.1X\ 10^{-10}$
1440	$8.6X\ 10^{-11}$
6000	$3.0X\ 10^{-11}$

Other gasses: 10% of water rate.

Viton:

H2O:

Short Re-exposure to air. (Ref.1)	
Time	Q
min.	Torr-L/s-cm^2
300	$1.5X\ 10^{-8}$
6000	$3X\ 10^{-9}$

No Re-exposure (Ref.1)	
Time	Q
min.	Torr-L/s-cm^2
720	$1X\ 10^{-10}$
6000	$4X\ 10^{-11}$

Other gasses: 10% of water rate.

END STATION / MID STATION PUMPDOWN

Pumpdown of the End station section using one the QDP80 dry pump set, and one main turbomolecular pump and 1 Main ion pump.

Roughing pump

The QDP80 pump is used to rough down the end or mid stations. It also serves as the backing pump to the main turbo: STPH2000.

Turbo pump

The main turbo, STPH2000, is turned on when a pressure of 1 mbar has been reached using the QDP80. The bypass is closed across the turbo pump and the turbo pump starts pumping. The STPH2000 is a wide range turbo which has a drag stage to pump at high inlet pressures. The backing pump of the main turbo is located in the mechanical room.

Main Ion pump

The main ion pump is a 2500 L/s (N2) Varian Ion Pump with a 350 mm inlet tube, which can be isolated by a 350 mm (14 inch) gate valve. The End Station and Mid Station are each equipped with one Main ion pump.

CORNER STATION PUMPDOWN

Pumpdown of the corner station sections is accomplished using two the EDP200/EH2600 dry pump set, and two main turbomolecular pump and several Main ion pumps.

WA CORNER STATION

The WA corner station has two roughing cart sets, two turbomolecular pump sets, and 8 main ion pumps. 4 Main ion pumps are on the Vertex section, one each on the beam manifold sections, and two on the diagonal (offset) section.

LA CORNER STATION

The LA corner station has two roughing cart sets, two turbomolecular pump sets, and 4 main ion pumps. 4 Main ion pumps are on the Vertex section.

Roughing pump

The roughing system is separated in two skids. The EDP200 is located in the mechanical room, and the EH2600 Roots blower is move around the detector building. Two 6 inch headers runs in the detector building back to the mechanical room.

Turbo pump

The main turbo, STPH2000C, is turned on when a pressure of 0.1 Torr has been reached. The backing pump of the main turbo is located in the mechanical room.

Main Ion pump

The main ion pump is a 2500 L/s (N2) Varian Ion Pump with a 350 mm inlet tube, which can be isolated by a 350 mm (14 inch) gate valve.

Pumpdown curves:

END STATION PUMPDOWN

Figure V049-1-078-1a: 0-100 hours
Figure V049-1-078-1b 0-32 hours

MID STATION PUMPDOWN

Figure V049-1-078-2a 0-100 hours
Figure V049-1-078-2b 0-32 hours

WA, CORNER STATION PUMPDOWN

Figure V049-1-078-3a 0-100 hours
Figure V049-1-078-3b 0-32 hours

LA, CORNER STATION PUMPDOWN

Figure V049-1-078-4a 0-100 hours
Figure V049-1-078-4b 0-32 hours

WA, VERTEX ISOLATABLE SECTION , CORNER STATION PUMPDOWN

Figure V049-1-078-5 0-24 hours

References

1. W.G. Perkins' "Permeation and Outgassing of Vacuum Materials," *Journal of Vacuum Science & Technology*, Vol. 10, No.4, 1973.

2. R.S. Barton and R.P. Govier. "The effect of cleaning technique on the outgassing rate of 18/9/1 stainless steel," *Vacuum* , Vol. 20, No.1, 1970.

3. G. Moraw and R. Dobrozemsky, "Attainment of outgassing rates below 10^{-13} Torr-liters/sec-cm^2 for Aluminum and stainless steel after bakeout at moderate temperatures," *Proceedings 6th International Vacuum Congress*, 1974.

4. H.F. Dylla, D.M. Manos, P.H. LaMarche, "Correlation of outgassing of stainless steel and aluminum with various surface treatments." *Journal of Vacuum Science & Technology*, Vol. A11, No.5, 1993.

5. M. Li and H.F. Dylla, "Model for outgassing from metal surfaces II." *Journal of Vacuum Science & Technology*, Vol. A12, No.4, 1994.

6. S. Okamura, E. Miyauchi, and T. Hisatsugu, "Outgassing measurements of finely polished stainless steel." *Journal of Vacuum Science & Technology*, Vol. A 9, No.4, 1991.

7. R. Calder and G. Lewin, " Reduction of stainless steel outgassing in ultra-high vacuum," *Journal of Applied Physics,* Vol 18, 1967.

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9. D. Wu, R.M.Stephens, R.A. Outlaw, and P. Hopson, "An Auger Electron Spectroscopy Study of Surface-Preparation Contaminants", *NASA Technical Paper 2972*, Feb. 1990

10. S. Rezaie-Serej, R.A. Outlaw, "Thermal desorption of CO and H2 from degassed 304 and 347 stainless steel", *Journal of Vacuum Science & Technology*, Vol. A12, No.5, 1994.

11. J.D Herbert, A.E. Groome, "Study of cleaning agents for stainless steel for ultrahigh vacuum use", *Journal of Vacuum Science & Technology*, Vol. A12, No.4, 1994.

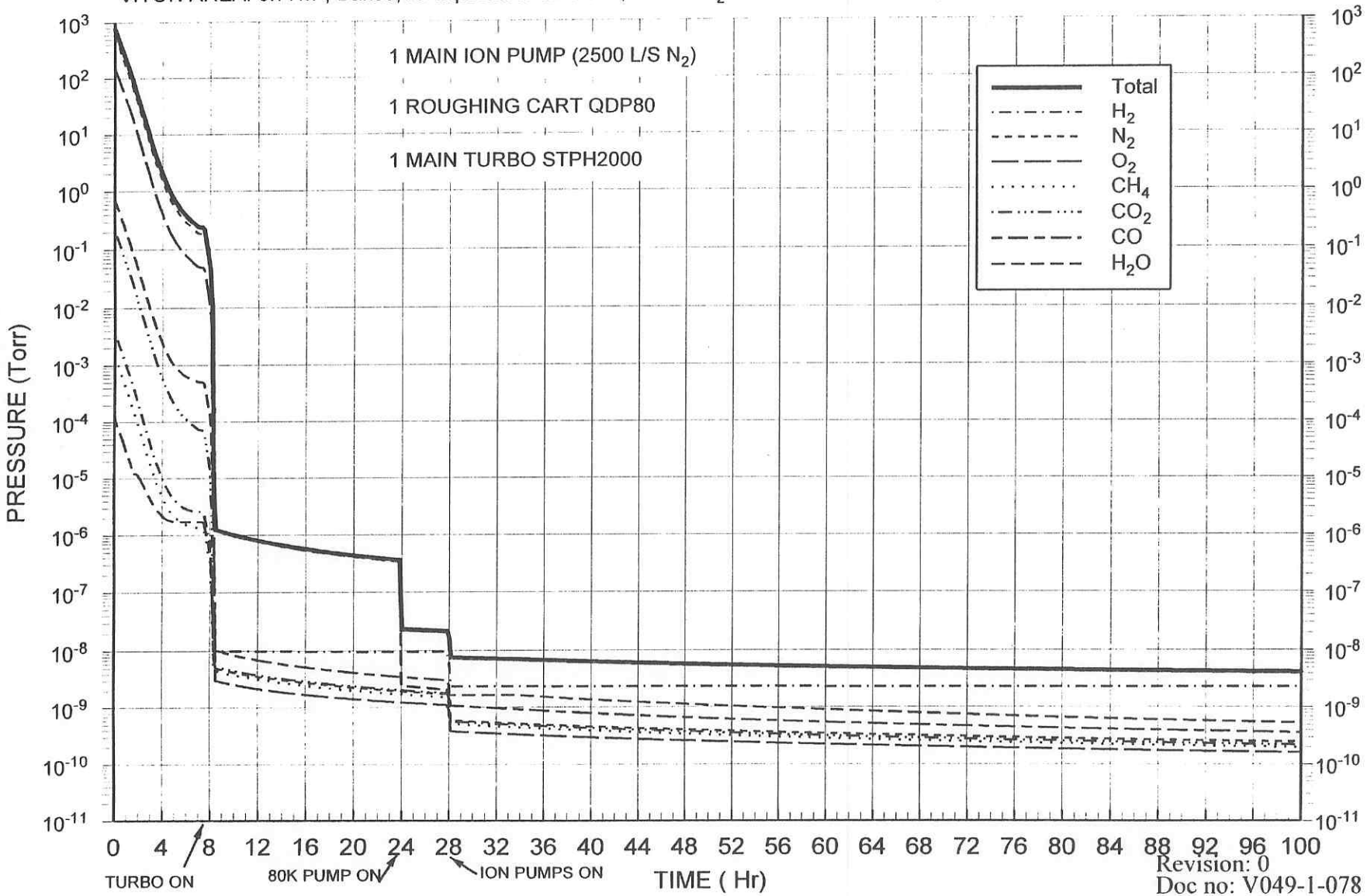
12. B.C Moore, "Recombination limited outgassing of stainless steel", *Journal of Vacuum Science & Technology*, Vol. A13, No.3, 1995, pp. 545-548

13. L. de Csernatony, "The properties of Viton "A" elastomers II", *Vacuum* , Vol. 16, No.3, 1966.

PROJECT: LIGO BY: R.THAN
PROJECT NO: V59049 DATE:
TITLE:FIGURE V049-1-078-1a, END STATION PUMPDOWN

STEEL AREA: 119 m^2, Volume: 56 m^3, H_2=1X10^{-11} Torr-L/s-cm^2, H_2O=1X10^{-6}*$t^{-1.15}$, t=min, OTHER GASSES: 10%

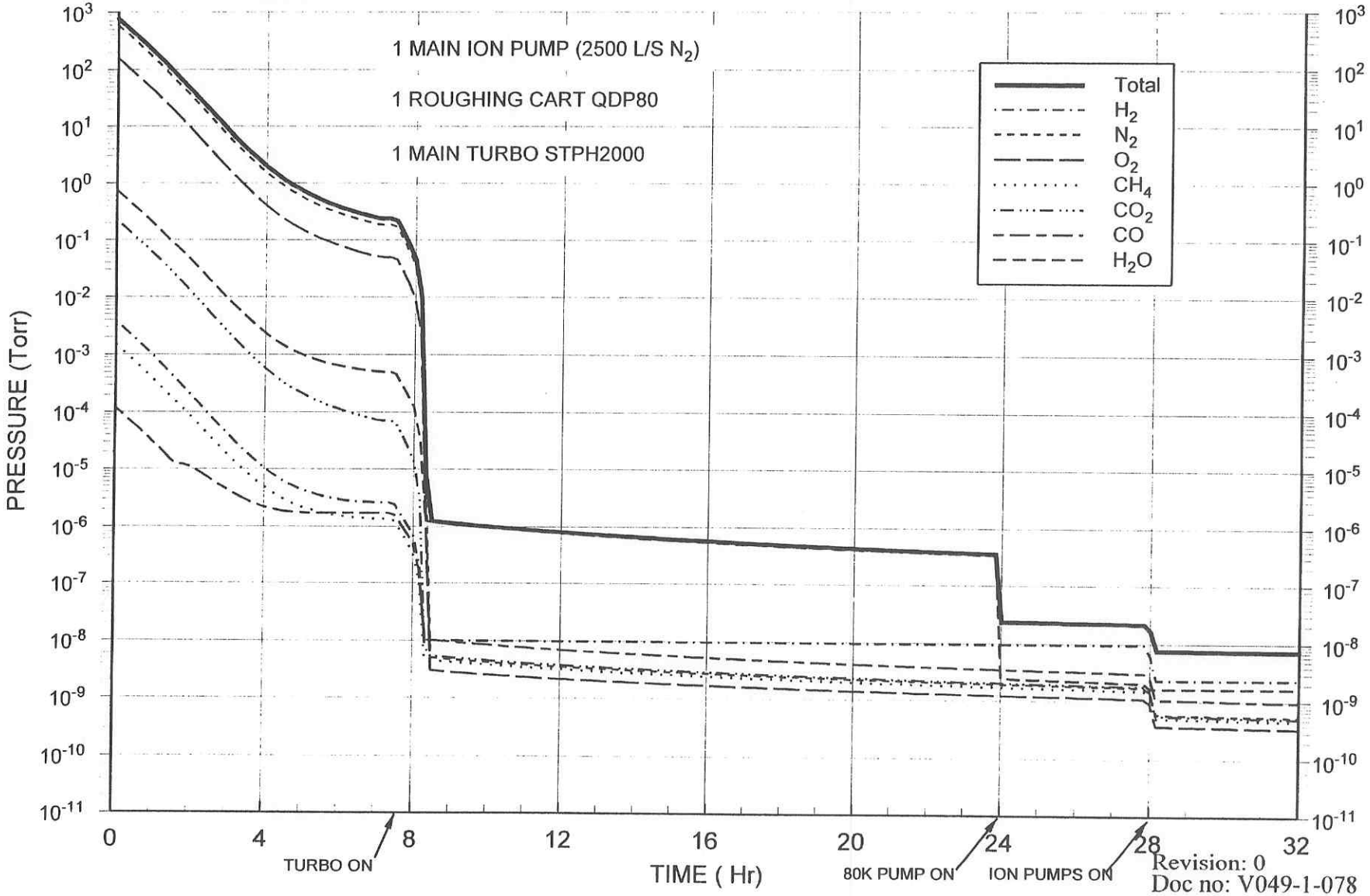
VITON AREA: 0.77m^2, Baked, re-exposed to air 0.5 hr, 100 hr: H_2O=3X10^{-9} Torr-L/s-cm^2, OTHER GASSES=3X10^{-10} Torr-L/s-cm^2



