OPERATING PROCEDURES
80K PUMP

FOR

LIGO VACUUM EQUIPMENT

Hanford, Washington
and
Livingston, Louisiana

PREPARED BY: David Moore

QUALITY ASSURANCE: N/A

TECHNICAL DIRECTOR: D. A. McWilliam

PROJECT MANAGER: R. M. Bayley

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Ø	DM 9/30/96	RES 10/1/96	Initial release, DEO # 0282

PROCESS SYSTEMS INTERNATIONAL, INC.				SPECIFICATION	
INITIAL APPROVALS	PREPARED	DATE	APPROVED	DATE	Number A V049-2-143	Rev.
	DMoore	9/30/96	RES	10/1/96		Ø

Reference Drawings/Documents:

P&IDs: V049-0-006, Rev. 3

1.0 GENERAL DESCRIPTION

The 80K cryopumps are a part of the LIGO vacuum pumping subsystem. Together with the ion pumps, they are designed to provide "vibration-free" pumping during normal operation of the LIGO interferometer.

There are two types of 80K pumps: long and short. The long 80K pumps have a cylindrical cold surface (liquid nitrogen reservoir) 3.7 m long, and the short 80K pumps have a cold surface 1.2 m long. In all other respects, with the exception of minor structural details, they are identical.

Each pump is fed by a liquid nitrogen storage dewar. The dewar has been sized to provide sufficient liquid nitrogen for about 90 days of cryopump operation. A level control valve, located near the dewar senses the liquid level in the pump reservoir, and modulates to maintain the reservoir's liquid level. A manual bypass valve in parallel with, and located near the level control valve is used for cooldown of the pump to 80K.

When it becomes necessary to regenerate the cryopump (drive condensible gases off the pump's cold surface), liquid nitrogen from the dewar is vaporized and warmed up to near outside ambient air temperature in a vaporizer, and introduced into a heater which heats the gas up to the required regeneration temperature. Cryopump regeneration is recommended every 90 days during the first year of operation of the vacuum system. After that, operational experience with the vacuum system will dictate the frequency with which the pump is regenerated. Trending the rate of liquid nitrogen consumption will help in making that determination.

2.0 EQUIPMENT TAG NUMBERS

These operating procedures reference the instrument and equipment tag numbers for cryopump WCP1 (Washington corner station). Corresponding tag numbers for equipment performing the same functions at other stations on the interferometer may be found in Table 1 on P&ID V049-0-006.

3.0 UNIT START CONDITIONS

3.1 Prior to startup and cooldown of the cryopump, the following equipment states must exist:

- All valves must be aligned in the positions listed in Table I.
- Dewar pressure regulators must be adusted to give a pressure at the top of the dewar of 5 psig (PI105 reading).
- The regeneration heater must be off.

4.0 COOLDOWN

4.1 To cool down the pump to normal operating temperature, execute the following sequence of events:

4.1.1 Open the manual dewar liquid draw valve.

4.1.2 Partially open HV194. The valve should be open no more than about 10% initially to avoid shocking the pump reservoir.

4.1.3 Apply power to SM109, the GN2 vent heater. Except when the 80K pump has been warmed up and shut down, the vent heater must be left on at all times.

4.1.4 Observe the cooldown rate of the 80K pump by monitoring TI102. The pump should be allowed to cool down over a several hour period to maximize the structural life of the pump reservoir. The position of HV194 may be adjusted either further open or further closed during the cooldown as needed.

4.1.5 Close HV194 as the reservoir approaches 75% full and place LV100 in automatic level control mode with a set point of 93% full.

5.0 NORMAL OPERATION

5.1 When the 80K pump is in its normal operating mode, the equipment must be in the following states:

- All valves must be aligned according to Table II.
- The regeneration heater must be off.

In this state, the liquid level control valve will automatically maintain the level of liquid nitrogen in the cryopump reservoir.

6.0 SHORT PUMP REGENERATION

6.1 The purpose of this function is to drive accumulated condensibles off the surface of the pump reservoir surface. The buildup of these condensibles increases radiant heat loading on the reservoir, thereby increasing the rate at which liquid nitogen is consumed. The regeneration of the pump should be done with a heater blanket, as this prevents moisture driven off the pump reservoir from recondensing on the hot walls of the pump vacuum shell.

6.2 The procedure to regenerate the pump is as follows:

6.2.1 Attach the turbopump and its backing pump to the pumpout port on the cryopump. The backing pump should be used for pumpout of the moisture driven off the reservoir surface.