PROJECT: LIGO BY: R.THAN
PROJECT NO: V59049 DATE:
TITLE:FIGURE V049-1-078-1b, END STATION PUMPDOWN

STEEL AREA: 119 m^2, Volume: 56 m^3, H_2=1X10^{-11} Torr-L/s-cm^2, H_2O=1X10^{-6}*$t^{-1.15}$, t=min, OTHER GASSES: 10%

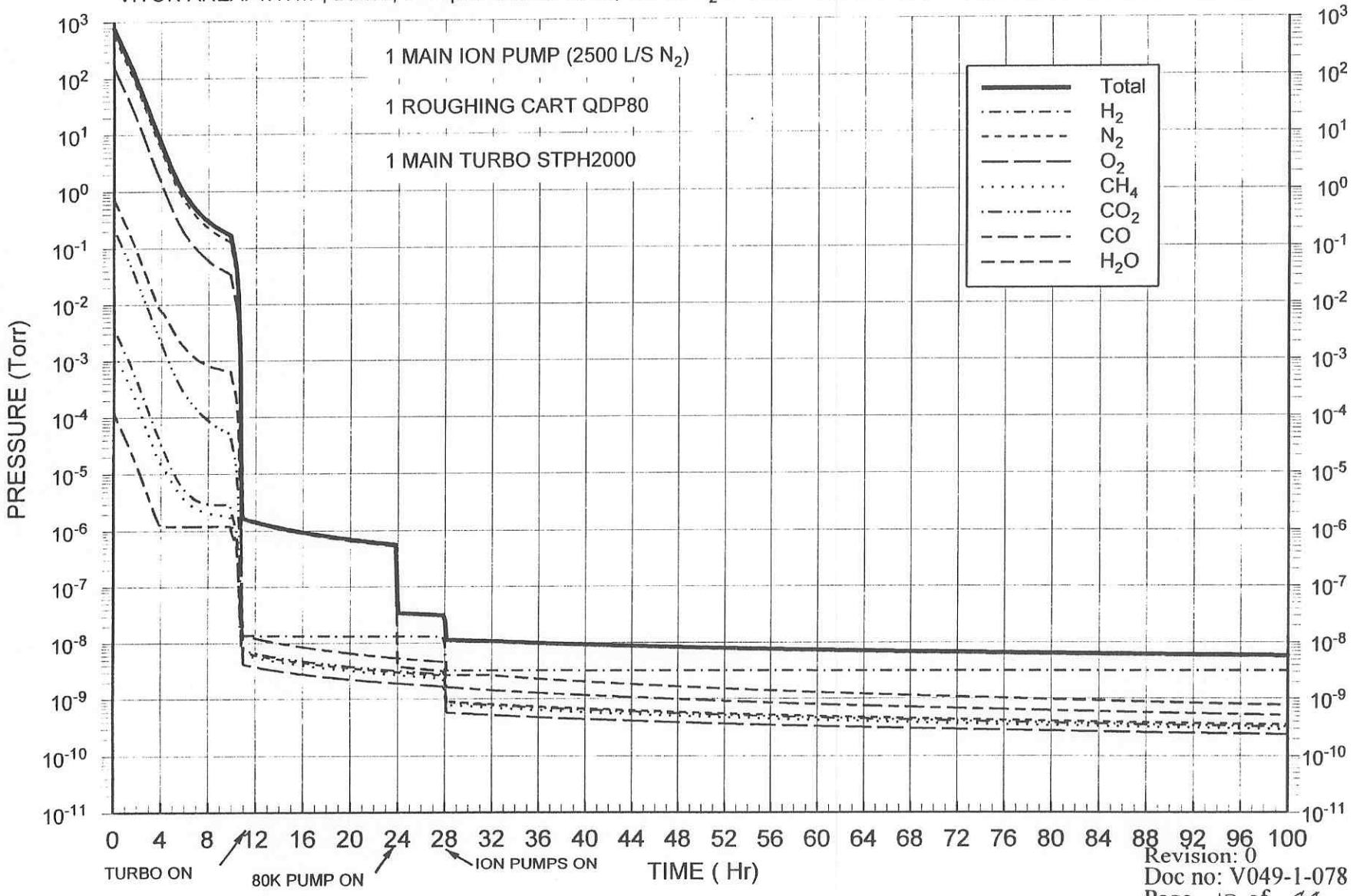
VITON AREA: 0.77m^2, Baked, re-exposed to air 0.5 hr, 100 hr: H_2O=3X10^{-9} Torr-L/s-cm^2, OTHER GASSES=3X10^{-10} Torr-L/s-cm^2



PROJECT: LIGO BY: R.THAN
PROJECT NO: V59049 DATE:
TITLE:FIGURE V049-1-078-2a, MID STATION PUMPDOWN

STEEL AREA: 162 m^2, Volume: 72 m^3, H_2=1X10^{-11} Torr-L/s-cm^2, H_2O=1X10^{-6}*$t^{-1.15}$, t=min, OTHER GASSES: 10%

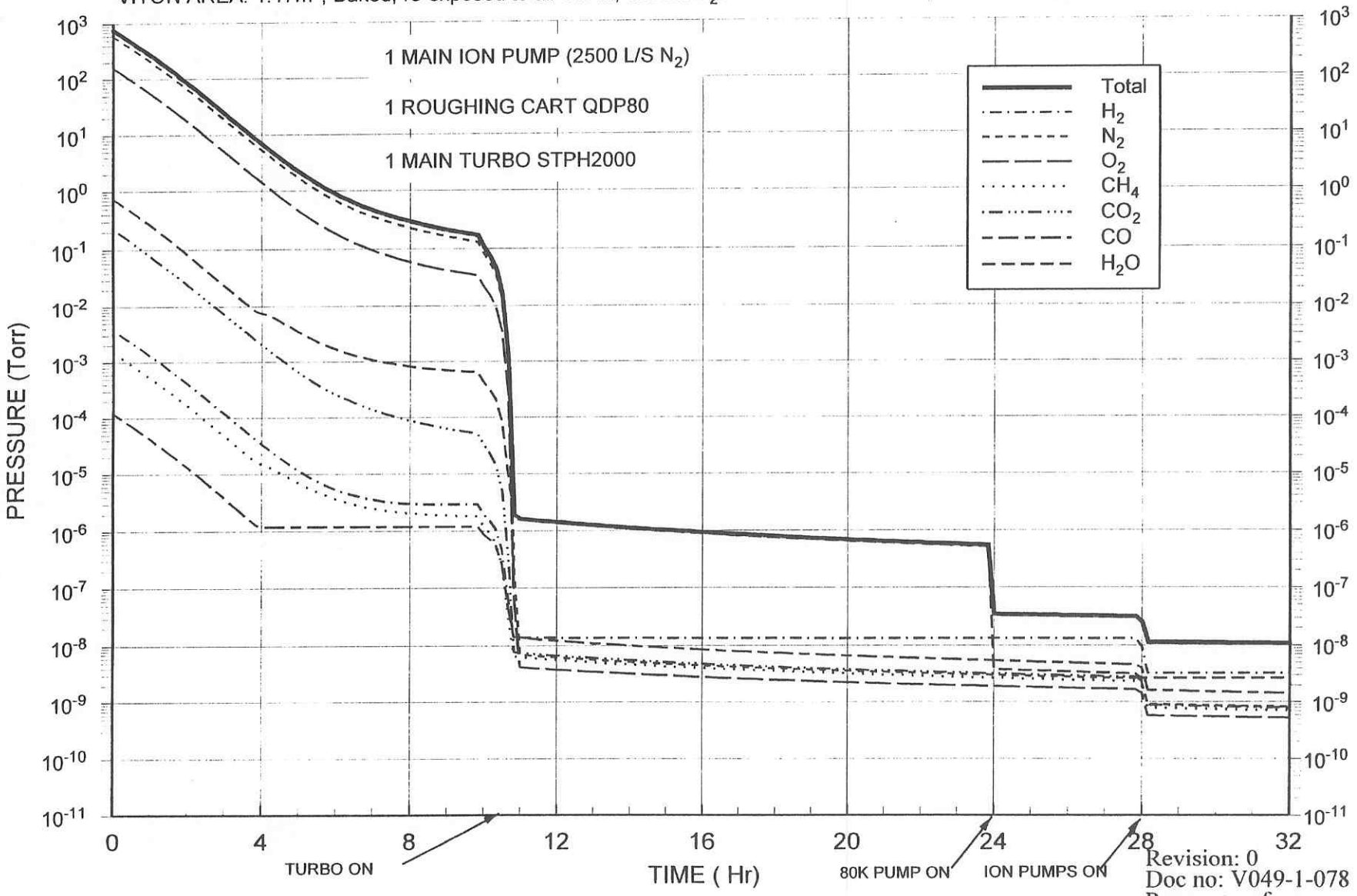
VITON AREA: 1.17m^2, Baked, re-exposed to air 0.5 hr, 100 hr: H_2O=3X10^{-9} Torr-L/s-cm^2, OTHER GASSES=3X10^{-10} Torr-L/s-cm^2



PROJECT: LIGO BY: R.THAN
PROJECT NO: V59049 DATE:
TITLE:FIGURE V049-1-078-2b, MID STATION PUMPDOWN

STEEL AREA: 162 m^2, Volume: 72 m^3, H_2=1X10^{-11} Torr-L/s-cm^2, H_2O=1X10^{-6}*$t^{-1.15}$, t=min, OTHER GASSES: 10%

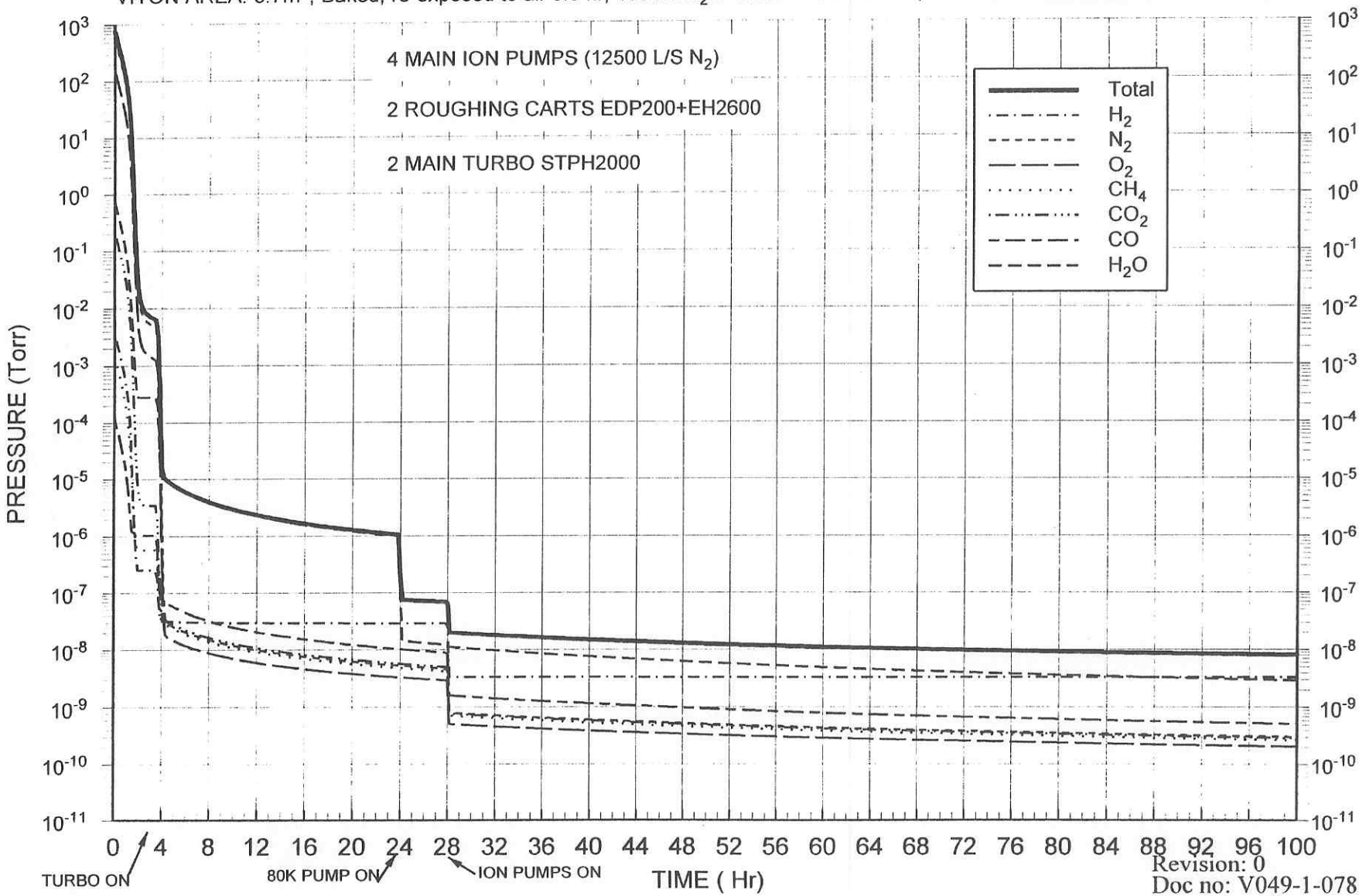
VITON AREA: 1.17m^2, Baked, re-exposed to air 0.5 hr, 100 hr: H_2O=3X10^{-9} Torr-L/s-cm^2, OTHER GASSES=3X10^{-10} Torr-L/s-cm^2



PROJECT: LIGO BY: R.THAN
PROJECT NO: V59049 DATE:
TITLE:FIGURE V049-1-078-3a, VERTEX & BEAM MANIFOLD-CORNER STATION PUMPDOWN, WA

STEEL AREA: 732 m^2, Volume: 316 m^3, H_2=1X10^{-11} Torr-L/s-cm^2, H_2O=1X10^{-6}*$t^{-1.15}$, t=min, OTHER GASSES: 10%

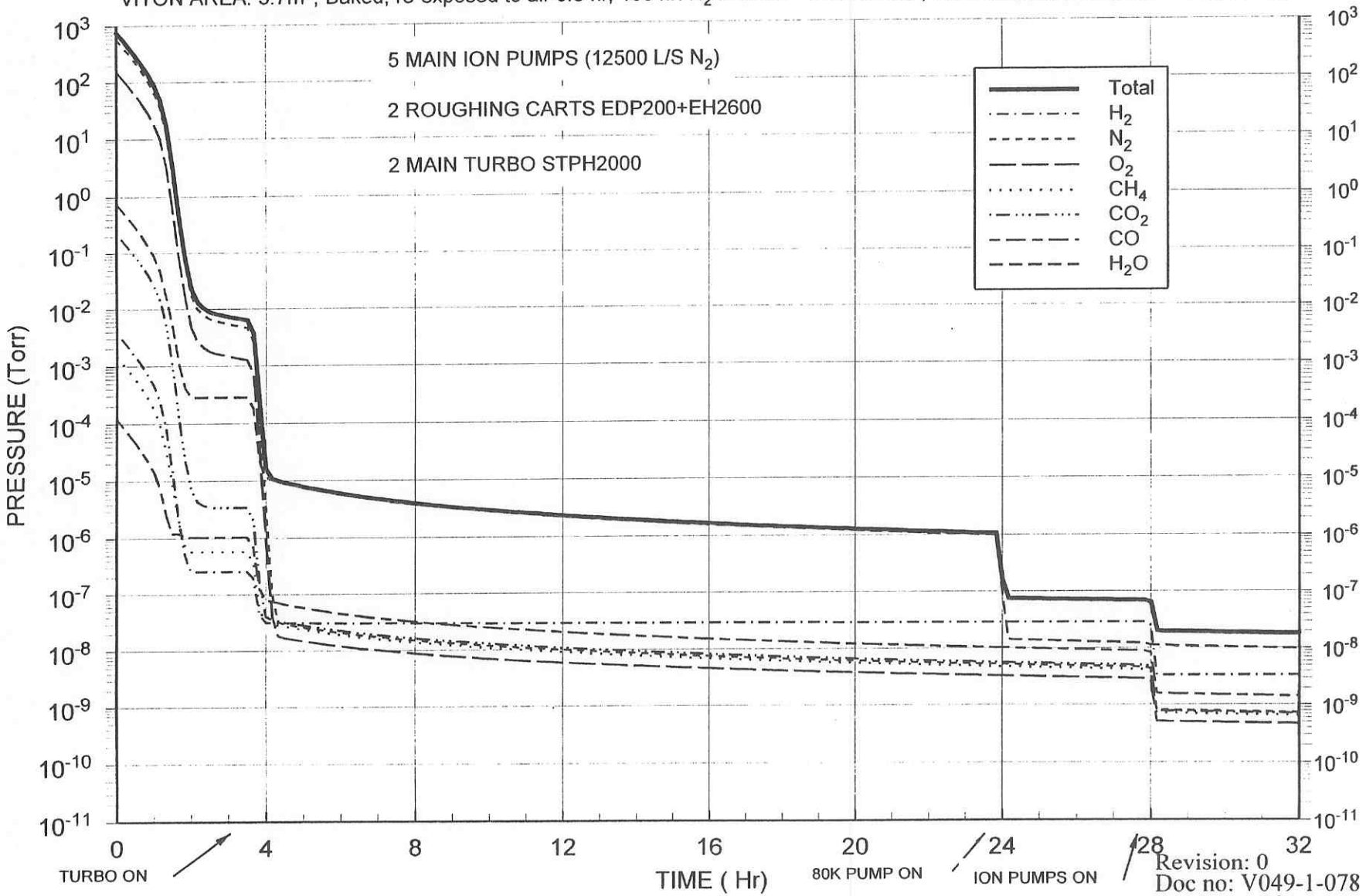
VITON AREA: 3.7m^2, Baked, re-exposed to air 0.5 hr, 100 hr: H_2O=3X10^{-9} Torr-L/s-cm^2, OTHER GASSES=3X10^{-10} Torr-L/s-cm^2



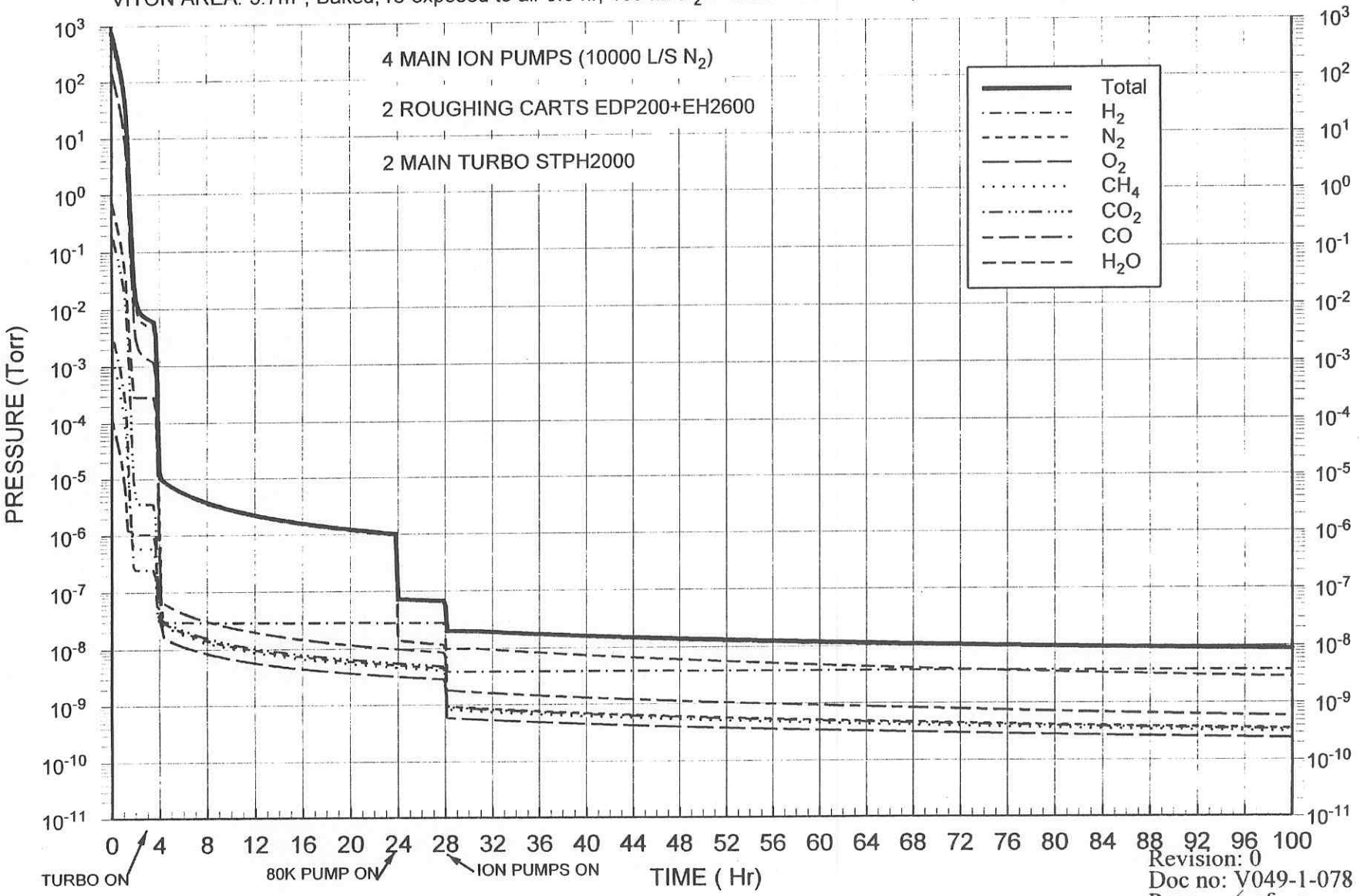
PROJECT: LIGO BY: R.THAN
PROJECT NO: V59049 DATE:
TITLE:FIGURE V049-1-078-3b, VERTEX & BEAMMANIFOLD-CORNER STATION PUMPDOWN, WA

STEEL AREA: 732 m^2, Volume: 316 m^3, H_2=1X10^{-11} Torr-L/s-cm^2, H_2O=1X10^{-6}*$t^{-1.15}$, t=min, OTHER GASSES: 10%

VITON AREA: 3.7m^2, Baked, re-exposed to air 0.5 hr, 100 hr: H_2O=3X10^{-9} Torr-L/s-cm^2, OTHER GASSES=3X10^{-10} Torr-L/s-cm^2



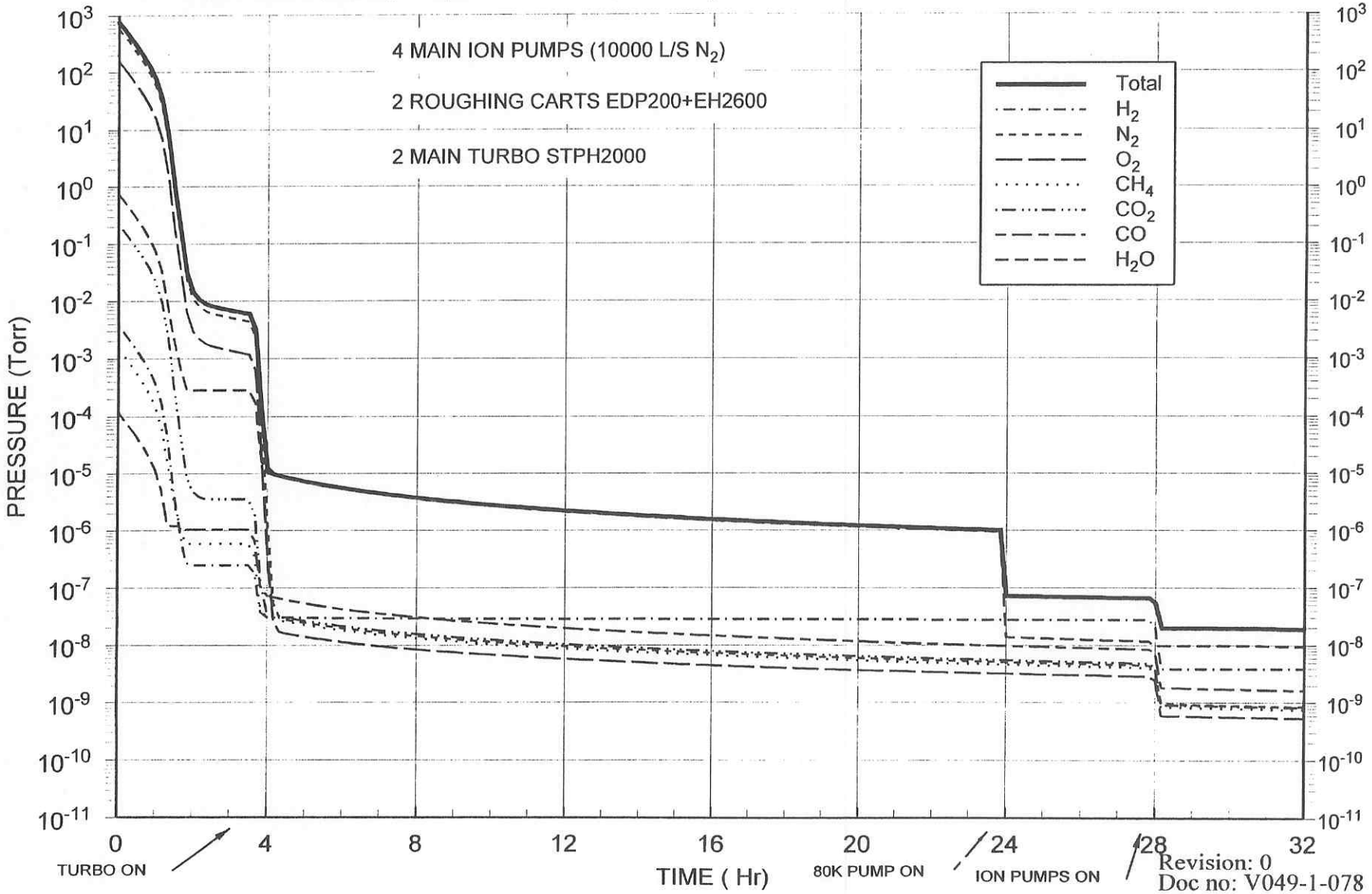
PROJECT: LIGO BY: R.THAN
PROJECT NO: V59049 DATE:
TITLE:FIGURE V049-1-078-4a, VERTEX & BEAM MANIFOLD-CORNER STATION PUMPDOWN, LA
STEEL AREA: 695 m^2, Volume: 298 m^3, H_2=1X10^{-11} Torr-L/s-cm^2, H_2O=1X10^{-6}*$t^{-1.15}$, t=min, OTHER GASSES: 10%
VITON AREA: 3.7m^2, Baked, re-exposed to air 0.5 hr, 100 hr: H_2O=3X10^{-9} Torr-L/s-cm^2, OTHER GASSES=3X10^{-10} Torr-L/s-cm^2