Note: The ballast valve on the backing pump must be opened to prevent water vapor from condensing in the backing pump. When this is done, activate the backing pump. Do not turn on the turbopump if the pressure in the 80K pump vacuum space is above 0.5 torr. Purge the intermediate vacuum header with N_2 to prevent condensation in the header.

6.2.2 Close the large gate valves on either end of the pump beam tube ports and padlock them. **Note: This is an extremely important step. The gate valves must be closed prior to proceeding with the pump regeneration.**

6.2.3 With the exception of the dewar liquid draw valve (V-15), which is left open, line up all valves in the Startup position (Table I).

6.2.4 Attach the heater blanket to the vacuum shell of the 80K pump including the vacuum gauge pair. (Remove electronics for gauge pair). Also attach heater blankets specifically designed for use on "other" side of gate valve to warm up valve gate.

6.2.5 Set the heater blanket temperature controls at 100 deg. C.

6.2.6 Open the regeneration vent valve (HV107) and the vaporizer feed valve (V-11).

6.2.7 Align valves acording to Table III. HV190 should be open last, opening it only enough to allow a flow rate of 50 grams/sec. This is done by observing the flowmeter, FI104.

6.2.8 Monitor the temperature rise in the reservoir via TI102. The temperature will not change until all of the liquid in the reservoir has been cleared. This will take about 1-1/2 hours.

6.2.9 When the reservoir temperature has risen to near that of the outdoor ambient (within 50^0C), set the controls on the heater blanket to 150 deg. C, set the controls (TIC103) on the regeneration heater to 150 deg. C, and activate the regeneration heater. (The regeneration heater setpoint may have to be set somewhat higher than this to overcome heat losses through the insulation.) This sequence of events completes the steps necessary to bring the cryopump to the regeneration temperature. The pump is estimated to require about 8 hours of total warmup time to 150 deg. C. The vacuum level in the 80K pump will determine how long the pump will need to be kept at this temperature. The flowrate may be reduced at this time to conserve liquid nitrogen.

6.2.10 Monitor flange annulus pressure on annulus ion pumps during warm-up. If ion pump trips, connect aux turbo cart to pump.

6.2.11 When the regeneration process is complete, (when the pressure at the vacuum pump is less than 1 x 10^{-4} torr) return all valves except the dewar liquid draw valve (V-15), to the positions indicated in Table I and shut off the regeneration heater.

7.0 LONG PUMP REGENERATION

7.1 The procedures to regenerate the long pump are identical to the short pump with the exception of the following:

- The liquid in the pump will take longer to vaporize - about 2.3 hours. Therefore the pump will remain at 80K for a longer time than the short pump.
- After the regeneration heater is reset to 150 deg. C, increase the flowrate in the regeneration line to 100 gm./sec. by further opening HV190 and adjusting the flowrate by observing FI104. This will allow a reasonably short warmup time. When the 80K pump reaches 150 deg. C, the flow may be reduced to conserve liquid nitrogen.

8.0 PUMP WARMUP

8.1 The procedure to warm up either the short or the long pump to room temperature are as follows:

8.1.1 With the exception of the dewar liquid draw valve (V-15), which is left open, line up all valves in the Startup position (Table I).

8.1.2 Close the large gate valves on either end of the pump beam tube ports and padlock them. **Note: This is an extremely important step. The gate valves must be closed prior to proceeding with the pump regeneration.**

8.1.3 Attach the turbopump and its backing pump to the pumpout port on the cryopump. The backing pump should be used for pumpout of the moisture driven off the reservoir surface.

Note: The ballast valve on the backing pump must be opened to prevent water vapor from condensing in the backing pump. When this is done, activate the backing pump. Do not turn on the turbopump if the pressure in the 80K pump vacuum space is above 0.5 torr.

8.1.4 Open the regeneration vent valve (HV107) and the vaporizer feed valve (V-11).

8.1.5 Align valves acording to Table III. HV190 should be open last, opening it only enough to allow a flow rate of 50 grams/sec. This is done by observing the flowmeter, FI104.

8.1.6 Monitor the temperature rise in the reservoir via TI102. The temperature will not change until all of the liquid in the reservoir has been cleared. This will take about 1-1/2 hours.

8.1.7 When the reservoir temperature has risen to near that of the outdoor ambient, set the regeneration heater controls (TIC103) to 20 deg. C and activate the regeneration heater. Hold the process in this state and monitor the pressure in the 80K pump annular vacuum space. The heater may be shut off and the valves may be returned to the positions listed in Table I with the exception of V-15, which may be left open, at any time that the vacuum level in the cryopump annular space reaches an acceptable level.