PROJECT: LIGO BY: R.THAN
PROJECT NO: V59049 DATE:
TITLE:FIGURE V049-1-078-4b, VERTEX & BEAMMANIFOLD-CORNER STATION PUMPDOWN, LA

STEEL AREA: 695 m^2, Volume: 298 m^3, H_2=1X10^{-11} Torr-L/s-cm^2, H_2O=1X10^{-6}*$t^{-1.15}$, t=min, OTHER GASSES: 10%

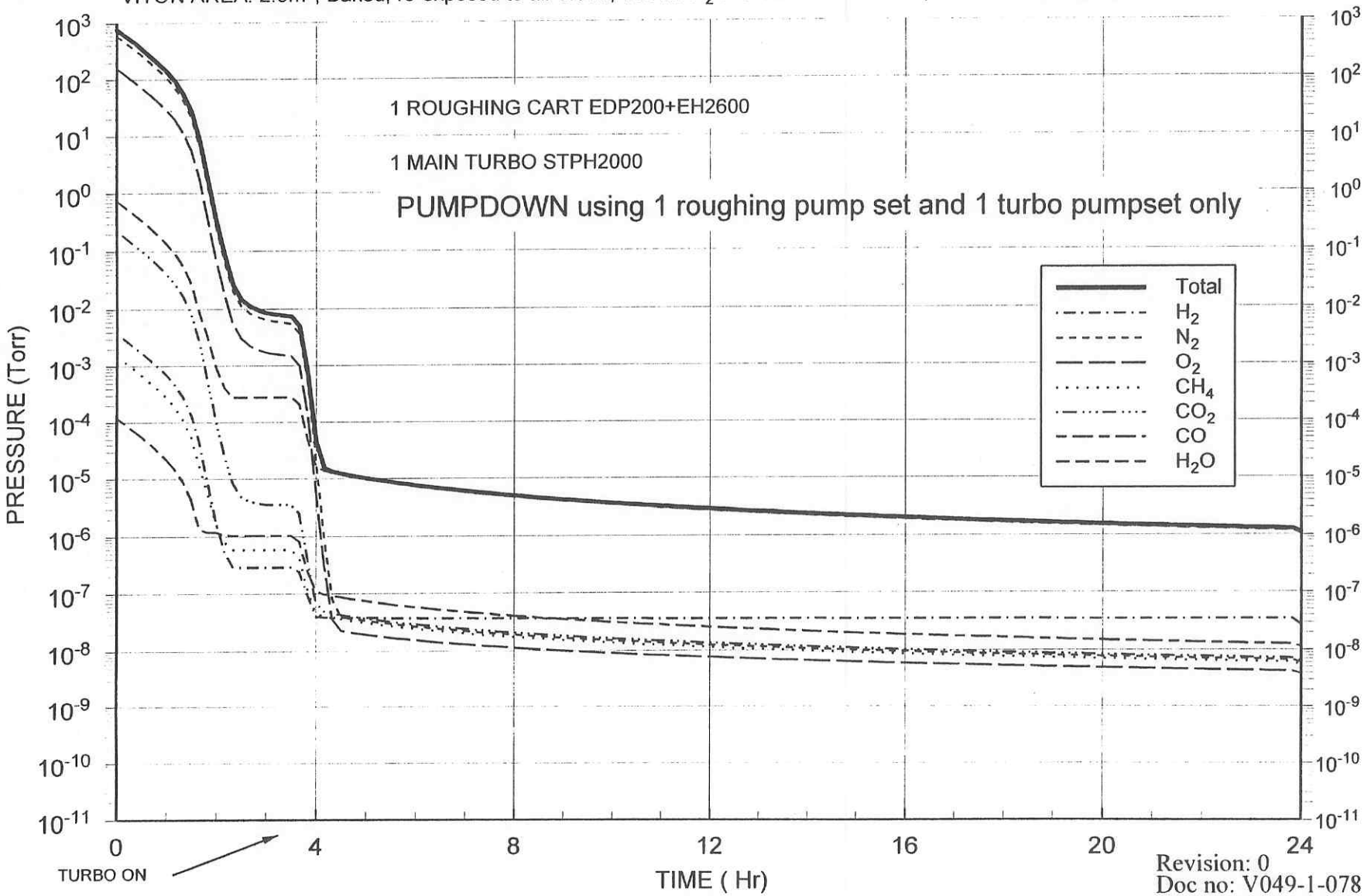
VITON AREA: 3.7m^2, Baked, re-exposed to air 0.5 hr, 100 hr: H_2O=3X10^{-9} Torr-L/s-cm^2, OTHER GASSES=3X10^{-10} Torr-L/s-cm^2



PROJECT: LIGO BY: R.THAN
PROJECT NO: V59049 DATE:
TITLE:FIGURE V049-1-078-5, VERTEX SECTION, CORNER STATION PUMPDOWN, WA

STEEL AREA: 430 m^2, Volume: 187 m^3, H_2=1X10^{-11} Torr-L/s-cm^2, H_2O=1X10^{-6}*$t^{-1.15}$, t=min, OTHER GASSES: 10%

VITON AREA: 2.5m^2, Baked, re-exposed to air 0.5 hr, 100 hr: H_2O=3X10^{-9} Torr-L/s-cm^2, OTHER GASSES=3X10^{-10} Torr-L/s-cm^2



PROJECT: LIGO BY: R. THAN DEPT: 744
PROJECT NO: V59049 DATE:
TITLE: END STATION PRESSURES

END STATION PARAMETERS

END STATIONS with 80K Pump										
						Viton				
Outgassing area	119	M^2				7757	cm^2			
						3.00E-09	Torr-L/s-cm^2			
Gas species	Partial pressure		Final Outgassing rates					Partial pressure		
	Goals	Ion Pump	80K pump	Vacuum Vessel Metal		O-rings	Total	Metal	O-ring	Total
	100 hrs of pumping	peed (1 pumps)						contribution	contribution	
	Torr	L/s	L/s	Torr-L/s-cm^2	Torr-L/s	Torr-L/s	Torr-L/s	Torr	Torr	Torr
		1								
N2	5.00E-10	2,000		2.00E-13	2.38E-07	3.88E-07	6.26E-07	1.19E-10	1.94E-10	**3.13E-10**
CO	5.00E-10	1,900		5.00E-13	5.96E-07	3.88E-07	9.84E-07	3.14E-10	2.04E-10	**5.18E-10**
CO2	2.00E-10	2,150		2.00E-13	2.38E-07	3.88E-07	6.26E-07	1.11E-10	1.80E-10	**2.91E-10**
CH4	2.00E-10	2,200		2.00E-13	2.38E-07	3.88E-07	6.26E-07	1.08E-10	1.76E-10	**2.85E-10**
Others	5.00E-10	1,700		2.00E-13	2.38E-07	3.88E-07	6.26E-07	1.40E-10	2.28E-10	**3.68E-10**
H2	5.00E-09	4,200		1.00E-11	1.19E-05	3.88E-07	1.23E-05	2.84E-09	9.23E-11	**2.93E-09**
H2O	5.00E-09		142,000	5.00E-11	5.96E-05	2.33E-05	8.29E-05	4.20E-10	1.64E-10	**5.8349E-10**
TOTAL gasses	1.90E-09				1.55E-06	2.33E-06	3.88E-06	7.92E-10	9.83E-10	**1.78E-09**
TOTAL with H2	6.40E-09				1.35E-05	2.33E-06	1.58E-05	3.63E-09	1.08E-09	**4.70E-09**
TOTAL with H2O,H2	1.90E-09				7.31E-05	2.56E-05	9.86E-05	4.05E-09	1.24E-09	**5.29E-09**

PROJECT: LIGO BY: R. THAN DEPT: 744
PROJECT NO: V59049 DATE:
TITLE: END STATION PRESSURES

END STATION PARAMETERS

END STATIONS with 80K Pump							
	Qty'	Length m		Area m^2		Volume m^3	Weight kg
Short 80K cryopump chamber	1	2.5		16.59		9.95	915.33
Short 80K cryopump surface	1	1.2		9.80		0.00	
183 cm beam manifold		3.3		18.97		8.68	1046.91
157 cm intercon spool		1		4.93		1.94	272.17
116 cm intercon spool		3.2		11.66		3.74	643.50
BSC	1	1.5		57.21		31.67	3157.10
Total		12.70		***119***		**56**	**6035**
VACUUM SYSTEM		Pump		Total	Total	Specific	Specific
	Qty'	Speed	Net Speed	Speed	Net Speed	speed/ Vol	speed/ Area
ION PUMPS , 0.5m intercon	1	l/s	l/s	l/s	l/s	l/s-m^3	l/s-m^2
N2	1	2500	2000	2500	2000	35.73	**16.78**
CO	1	2350	1900	2350	1900	33.94	**15.94**
CO2	1	2940	2150	2940	2150	38.41	**18.04**
CH4	1	2650	2200	2650	2200	39.30	**18.46**
O2	1	2100	1700	2100	1700	30.37	**14.27**
He	1	295	290	295	290	5.18	**2.43**
Ar	1	590	550	590	550	9.83	**4.62**
H2	1	4700	4200	4700	4200	75.03	**35.24**
H2O	1	2940	2400				
TURBO MOLECULAR *	1	1500	1000	1500	1000	17.86	8.39
* Nitrogen speed							
DRY PUMP QDP80	1	22	18	22	18	0.32	0.15
80K CRYOPUMP **	1	142000	142000	142000	142000	2536.68	**1191.59**
** Water speed							

PROJECT: LIGO BY: R.THAN DEPT: 744
PROJECT NO: V59049 DATE:
TITLE: VITON O-RING AREA END STATION

FLANGE SIZE		Length	Area
INCH	Qty'	m	cm^2
104	1	8.54	937
84	0	6.94	0
72	1	5.98	657
60	4	5.03	2206
48	0	4.07	0
44	4	3.75	1646
Bonnet/Gate	6	3.51	2311
			7757

PROJECT: LIGO BY: R. THAN DEPT: 744
PROJECT NO: V59049 DATE:
TITLE: MID STATION PRESSURES

MID STATION PARAMETERS

MID STATIONS with 80K Pumps										
						Viton				
Outgassing area	162	M^2				11715	cm^2			
						3.00E-09	Torr-L/s-cm^2			
Gas species	Partial pressure		Final Outgassing rates					Partial pressure		
	Goals	Ion Pump	80K pump	Vacuum Vessel Metal		O-rings	Total	Metal	O-ring	Total
	100 hrs of pumping	Speed						contribution	contribution	
	Torr	L/s	L/s	Torr-L/s-cm^2	Torr-L/s	Torr-L/s	Torr-L/s	Torr	Torr	Torr
		1								
N2	5.00E-10	2,000		2.00E-13	3.25E-07	5.86E-07	9.10E-07	1.62E-10	2.93E-10	**4.55E-10**
CO	5.00E-10	1,900		5.00E-13	8.11E-07	5.86E-07	1.40E-06	4.27E-10	3.08E-10	**7.35E-10**
CO2	2.00E-10	2,150		2.00E-13	3.25E-07	5.86E-07	9.10E-07	1.51E-10	2.72E-10	**4.23E-10**
CH4	2.00E-10	2,200		2.00E-13	3.25E-07	5.86E-07	9.10E-07	1.48E-10	2.66E-10	**4.14E-10**
Others	5.00E-10	1,700		2.00E-13	3.25E-07	5.86E-07	9.10E-07	1.91E-10	3.45E-10	**5.35E-10**
H2	5.00E-09	4,200		1.00E-11	1.62E-05	5.86E-07	1.68E-05	3.86E-09	1.39E-10	**4.00E-09**
H2O	5.00E-09		284,000	5.00E-11	8.11E-05	3.51E-05	1.16E-04	2.86E-10	1.24E-10	**4.0945E-10**
TOTAL gasses	1.90E-09				2.11E-06	3.51E-06	5.62E-06	1.08E-09	1.48E-09	**2.56E-09**
TOTAL with H2	6.40E-09				1.83E-05	3.51E-06	2.19E-05	4.94E-09	1.62E-09	**6.57E-09**
TOTAL with H2O,H2	1.19E-08				9.95E-05	3.87E-05	1.38E-04	5.23E-09	1.75E-09	**6.98E-09**

PROJECT: LIGO BY: R. THAN DEPT: 744
PROJECT NO: V59049 DATE:
TITLE: MID STATION PRESSURES

MID STATION PARAMETERS

MID STATIONS with 80K Pumps							
	Qty'	Length		Area		Volume	Weight
		m		m^2		m^3	Approx
Short 80K cryopump chamber	2	2.5		33.18		19.91	1830.66
Short 80K cryopump surface	2	1.2		19.60		0.00	
183 cm beam manifold		3.8		21.85		9.99	1205.53
116 cm intercon spool		7		25.51		8.18	1407.67
157 cm intercon spool		1		4.93		1.94	272.17
BSC	1	3.5		57.21		31.67	3157.10
Total		19.00		***162***		**72**	**7873**
VACUUM SYSTEM		Pump		Total	Total	Specific	Specific
	Qty'	Speed	Net Speed	Speed	Net Speed	speed/ Vol	speed/ Area
ION PUMPS , 0.5m intercon	1	l/s	l/s	l/s	l/s	l/s-m^3	l/s-m^2
N2	1	2500	2000	2500	2000	27.90	**12.32**
CO	1	2350	1900	2350	1900	26.50	**11.71**
CO2	1	2940	2150	2940	2150	29.99	**13.25**
CH4	1	2650	2200	2650	2200	30.69	**13.56**
O2	1	2100	1700	2100	1700	23.71	**10.48**
He	1	295	290	295	290	4.05	**1.79**
Ar	1	590	550	590	550	7.67	**3.39**
H2	1	4700	4200	4700	4200	58.59	**25.88**
H2O	1	2940	2400	2940	2400	33.48	**14.79**
TURBO MOLECULAR *	1	1500	1000	1500	1000	**13.95**	6.16
* Nitrogen speed							
DRY PUMP QDP80	1	22	18	22	18	**0.25**	0.11
80K CRYOPUMP **	2	142000		284000		3961.58	**1750.06**
** Water speed							

PROJECT: LIGO BY: R.THAN DEPT: 744
PROJECT NO: V59049 DATE:
TITLE: VITON O-RING AREA MID STATION

FLANGE SIZE		Length	Area
INCH	Qty'	m	cm^2
104	1	8.54	937
84	0	6.94	0
72	1	5.98	657
60	4	5.03	2206
48	0	4.07	0
44	8	3.75	3292
Bonnet/Gate	12	3.51	4623
			11715

PROJECT: LIGO BY: R. THAN DEPT: 744
PROJECT NO: V59049 DATE:
TITLE: CORNER STATION PRESSURES

CORNER STATION, WA
PARAMETERS

CORNER STATION (WA) VERTEX & ARM ISOLATABLE SECTION with 80K Pump										
						VITON				
Outgassing area	732	M^2				37639	cm^2			
						3.00E-09	Torr-L/s-cm^2			
Gas species	Partial pressure			Final Outgassing rates				Partial pressure		
	Goals	Ion Pump	80K pump	Vacuum Vessel Metal		O-rings	Total	Metal	O-ring	**Total**
	100 hrs of pumping	speed						contribution	contribution	
	Torr	L/s	L/s	Torr-L/s-cm^2	Torr-L/s	Torr-L/s	Torr-L/s	Torr	Torr	**Torr**
N2	5.00E-10	10000		2.00E-13	1.46E-06	1.88E-06	3.35E-06	1.46E-10	1.88E-10	**3.35E-10**
CO	5.00E-10	9500		5.00E-13	3.66E-06	1.88E-06	5.54E-06	3.85E-10	1.98E-10	**5.83E-10**
CO2	2.00E-10	10750		2.00E-13	1.46E-06	1.88E-06	3.35E-06	1.36E-10	1.75E-10	**3.11E-10**
CH4	2.00E-10	11000		2.00E-13	1.46E-06	1.88E-06	3.35E-06	1.33E-10	1.71E-10	**3.04E-10**
Others	5.00E-10	8500		2.00E-13	1.46E-06	1.88E-06	3.35E-06	1.72E-10	2.21E-10	**3.94E-10**
H2	5.00E-09	21000		1.00E-11	7.32E-05	1.88E-06	7.50E-05	3.48E-09	8.96E-11	**3.57E-09**
H2O	5.00E-09		142,000	5.00E-11	3.66E-04	1.13E-04	4.79E-04	2.58E-09	7.95E-10	**3.3712E-09**
TOTAL gasses	1.90E-09				9.51E-06	1.13E-05	2.08E-05	9.73E-10	9.54E-10	**1.93E-09**
TOTAL with H2	6.40E-09				8.27E-05	1.13E-05	9.40E-05	4.46E-09	1.04E-09	**5.50E-09**
TOTAL with H2O,H2	1.90E-09				4.48E-04	1.24E-04	5.73E-04	7.03E-09	1.84E-09	**8.87E-09**

PROJECT: LIGO BY: R. THAN DEPT: 744
PROJECT NO: V59049 DATE:
TITLE: CORNER STATION PRESSURES

CORNER STATION, WA
PARAMETERS

CORNER STATION (WA) VERTEX & ARM ISOLATABLE SECTION with 80K Pump							
	Qty'	Length		Area		Volume	Weight
		m		m^2		m^3	kg
Long 80K Cryopump chamber	1	4.2	m	31.67		19.00	1747.45
Long 80K Cryopump surface	1	3.7	m	30.22			
183 cm beam manifold		25.6	m	147.18		67.33	8121.47
157m intercon spool		6.7	m	33.05		12.97	1823.55
122 cm intercon spool		7.3	m	27.98		8.53	1543.92
116 cm intercon spool		3	m	10.93		3.17	603.29
BSC	4	4	m	228.85		126.68	12628.40
HAM	6		m	164.40		67.53	9071.65
76 cm cleaner tube		24	m	57.30		10.89	3162.05
Total		78.50	m	***732***		**316**	**38702**
VACUUM SYSTEM		Pump		Total	Total	Specific	Specific
	Qty'	Speed	Net Speed	Speed	Net Speed	speed/ Vol	speed/ Area
ION PUMPS , 0.5m intercon	5	l/s	l/s	l/s	l/s	l/s-m^3	l/s-m^2
N2	5	2500	2000	12500	10000	31.63	**13.67**
CO	5	2350	1900	11750	9500	30.05	**12.99**
CO2	5	2940	2150	14700	10750	34.01	**14.69**
CH4	5	2650	2200	13250	11000	34.80	**15.04**
O2	5	2100	1700	10500	8500	26.89	**11.62**
He	5	295	290	1475	1450	4.59	**1.98**
Ar	5	590	550	2950	2750	8.70	**3.76**
	5						
H2	5	4700	4200	23500	21000	66.43	**28.71**
H2O	5	2940	2400				
TURBO MOLECULAR *	1	1500	1000	1500	1000	3.16	1.37
* Nitrogen speed							
ROOTS 10 Torr - 0.01 Torr	2	600	438	1200	876	2.77	1.20
Claw&Root 760 Torr - 10 Torr	2	83	78	166	156	0.49	0.21
80K CRYOPUMP **	1	142000	142000	142000	142000	449.21	**194.10**
** Water speed							

PROJECT: LIGO BY: R. THAN DEPT: 744
PROJECT NO: V59049 DATE:
TITLE: CORNER STATION PRESSURES

CORNER STATION, WA
PARAMETERS

CORNER STATION (WA) BEAM MANIFOLD with 80K Pump							
	Qty'	Length		Area		Volume	Weight
		m		m^2		m^3	kg
Long 80K Cryopump chamber	1	4.2	m	31.67		19.00	1747.45
Long 80K Cryopump surface	1	3.7	m	30.22			
183 cm beam manifold		25.6	m	147.18		67.33	8121.47
157 cm intercon spool		1.2	m	5.92		2.32	326.61
122 cm intercon spool		4.9	m	18.78		5.73	1036.33
116 cm intercon spool	0	3	m	10.93		3.17	603.29
BSC	1	4	m	57.21		31.67	3157.10
HAM	0		m	0.00		0.00	0.00
76 cm cleaner tube		0	m	0.00		0.00	0.00
Total		46.60	m	***302***		**129**	**14992**
VACUUM SYSTEM		Pump		Total	Total	Specific	Specific
	Qty'	Speed	Net Speed	Speed	Net Speed	speed/ Vol	speed/ Area
ION PUMPS , 0.5m intercon	1	l/s	l/s	l/s	l/s	l/s-m^3	l/s-m^2
N2	1	2500	2000	2500	2000	15.48	**6.62**
CO	1	2350	1900	2350	1900	14.70	**6.29**
CO2	1	2940	2150	2940	2150	16.64	**7.12**
CH4	1	2650	2200	2650	2200	17.02	**7.29**
O2	1	2100	1700	2100	1700	13.16	**5.63**
He	1	295	290	295	290	2.24	**0.96**
Ar	1	590	550	590	550	4.26	**1.82**
	1			0	0	0.00	**0.00**
H2	1	4700	4200	4700	4200	32.50	**13.91**
H2O	1	2940	2400				
TURBO MOLECULAR *	1	1500	1000	1500	1000	7.74	3.31
* Nitrogen speed							
ROOTS 10 Torr - 0.01 Torr	2	600	438	1200	876	6.78	2.90
Claw&Root 760 Torr - 10 Torr	2	83	78	166	156	1.21	0.52
80K CRYOPUMP **	1	142000	142000	142000	142000	1098.86	**470.34**
** Water speed							

PROJECT: LIGO BY: R. THAN DEPT: 744
PROJECT NO: V59049 DATE:
TITLE: CORNER STATION PRESSURES

CORNER STATION, WA
PARAMETERS

DIAGONAL (OFFSET) SECTION, WA							
	Qty'	Length		Area		Volume	Weight
		m		m^2		m^3	kg
183 cm beam manifold		0	m	0.00		0.00	0.00
157 cm intercon spool		2.2	m	10.85		4.26	598.78
122 cm intercon spool		6.7	m	25.68		7.83	1417.03
116 cm intercon spool	0	0	m	0.00		0.00	0.00
BSC	1	4	m	57.21		31.67	3157.10
HAM	6			164.40		67.53	9071.65
76 cm cleaner tube		24	m	57.30		10.89	3162.05
Total		36.90	m	***315***		**122**	**17407**
VACUUM SYSTEM		Pump		Total	Total	Specific	Specific
	Qty'	Speed	Net Speed	Speed	Net Speed	speed/ Vol	speed/ Area
ION PUMPS , 0.5m intercon	2	l/s	l/s	l/s	l/s	l/s-m^3	l/s-m^2
N2	2	2500	2000	5000	4000	32.74	**12.68**
CO	2	2350	1900	4700	3800	31.10	**12.05**
CO2	2	2940	2150	5880	4300	35.19	**13.63**
CH4	2	2650	2200	5300	4400	36.01	**13.95**
O2	2	2100	1700	4200	3400	27.83	**10.78**
He	2	295	290	590	580	4.75	**1.84**
Ar	2	590	550	1180	1100	9.00	**3.49**
	2			0	0	0.00	**0.00**
H2	2	4700	4200	9400	8400	68.75	**26.63**
H2O	2	2940	2400				
TURBO MOLECULAR *	1	1500	1000	1500	1000	8.18	3.17
* Nitrogen speed							
ROOTS 10 Torr - 0.01 Torr	1	600	438	600	438	3.58	1.39
Claw&Root 760 Torr - 10 Torr	1	83	78	83	78	0.64	0.25
80K CRYOPUMP **	1	142000	142000	142000	142000	1162.21	**450.16**
** Water speed							

PROJECT: LIGO BY: R. THAN DEPT: 744
PROJECT NO: V59049 DATE:
TITLE: CORNER STATION PRESSURES

CORNER STATION, WA
PARAMETERS

VERTEX SECTION, WA							
	Qty'	Length		Area		Volume	Weight
		m		m^2		m^3	kg
183 cm beam manifold		0	m	0.00		0.00	0.00
157 cm intercon spool		5.5	m	27.13		10.65	1496.94
122 cm intercon spool		2.4	m	9.20		2.81	507.59
116 cm intercon spool	0	0	m	0.00		0.00	0.00
BSC	3	4	m	171.64		95.01	9471.30
HAM	6			164.40		67.53	9071.65
76 cm cleaner tube		24	m	57.30		10.89	3162.05
Total		35.90	m	***430***		**187**	**23710**
VACUUM SYSTEM		Pump		Total	Total	Specific	Specific
	Qty'	Speed	Net Speed	Speed	Net Speed	speed/ Vol	speed/ Area
ION PUMPS , 0.5m intercon	4	l/s	l/s	l/s	l/s	l/s-m^3	l/s-m^2
N2	4	2500	2000	10000	8000	65.48	**25.36**
CO	4	2350	1900	9400	7600	62.20	**24.09**
CO2	4	2940	2150	11760	8600	70.39	**27.26**
CH4	4	2650	2200	10600	8800	72.02	**27.90**
O2	4	2100	1700	8400	6800	55.65	**21.56**
He	4	295	290	1180	1160	9.49	**3.68**
Ar	4	590	550	2360	2200	18.01	**6.97**
	4			0	0	0.00	**0.00**
H2	4	4700	4200	18800	16800	137.50	**53.26**
H2O	4	2940	2400				
TURBO MOLECULAR *	1	1500	1000	1500	1000	8.18	3.17
* Nitrogen speed							
ROOTS 10 Torr - 0.01 Torr	1	600	438	600	438	3.58	1.39
Claw&Root 760 Torr - 10 Torr	1	83	78	83	78	0.64	0.25
80K CRYOPUMP **	1	142000	142000	142000	142000	1162.21	**450.16**
** Water speed							