9.0 PUMP OFF

9.1 The pump may be considered to be in the off state under the following conditions:

- Valves are lined up according to Table I
- Power to the regeneration heater (TIC103) is off.
- Power to the vent heater (SM109) is off.

10.0 SAFETY

10.1 An alarm list with action to be taken is shown in Table III.

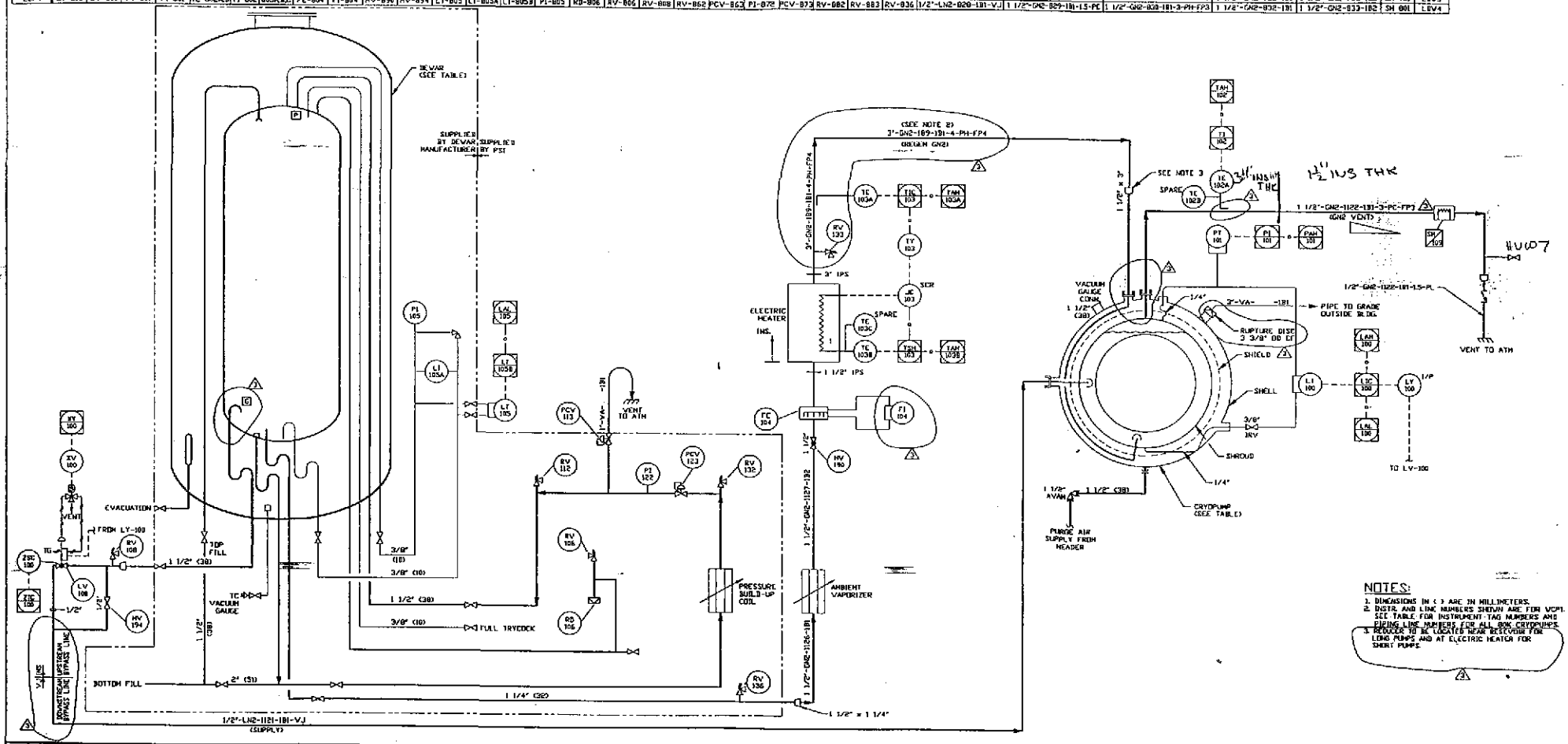
TABLE I

UNIT VALVE POSITIONS

FOR STARTUP

VALVE	MODE	POSITION	REMARKS
HV194	MANUAL	CLOSED	
V-15	MANUAL	CLOSED	DEWAR LIQUID DRAW VALVE
LV100	MANUAL	CLOSED	
HV190	MANUAL	CLOSED	
HV---	MANUAL	CLOSED	REGEN. VENT VALVE