PROJECT: LIGO BY: R.THAN DEPT: 744
PROJECT NO: V59049 DATE:
TITLE: VITON O-RING AREA CORNER STATION ,WA

RIGHT/LEFT BEAM MANIFOLD			
FLANGE SIZE		Length	Area
INCH	Qty'	m	cm^2
104	1	8.54	937
84	0	6.94	0
72	5	5.98	3283
60	4	5.03	2206
48	3	4.07	1340
Bonnet/Gate	7	3.51	2697
44	4	3.75	1646
		TOTAL	**12109**
VERTEX			
FLANGE SIZE		Length	Area
INCH	Qty'	m	cm^2
104	3	8.54	2810
84	12	6.94	9141
72	0	5.98	0
60	23	5.03	12686
48	2	4.07	893
44	0	3.75	0
		TOTAL	**25530**
DIAGONAL			
FLANGE SIZE		Length	Area
INCH	Qty'	m	cm^2
104	1	8.54	937
84	12	6.94	9141
72	0	5.98	0
60	15	5.03	8274
48	4	4.07	1786
Bonnet	2	3.51	770
44	0	3.75	0
		TOTAL	**20908**
DIAGONAL			***20908***
VERTEX			***25530***
RIGHT BEAM MANIFOLD			***12109***
LEFT BEAM MANIFOLD			***12109***
			70655

PROJECT: LIGO BY: R. THAN DEPT: 744
PROJECT NO: V59049 DATE:
TITLE: LA, CORNER STATION PRESSURES

CORNER STATION, LA
PARAMETERS

CORNER STATION (LA) VERTEX & BEAM MANIFOLD ISOLATABLE SECTION with 80K Pump										
Outgassing area	695	M^2				36746	cm^2			
						3.00E-09	Torr-L/s-cm^2			
Gas species	Partial pressure		Final Outgassing rates					Partial pressure		
	Goals	Ion Pump	80K pump	Vacuum Vessel Metal		O-rings **	Total	Metal	O-ring	Total
	100 hrs of pumping	peed (1 pumps)						contributio	contributio	
	Torr	L/s	L/s	Torr-L/s-cm^2	Torr-L/s	Torr-L/s	Torr-L/s	Torr	Torr	Torr
		1								
N2 *	5.00E-10	8,000		2.00E-13	1.39E-06	1.84E-06	3.23E-06	1.74E-10	2.30E-10	**4.03E-10**
CO	5.00E-10	7,600		5.00E-13	3.47E-06	1.84E-06	5.31E-06	4.57E-10	2.42E-10	**6.99E-10**
CO2	2.00E-10	8,600		2.00E-13	1.39E-06	1.84E-06	3.23E-06	1.62E-10	2.14E-10	**3.75E-10**
CH4	2.00E-10	8,800		2.00E-13	1.39E-06	1.84E-06	3.23E-06	1.58E-10	2.09E-10	**3.67E-10**
Others	5.00E-10	6,800		2.00E-13	1.39E-06	1.84E-06	3.23E-06	2.04E-10	2.70E-10	**4.74E-10**
H2	5.00E-09	16,800		1.00E-11	6.95E-05	1.84E-06	7.13E-05	4.13E-09	1.09E-10	**4.24E-09**
H2O	5.00E-09		142,000	5.00E-11	3.47E-04	1.10E-04	4.58E-04	2.45E-09	7.76E-10	**3.222E-09**
TOTAL gasses	1.90E-09				9.03E-06	1.10E-05	2.01E-05	1.15E-09	1.16E-09	**2.32E-09**
TOTAL with H2	6.40E-09				7.85E-05	1.10E-05	8.95E-05	5.29E-09	1.27E-09	**6.56E-09**
TOTAL with H2O,H2	1.90E-09				4.26E-04	1.21E-04	5.47E-04	7.73E-09	2.05E-09	**9.78E-09**

PROJECT: LIGO BY: R. THAN DEPT: 744
PROJECT NO: V59049 DATE:
TITLE: LA, CORNER STATION PRESSURES

CORNER STATION, LA
PARAMETERS

CORNER STATION (LA) VERTEX & BEAM MANIFOLD ISOLATABLE SECTION with 80K Pump							
	Qty'	Length		Area		Volume	Weight
		m		m^2		m^3	kg
Long 80K Cryopump chamber	1	4.2	m	31.67		19.00	1747.45
Long 80K Cryopump surface	1	3.7	m	30.22			
183 cm beam manifold		37	m	212.72		97.32	11738.06
122 cm intercon spool		6	m	23.00		7.01	1268.98
116 cm intercon spool		1	m	3.64		1.06	201.10
BSC	3	4	m	171.64		95.01	9471.30
HAM	6		m	164.40		67.53	9071.65
76 cm cleaner tube		24	m	57.30		10.89	3162.05
Total		79.90	m	***695***		**298**	**36661**
VACUUM SYSTEM		Pump		Total	Total	Specific	Specific
	Qty'	Speed	Net Speed	Speed	Net Speed	speed/ Vol	speed/ Area
ION PUMPS , 0.5m intercon	4	l/s	l/s	l/s	l/s	l/s-m^3	l/s-m^2
N2	4	2500	2000	10000	8000	26.86	**11.52**
CO	4	2350	1900	9400	7600	25.52	**10.94**
CO2	4	2940	2150	11760	8600	28.88	**12.38**
CH4	4	2650	2200	10600	8800	29.55	**12.67**
O2	4	2100	1700	8400	6800	22.83	**9.79**
He	4	295	290	1180	1160	3.89	**1.67**
Ar	4	590	550	2360	2200	7.39	**3.17**
	4						
H2	4	4700	4200	18800	16800	56.41	**24.19**
H2O	4	2940	2400			0.00	
TURBO MOLECULAR *	1	1500	1000	1500	1000	3.36	1.44
* Nitrogen speed							
ROOTS 10 Torr - 0.01 Torr	2	600	438	1200	876	2.94	1.26
ROTARY 760 Torr - 10 Torr	2	138	100	276	200	0.67	0.29
80K CRYOPUMP **	1	142000	142000	142000	142000	476.80	**204.44**
** Water speed							

PROJECT: LIGO BY: R. THAN DEPT: 744
PROJECT NO: V59049 DATE:
TITLE: LA, CORNER STATION PRESSURES

CORNER STATION, LA
PARAMETERS

CORNER STATION (LA) entire station with 80K Pumps										
Outgassing area	898	M^2				47961	cm^2			
						3.00E-09	Torr-L/s-cm^2			
Gas species	Partial pressure		Final Outgassing rates					Partial pressure		
	Goals	Ion Pump	80K pump	Vacuum Vessel Metal		O-rings **	Total	Metal	O-ring	Total
	100 hrs of pumping	peed (1 pumps)						contributio	contributio	
	Torr	L/s	L/s	Torr-L/s-cm^2	Torr-L/s	Torr-L/s	Torr-L/s	Torr	Torr	Torr
N2 *	5.00E-10	8,000		2.00E-13	1.80E-06	2.40E-06	4.19E-06	2.25E-10	3.00E-10	**5.24E-10**
CO	5.00E-10	7,600		5.00E-13	4.49E-06	2.40E-06	6.89E-06	5.91E-10	3.16E-10	**9.07E-10**
CO2	2.00E-10	8,600		2.00E-13	1.80E-06	2.40E-06	4.19E-06	2.09E-10	2.79E-10	**4.88E-10**
CH4	2.00E-10	8,800		2.00E-13	1.80E-06	2.40E-06	4.19E-06	2.04E-10	2.73E-10	**4.77E-10**
Others	5.00E-10	6,800		2.00E-13	1.80E-06	2.40E-06	4.19E-06	2.64E-10	3.53E-10	**6.17E-10**
H2	5.00E-09	16,800	16800	1.00E-11	8.98E-05	2.40E-06	9.22E-05	5.35E-09	1.43E-10	**5.49E-09**
H2O	5.00E-09		284,000	5.00E-11	4.49E-04	1.44E-04	5.93E-04	1.58E-09	5.07E-10	**2.0885E-09**
TOTAL gasses	1.90E-09				1.17E-05	1.44E-05	2.61E-05	1.49E-09	1.52E-09	**3.01E-09**
TOTAL with H2	6.40E-09				1.02E-04	1.44E-05	1.16E-04	6.84E-09	1.66E-09	**8.50E-09**
TOTAL with H2O,H2	1.90E-09				5.51E-04	1.58E-04	7.09E-04	8.42E-09	2.17E-09	**1.06E-08**

PROJECT: LIGO BY: R. THAN DEPT: 744
PROJECT NO: V59049 DATE:
TITLE: LA. CORNER STATION PRESSURES

CORNER STATION, LA
PARAMETERS

CORNER STATION (LA) entire station with 80K Pumps							
	Qty'	Length		Area		Volume	Weight
		m		m^2		m^3	kg
Long 80K Cryopump chamber	2	4.2	m	63.33		38.00	3494.89
Long 80K Cryopump surface	2	3.7	m	60.44			
183 cm beam manifold		60	m	344.95		157.81	19034.69
122 cm intercon spool		9.5	m	36.41		11.11	2009.22
116 cm intercon spool	0	9.5	m	0.00		0.00	0.00
BSC	3	4	m	171.64		95.01	9471.30
HAM	6		m	164.40		67.53	9071.65
76 cm cleaner tube		24	m	57.30		10.89	3162.05
Total		114.90	m	***898***		**380**	**46244**
VACUUM SYSTEM		Pump		Total	Total	Specific	Specific
	Qty'	Speed	Net Speed	Speed	Net Speed	speed/ Vol	speed/ Area
ION PUMPS , 0.5m intercon	4	l/s	l/s	l/s	l/s	l/s-m^3	l/s-m^2
N2	4	2500	2000	10000	8000	21.03	**8.90**
CO	4	2350	1900	9400	7600	19.98	**8.46**
CO2	4	2940	2150	11760	8600	22.61	**9.57**
CH4	4	2650	2200	10600	8800	23.14	**9.79**
O2	4	2100	1700	8400	6800	17.88	**7.57**
He	4	295	290	1180	1160	3.05	**1.29**
Ar	4	590	550	2360	2200	5.78	**2.45**
	4						
H2	4	4700	4200	18800	16800		**18.70**
H2O	4	2940	2400			0.00	
TURBO MOLECULAR *	1	1500	1000	1500	1000	2.63	1.11
* Nitrogen speed							
ROOTS 10 Torr - 0.01 Torr	2	600	438	1200	876	2.30	0.97
ROTARY 760 Torr - 10 Torr	2	138	100	276	200	0.53	0.22
80K CRYOPUMP **	2	142000	142000	284000	284000	746.68	**316.09**
** Water speed							

PROJECT: LIGO BY: R.THAN DEPT: 744
PROJECT NO: V59049 DATE:
TITLE VITON O-RING AREA, CORNER STATION ,LA

RIGHT/LEFT BEAM MANIFOLD			
FLANGE SIZE		Length	Area
INCH	Qty'	m	cm^2
104	1	8.54	937
84	0	6.94	0
72	5	5.98	3283
60	0	5.03	0
48	1	4.07	447
Bonnet/Gate	7	3.51	2697
44	4	3.75	1646
		TOTAL	**9009**
VERTEX			
FLANGE SIZE		Length	Area
INCH	Qty'	m	cm^2
104	3	8.54	2810
84	12	6.94	9141
72	0	5.98	0
60	23	5.03	12686
48	2	4.07	893
44	0	3.75	0
		TOTAL	**25530**
VERTEX			***25530***
RIGHT BEAM MANIFOLD			***9009***
LEFT BEAM MANIFOLD			***9009***
			43549

Table 1

VIT 142	(E.H.V.) O-ring
Section	0.353 cm
ID	3.769 cm
Surface area	14.3 cm^2
Length	13 cm
L/A	0.91 cm^{-1}
Volume	1.26 cm^3

Initial gas content (estimated) 5.7 cm^3 air at NTP

Table 2

Curve No	Position of O-ring	Baking time (h)	Baking temperature °C
1	In chamber	—	—
2	In groove	—	—
3	In groove	16	100
4	In chamber	16	100

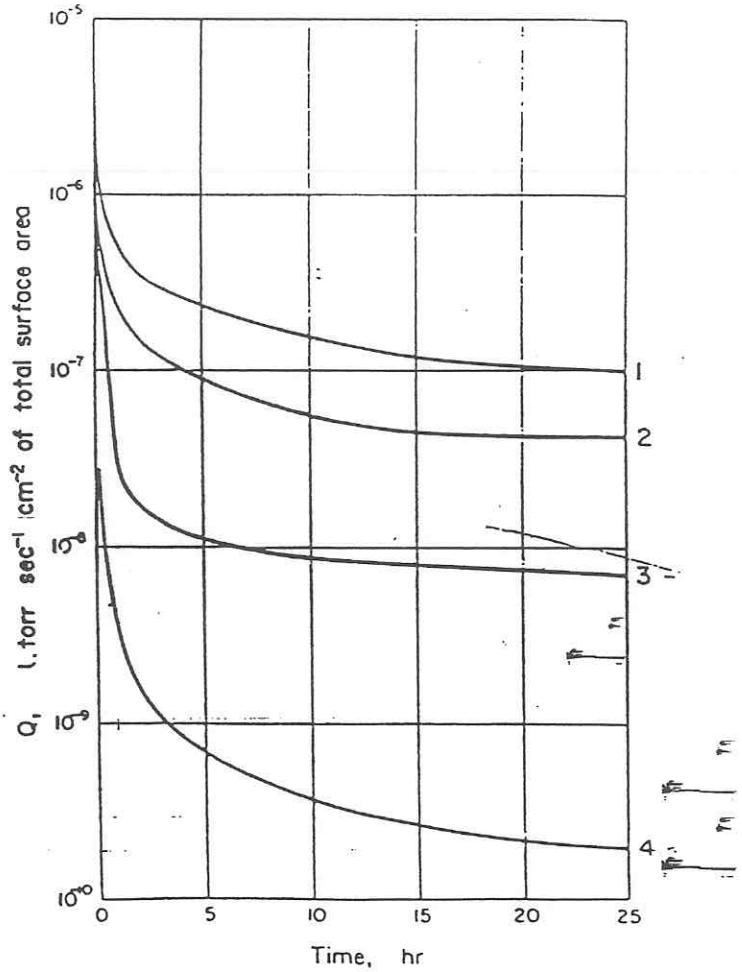


Figure 1. Gas evolution rates in litre torr sec^{-1} cm^{-1} of total area of O-ring against time in hours. See Table 2 for key.

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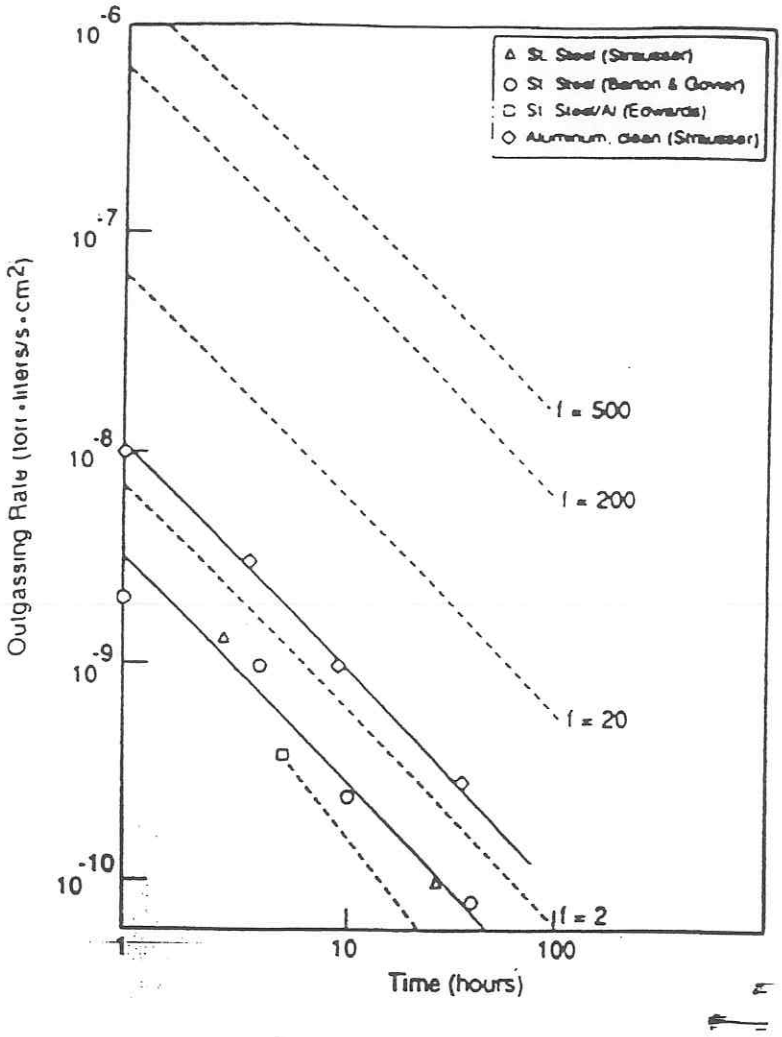


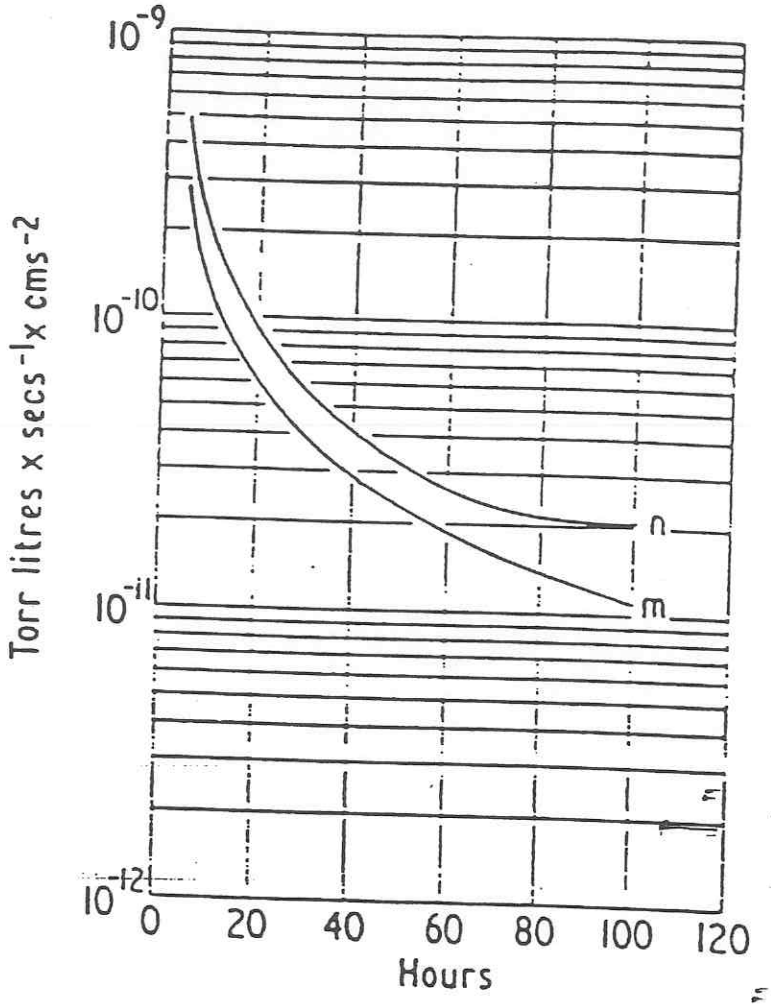
FIG. 1. A compilation of selected outgassing results from the literature for the outgassing of stainless steel and aluminum at ambient temperature. Measurements of Edwards (Ref. 1), Strausser (Ref. 5), and Barton and Govier (Ref. 6) are shown. The lower solid line indicates the literature average used for comparative stainless steel outgassing in this study. The dotted lines indicate the effect of increasing values of the surface-roughness factor f.

Vacuum Vol.20, No.1, 1970

The effect of cleaning technique on the outgassing rate of 18/9/1 stainless steel

received 6 October 1969; accepted 3 November 1969 VACUUM VOL 20 NO 1

R S Barton and R P Govier, *UKAEA Research Group, Culham Laboratory, Abingdon, Berkshire*



m. New sample machined & degreased. (Sample 10, Exp. 31).
n. Same sample following vapour blasting & degreasing. (Sample 10, Exp. 32).

Figure 8. Total outgassing per cm^2 of sample as a function of pumping time.

M. Li and H. F. Dylla: Water outgassing from metal surfaces. II

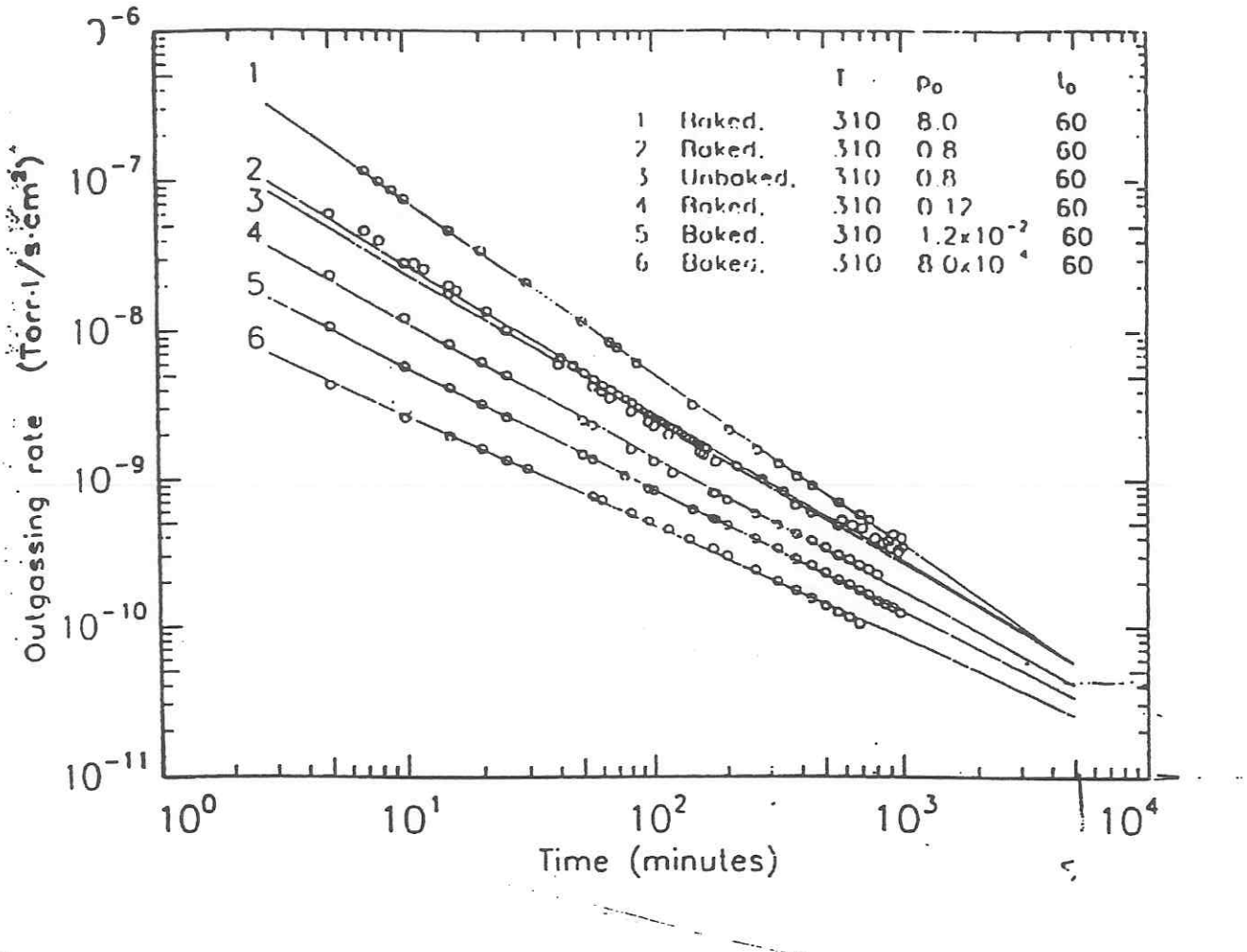


FIG. 1. Typical outgassing measurements for different H_2O exposure pressures in a $\log(Q)$ vs $\log(t)$ plot.