CRYOPUMP						TEMP CONTROL																	LINE NO. LN2	LINE NO. GN2 VENT	LINE NO. REGEN GN2		LINE NO.	LINE NO.	VENT HEATER	DEVAR
VCP1	LT-100	LV-100	PT-101	PI-101	TE-102A,B	TI-102	102A,B,C	FE-104	FI-104	HV-190	HV-194	LT-105	LI-105A	LI-105B	PI-105	RD-106	RV-106	RV-108	RV-112	PCV-113	PI-122	PCV-123	RV-132	RV-133	RV-136	1/2"-LN2-1121-181-VJ	1/2"-GN2-1122-181-15-PC	3"-GN2-189-181-4-PH-FP4	1 1/2"-GN2-1126-181	1 1/2"-GN2-1127-182	SH 109	VBW1
VCP2	LI-150	LV-150	PT-151	PI-151	TE-152A,B	TI-152	152A,B,C	FE-154	FI-154	HV-192	HV-196	LT-155	LI-155A	LI-155B	PI-155	RD-156	RV-156	RV-158	RV-142	PCV-143	PI-172	PCV-173	RV-182	RV-183	RV-186	1/2"-LN2-1123-181-VJ	1/2"-GN2-1124-181-15-PC	3"-GN2-191-181-4-PH-FP4	1 1/2"-GN2-1129-181	1 1/2"-GN2-1130-182	SH 110	VBW2
VCP4	LI-250	LV-250	PT-251	PI-251	TE-252A,B	TI-252	252A,B,C	FE-254	FI-254	HV-892	HV-896	LT-855	LI-855A	LI-855B	PI-255	RD-256	RV-256	RV-258	RV-262	PCV-263	PI-272	PCV-273	RV-282	RV-283	RV-286	1/2"-LN2-234-181-VJ	1/2"-GN2-235-181-15-PC	1/2"-GN2-238-181-3-PH-FP3	1 1/2"-GN2-241-181	1 1/2"-GN2-242-182	SH 295	VBV3
VCP5	LT-300	LV-300	PT-301	PI-301	TE-302A,B	TI-302	302A,B,C	FE-304	FI-304	HV-390	HV-394	LT-305	LI-305A	LI-305B	PI-305	RD-306	RV-306	RV-308	RV-312	PCV-313	PI-322	PCV-323	RV-332	RV-333	RV-336	1/2"-LN2-334-181-VJ	1/2"-GN2-335-181-15-PC	1/2"-GN2-338-181-3-PH-FP3	1 1/2"-GN2-341-181	1 1/2"-GN2-342-182	SH 302	VBV4
VCP6	LT-350	LV-350	PT-351	PI-351	TE-352A,B	TI-352	352A,B,C	FE-354	FI-354	HV-392	HV-396	LT-355	LI-355A	LI-355B	PI-355	RD-356	RV-356	RV-358	RV-362	PCV-363	PI-372	PCV-373	RV-382	RV-383	RV-386	1/2"-LN2-336-181-VJ	1/2"-GN2-337-181-15-PC	1/2"-GN2-339-181-3-PH-FP3	1 1/2"-GN2-344-181	1 1/2"-GN2-345-182	SH 303	VBV5
VCP7	LT-400	LV-400	PT-401	PI-401	TE-402A,B	TI-402	402A,B,C	FE-404	FI-404	HV-490	HV-494	LT-405	LI-405A	LI-405B	PI-405	RD-406	RV-406	RV-408	RV-462	PCV-463	PI-472	PCV-473	RV-482	RV-483	RV-486	1/2"-LN2-427-181-VJ	1/2"-GN2-428-181-15-PC	1/2"-GN2-429-181-3-PH-FP3	1 1/2"-GN2-431-181	1 1/2"-GN2-432-182	SH 402	VBV7
VCP8	LT-500	LV-500	PT-501	PI-501	TE-502A,B	TI-502	502A,B,C	FE-504	FI-504	HV-590	HV-594	LT-505	LI-505A	LI-505B	PI-505	RD-506	RV-506	RV-508	RV-562	PCV-563	PI-572	PCV-573	RV-582	RV-583	RV-586	1/2"-LN2-527-181-VJ	1/2"-GN2-528-181-15-PC	1/2"-GN2-529-181-3-PH-FP3	1 1/2"-GN2-531-181	1 1/2"-GN2-532-182	SH 502	VBV8
LCP1	LT-600	LV-600	PT-601	PI-601	TE-602A,B	TI-602	602A,B,C	FE-604	FI-604	HV-690	HV-694	LT-605	LI-605A	LI-605B	PI-605	RD-606	RV-606	RV-608	RV-612	PCV-613	PI-622	PCV-623	RV-632	RV-633	RV-636	1/2"-LN2-684-181-VJ	1/2"-GN2-685-181-15-PC	3"-GN2-688-181-4-PH-FP4	1 1/2"-GN2-691-181	1 1/2"-GN2-692-182	SH 684	LBV1
LCP2	LT-650	LV-650	PT-651	PI-651	TE-652A,B	TI-652	652A,B,C	FE-654	FI-654	HV-692	HV-696	LT-655	LI-655A	LI-655B	PI-655	RD-656	RV-656	RV-658	RV-642	PCV-643	PI-678	PCV-673	RV-682	RV-683	RV-690	1/2"-LN2-686-181-VJ	1/2"-GN2-687-181-15-PC	3"-GN2-689-181-4-PH-FP4	1 1/2"-GN2-694-181	1 1/2"-GN2-695-182	SH 695	LBV2
LCP3	LT-700	LV-700	PT-701	PI-701	TE-702A,B	TI-702	702A,B,C	FE-704	FI-704	HV-790	HV-794	LT-705	LI-705A	LI-705B	PI-705	RD-706	RV-706	RV-708	RV-762	PCV-763	PI-772	PCV-773	RV-782	RV-783	RV-736	1/2"-LN2-728-181-VJ	1/2"-GN2-729-181-15-PC	1/2"-GN2-730-181-3-PH-FP3	1 1/2"-GN2-732-181	1 1/2"-GN2-733-182	SH 701	LBV3
LCP4	LT-800	LV-800	PT-801	PI-801	TE-802A,B	TI-802	802A,B,C	FE-804	FI-804	HV-890	HV-894	LT-805	LI-805A	LI-805B	PI-805	RD-806	RV-806	RV-808	RV-862	PCV-863	PI-872	PCV-873	RV-882	RV-883	RV-836	1/2"-LN2-828-181-VJ	1/2"-GN2-829-181-15-PC	1/2"-GN2-830-181-3-PH-FP3	1 1/2"-GN2-832-181	1 1/2"-GN2-833-182	SH 801	LBV4