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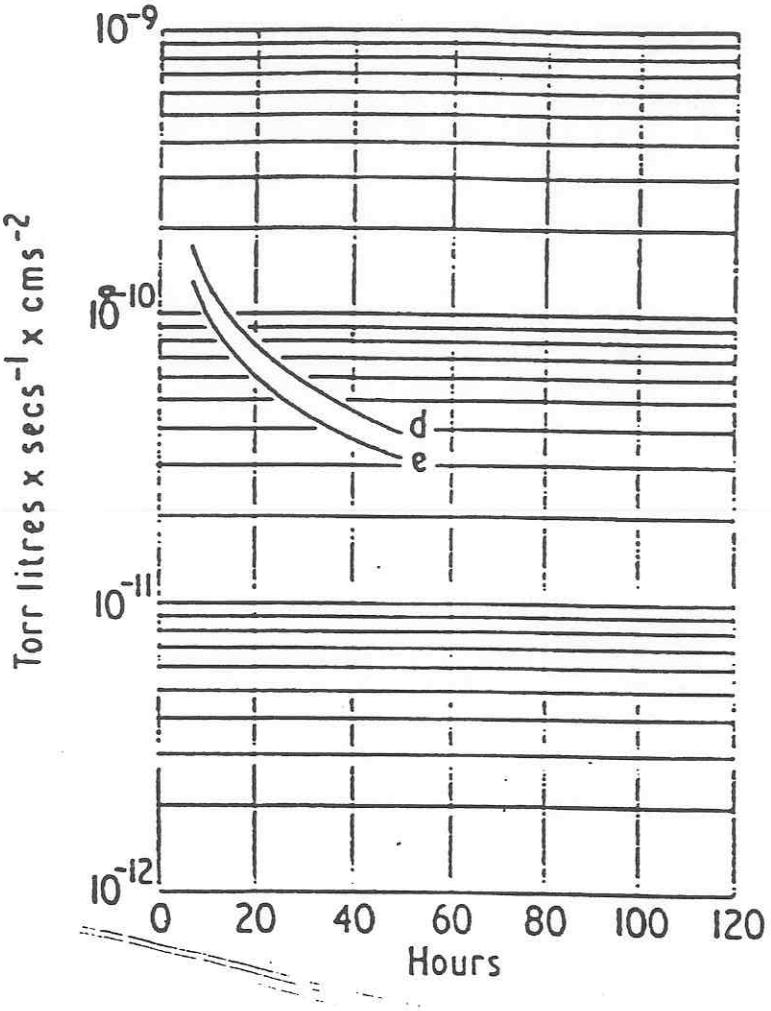
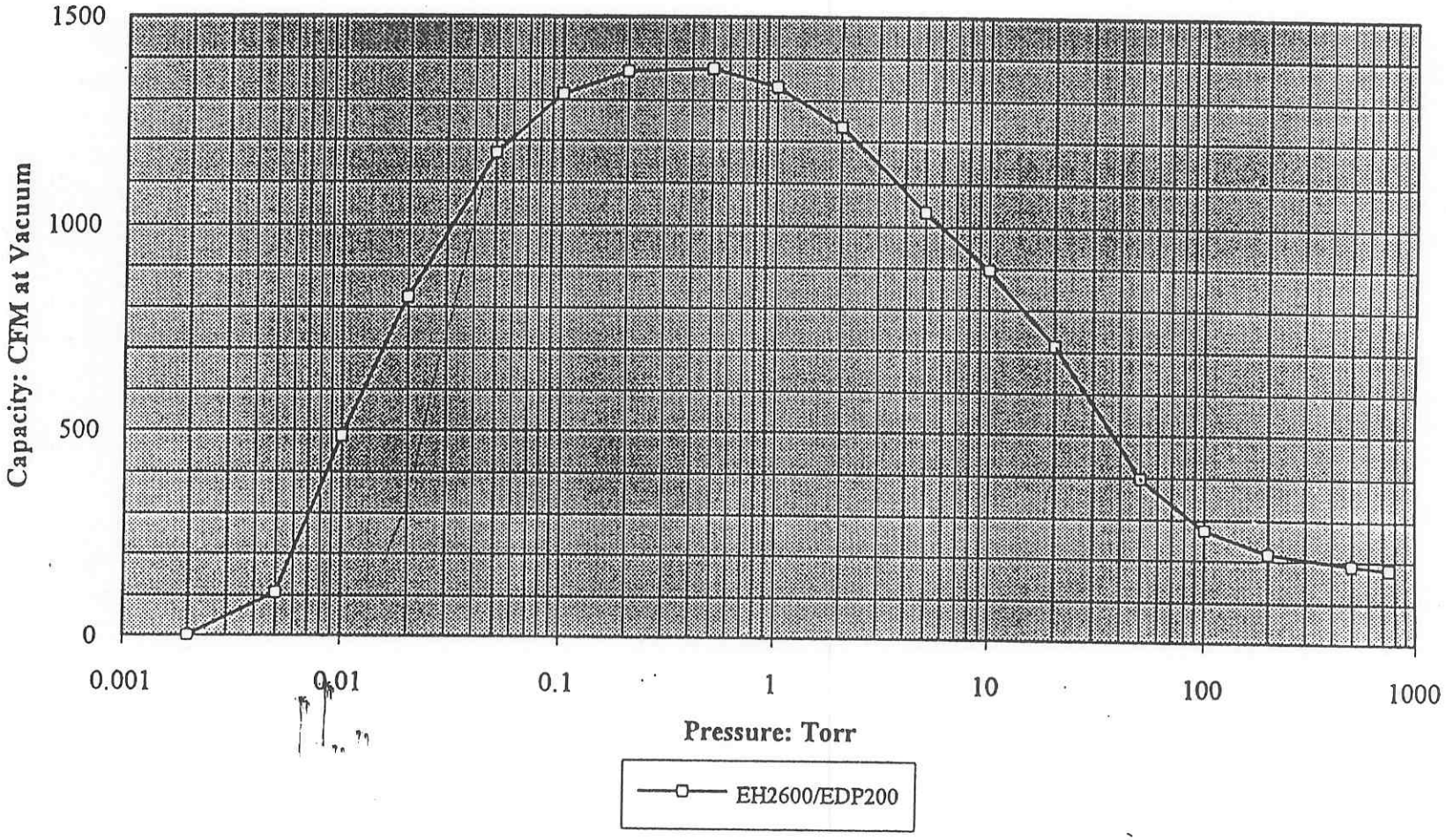
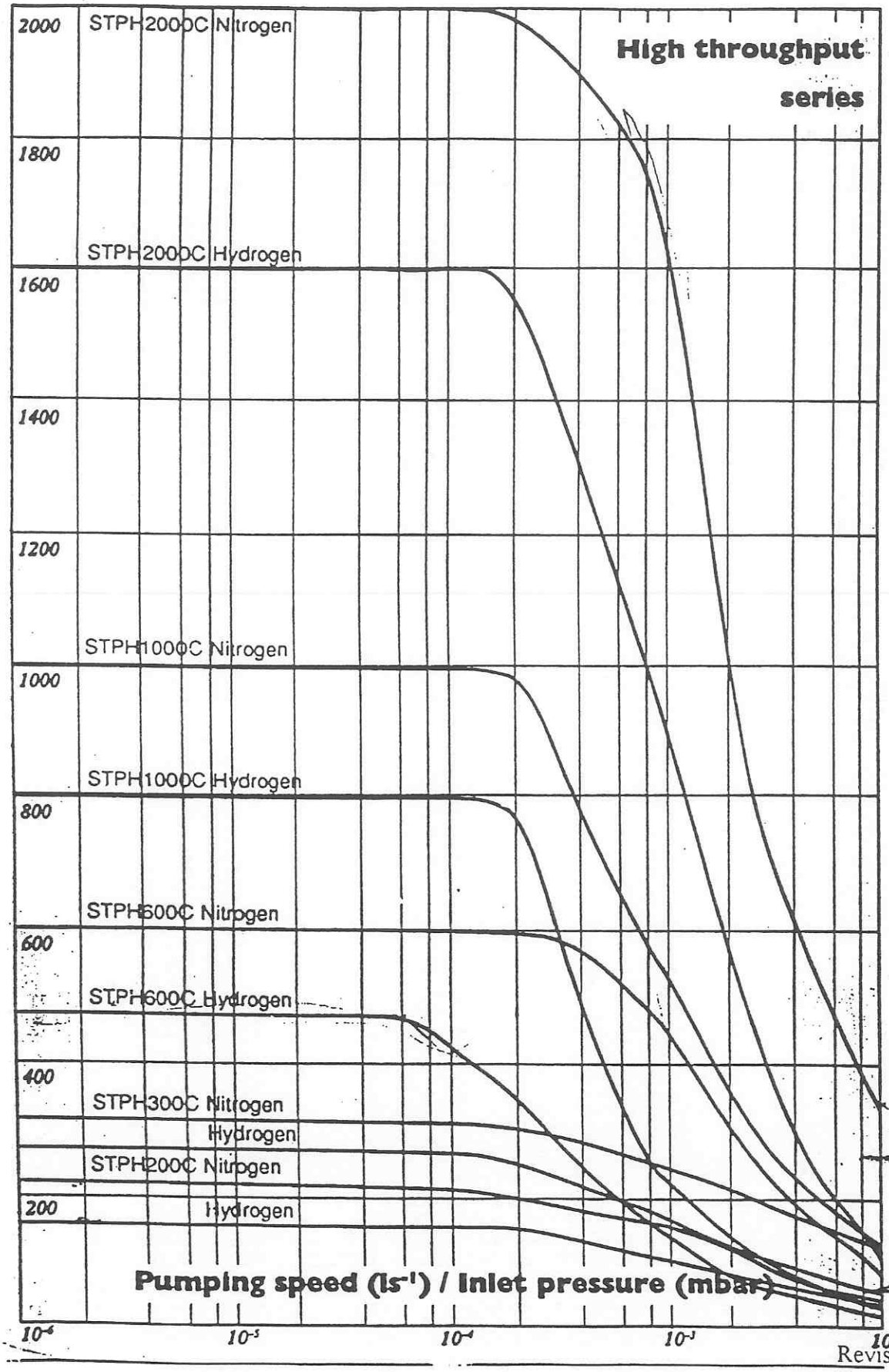


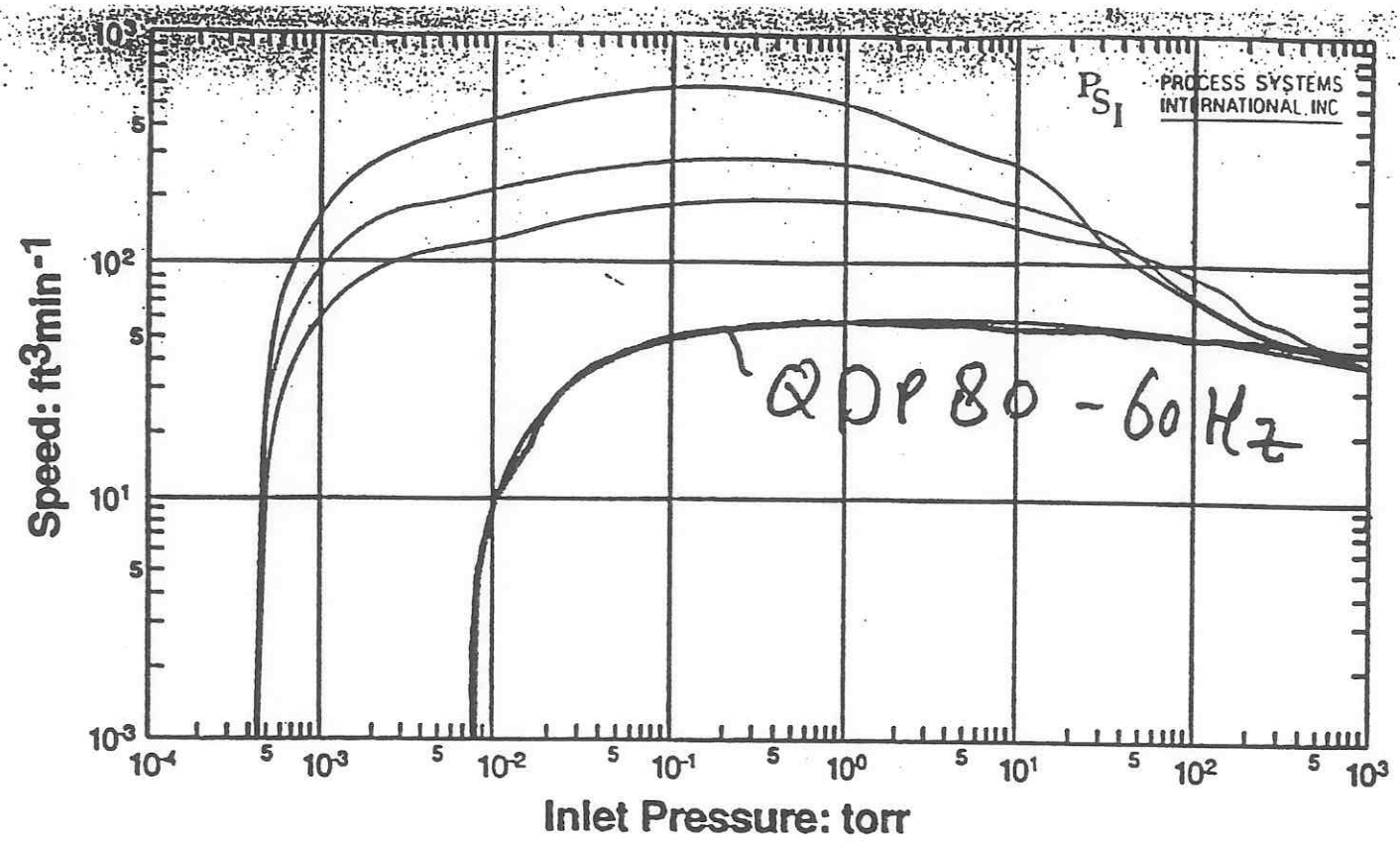
d. Sample honed & degreased (Sample 2, Exp.5)
e. Sample machined & degreased (Sample 2, Exp.9)

Figure 6. Total outgassing per cm² of sample as a function of pumping time.

EDP200/Booster Combinations




High throughput series
2000
STPH2000C Nitrogen
1800
STPH2000C Hydrogen
1600
1400
1200
STPH1000C Nitrogen
1000
STPH1000C Hydrogen
800
STPH600C Nitrogen
600
STPH600C Hydrogen
400
STPH300C Nitrogen
Hydrogen
STPH200C Nitrogen
200
Hydrogen
Pumping speed (ls⁻¹) / Inlet pressure (mbar)
10⁻⁶
10⁻⁵
10⁻⁴
10⁻³
10⁻²



QMB1200 + QDP80 50Hz QMB500 + QDP80 50Hz
QMB250 + QDP80 50Hz QDP80 50Hz