NOTES:

1. DIMENSIONS IN ( ) ARE IN MILLIMETERS.
2. DEVAR AND LINE NUMBERS SHOWN ARE FOR VCP1. SEE TABLE FOR INSTRUMENT TAG NUMBERS AND PIPING LINE NUMBERS FOR ALL 80K CRYOPUMPS.
3. REGEN TO BE LOCATED NEAR RECEIVER FOR LONG PUMPS AND AT ELECTRIC HEATER FOR SHORT PUMPS.

DWG. NO.	DESCRIPTION	DWG. NO.	DESCRIPTION
V049-0-001	P & ID LEGEND		

REFERENCE DRAWINGS

DEVIATE UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES:
FRACTIONAL ±
UNBALANCED MACHINED SURFACES
TWO PLACE DECIMAL ± .01
THREE PLACE DECIMAL ± .005
FINISHED SURFACE ONLY
BREAK CORNERS
REMOVE ALL BURRS

DO NOT SCALE THIS DRAWING

USED ON

NEXT ASSY

REV	DESCRIPTION									
3	ISSUE FOR FIR UPDATE									
2	REVISED FOR DEVAR PURCHASE	REB		BH			RJW	03.29.96	0188	
1	ISSUE FOR FIR	REB	RT	BH	TS	DMCV	RJW	04.26.96	0134	
0	ISSUE FOR DESIGN				BH	DMCV	RJW	03.07.96	0083	
P2	REVISED	REB	RT	BH	TS	DMCV	RJW	01.05.96	0032	
P1	PRELIMINARY DESIGN UPDATE	REB					KY	09.26.95	0003	
REV	DESCRIPTION					CHKD	DRVN	DATE	DES#	

ISSUE DESCRIPTION

PROCESS SYSTEMS INTERNATIONAL INC.
20 WALKUP DR. WESTBOROUGH, MASSACHUSETTS 01581 USA

PIPING & INSTRUMENTATION DIAGRAM
LIGO VACUUM EQUIPMENT
80K CRYOPUMP

CAD FILE	SIZE	DWG. NO.	REV.
V049D006	D	V049-0-006	3
SCALE: NONE		SHEET 1 OF 1	